

# Electromyographic Analysis of Forearm Muscles During Karate Punching With and Without Rigid Wrist Taping

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## ABSTRACT

**Background:** Wrist taping has been widely used in combat sports to prevent injuries; however, its effects on neuromuscular function during punching remain unclear. Understanding how taping influences forearm muscle activity can provide valuable insights into trauma prophylaxis and performance enhancement. We aimed to investigate the impact of rigid wrist taping on forearm muscle activity during punching movements. A total of 26 healthy male university students were included and divided into two punching task condition groups: with wrist taping (tape) and without taping (no-tape).

**Methods:** Surface electromyography recordings from the flexor carpi radialis (FCR), extensor carpi radialis (ECR), and extensor carpi ulnaris (ECU) were analysed, after which muscle activity was evaluated in pre- and post-impact phases. Subjective ease of punching and perceived impact were also assessed using a numerical rating scale.

**Results:** No significant differences in muscle activity were found between the conditions during the pre-impact phase. In contrast, during the post-impact phase, FCR activity was significantly more pronounced in the tape condition than in the no-tape condition ( $p < 0.05$ ). Both conditions showed greater muscle activity in all muscles during the post-impact phase than during the pre-impact phase ( $p < 0.05$ ). Subjective ratings indicated greater ease of punching and higher perceived impact in the tape condition ( $p < 0.01$ ).

**Conclusion:** Rigid wrist taping improves forearm muscle activity, particularly FCR, during the impact phase of punching. This effect may be mediated by increased proprioceptive input and joint stiffness, which facilitates force transmission and punching performance.

**Keywords:** Electromyography, wrist joint, injury prevention, sports

## 1. INTRODUCTION

Karate is a martial art and competitive sport characterised by controlling an opponent primarily through striking techniques, such as punches, strikes, and kicks, using all four limbs without the use of weapons. The number of practitioners has been increasing worldwide, and the sport has become widely disseminated internationally. However, epidemiological studies and systematic reviews have reported relatively

high incidence rates of injuries during both karate competitions and training (Thomas & Ornstein, 2018). These studies have indicated that karate injuries occur regardless of sex or age (Thomas & Ornstein, 2018) and are frequently observed not only during competition but also during routine training settings (Kiehl et al., 2025). Regarding injury location, previous studies have shown that injuries most frequently occur in the head/neck and lower



extremities, although a considerable proportion also affects the upper extremities (Čierna & Lystad, 2017). In particular, studies examining the causes and mechanisms of injuries have demonstrated that punching actions more frequently promote injuries than do kicking actions (Čierna & Lystad, 2017; Rahimi et al., 2012).

Punching movements in combat sports can be broadly classified into four types: jab, straight, hook, and uppercut, all of which involve high-speed and high-load actions. During all such movements, small joint moments (rotational forces) are consistently generated at the wrist regardless of skill level. Consequently, a substantial portion of the produced energy is absorbed by upper limb movements. Therefore, when an individual strikes a target, insufficient muscular support or poor alignment of the wrist can disrupt the kinetic chain of force transmission (Walilko et al., 2005). Furthermore, effective punching requires full elbow extension by the triceps brachii and wrist stabilisation with assistance from the extensor carpi radialis (ECR), which together ensure accurate force delivery at impact (Csákvári et al., 2025). These findings suggest that the mechanical load imposed on the upper extremity during this type of movement can increase injury risk. As force generated in the trunk and proximal upper limb is transmitted distally to the wrist, impact and reaction tend to concentrate on the wrist and forearm, making these regions particularly susceptible to high mechanical stress. During full-contact karate, in particular, the effectiveness of an attack largely depends on the force of the strike, which places repeated high mechanical loads on the wrist joint. Against this background, wrist taping has been commonly used as a preventive measure to reduce the risk of wrist injuries.

Taping materials, such as rigid tape (RT) and kinesiology tape (KT), have been commonly used in clinical and sports settings. RT is primarily used to restrict movement and excessive joint range of motion, thereby protecting injured tissues and stabilising joints and muscles (Daikuya & Okayama, 2025; Szeles & Green, 2025a). In contrast, KT is applied to facilitate circulation, reduce pain, enhance proprioception, and support muscles and joints (Li et al., 2022; Sarvestan et al., 2020). Thus, taping is generally used for the management and prophylaxis of injuries. In sports settings, however, it is sometimes applied even in the absence of a visible injury to enhance performance. Previous studies examining the effects of taping on performance have demonstrated that applying an RT to the wrist

increases arm swing velocity during running, whereas applying it to the ankle improves balance performance (Gao et al., 2023; Okayama & Hamamura, 2023). Furthermore, previous studies have shown that applying a KT to the forearm increases range of motion during throwing tasks, whereas applying it from the anterior inferior iliac spine to the tibial anterior tuberosity improves performance during drop jump landing (Oruk et al., 2023; Szeles & Green, 2025b). A systematic review examining studies employing rigid and elastic tapes, including a KT, also found that taping was associated with improvements in performance (Lau & Cheng, 2019). Beyond these changes in physical function, taping has also been reported to alleviate psychological anxiety in athletes (Sawkins et al., 2007). However, some studies have failed to demonstrate improvements in performance (Annino et al., 2022), with others suggesting that taping does not provide sufficient protective effects against injuries (Korkusuz et al., 2022).

As described earlier, wrist taping has been commonly used during punching movements to prevent injury. However, studies directly analysing the effects of wrist taping during punching have been limited. Previous research has demonstrated that wrist taping restricts wrist joint range of motion (Okayama & Hamamura, 2023). Furthermore, the use of RT combined with bandaging techniques has been shown to reduce wrist range of motion during punching movements (Gatt et al., 2023). Moreover, comparative analyses of wrist range of motion during static conditions and at the moment of impact have revealed a smaller range of motion during the latter. This reduction is considered to result from not only the mechanical restriction provided by bandaging and RT but also active neuromuscular control of the wrist (Gatt et al., 2023). However, enhancing mechanical fixation has been shown to decrease the difference between the wrist range of motion in static conditions and at the moment of impact, suggesting that active control may become less necessary (Gatt et al., 2023). Based on these findings, forearm muscle activation is required when mechanical stabilisation is insufficient. In practical settings, such as karate, complete wrist immobilisation is not feasible; therefore, the role of the forearm musculature becomes particularly important. Accordingly, the effects of wrist taping are likely to be reflected in forearm muscle activity, which directly contributes to joint control. However, the effects of wrist taping on forearm muscle activity during punching movements remains incompletely understood. Understanding the relationship

between taping and the activity dynamics of the forearm muscles that support the wrist is important to elucidate the mechanisms of wrist injury and develop preventive strategies. Therefore, this study primarily aimed to evaluate forearm muscle activity during punching and determine the effects of wrist taping with an RT on these activities.

## 2. METHODS

### Participants

A total of 26 healthy male university students with no upper or lower limb disorders or injuries in medical anamnesis participated in this study. Participant characteristics (mean  $\pm$  standard deviation) were as follows: age,  $20.2 \pm 0.4$  years (range: 20–21 years); height,  $170.3 \pm 5.2$  cm (range: 160.0–180.0 cm); and body mass,  $62.2 \pm 7.8$  kg (range: 48.0–76.0 kg). This study was approved by the Ethical Review Committee of Osaka University of Human Sciences regarding Research on Human Subjects (Approval No. 2022-4). All participants were provided with a full explanation of the study and subsequently provided informed consent prior to participation. Sample size was calculated using G\*Power software (version 3.1.9.6) and was based on a t-test using data from a preliminary experiment. The effect size was estimated to be 0.75–0.9, with an alpha level of 0.05, statistical power of 0.9, and an anticipated dropout rate of 20%. Based on these parameters, we determined that a sample size of 20–26 participants would be required.

### Protocol

Participants performed punching movements using their dominant upper limb, during which surface electromyography (EMG) of the forearm muscles was performed. Prior to data collection, an experienced karate practitioner provided instructions on proper punching technique and key

precautions. Participants performed punching under two conditions: with wrist taping (tape group), applied according to the previously depicted method (Constantinou & Brown, 2010), and without taping (no-tape group). Each condition was simulated twice, resulting in a total of four trials.

### Experimental setup

The starting position was a fighting stance (*ku-mite-dachi*, a Japanese karate fighting stance), with the lower limb opposite to the dominant upper limb placed forward. To ensure consistency across trials, markers were placed on the floor to ensure that all measurements were performed in the same stance.

Participants were instructed to strike a target mark on a focus mitt (*RYUJIN Punching Mitt*, *RYUJIN Co., Ltd., Kanagawa, Japan*). A 30-s rest interval was incorporated between trials. A male practitioner with 12 years of karate experience who had previously won a national championship held the mitt at chest level and received all punches from the participants. The target mark on the mitt was positioned at the height corresponding to 90° of shoulder flexion of each participant.

### Taping procedure

The RT (*Battlewin non-elastic tape*, 38 mm; *Nichiban Co., Ltd., Tokyo, Japan*) was used for wrist taping. Using the styloid processes at the distal forearm of the dominant wrist as anatomical landmarks, the tape was fixed in a neutral wrist position (midway between flexion and extension), wrapping twice from the radial to the ulnar side across the dorsal aspect.

Care was taken to avoid excessive compression. Moreover, the tape was applied while ensuring that the participant perceived an appropriate level of stability (Figure 1).

Figure 1. Application of a wrist taping technique



**Note:** Application of the rigid wrist taping. The non-elastic tape is wrapped circumferentially twice around the distal forearm over the styloid processes, creating a secure band from the radial to the ulnar side.

### EMG measurement

Surface EMG was recorded using a Clinical DTS system (Noraxon USA Inc., Scottsdale, AZ, USA), and synchronised video recordings were obtained simultaneously. The muscles examined were the flexor carpi radialis (FCR), ECR, and extensor carpi ulnaris (ECU) on the punching side. After appropriate skin preparation, electrodes were placed parallel to the fibre orientation of each muscle in accordance with the SENIAM recommendations and previous studies (SENIAM) (Ahmad & Chappell, 2009; Pan et al., 2022; Robinson et al., 2023). The inter-electrode distance was set at 20 mm. EMG data were recorded at a sampling frequency of 1 kHz. Signal processing was performed using MyoResearch software (Noraxon USA Inc., Scottsdale, AZ, USA), with a band-pass filter set between 10 and 500 Hz. The raw EMG signals were full-wave rectified, and the integrated EMG (IEMG) was calculated. IEMG values were normalised to those obtained from the same muscles during quiet standing. Specifically, the IEMG recorded during each punching phase was divided by the corresponding IEMG obtained during quiet standing, and the resulting values were expressed as ratios relative to quiet standing. For normalisation, a 5-s segment with the most stable signal was selected from a 10-s quiet standing recording. The punching movement was divided into two phases using synchronised video recordings obtained through the Noraxon system. The onset of trunk rotation was visually identified from the video and defined as the

start of the pre-impact phase. The first video frame showing contact between the fist and the focus mitt was defined as the impact event. The pre-impact phase was defined as the period from the onset of trunk rotation to the impact event. The post-impact phase was defined as the period from the impact event to the frame showing maximum deformation of the focus mitt.

### Outcome measures

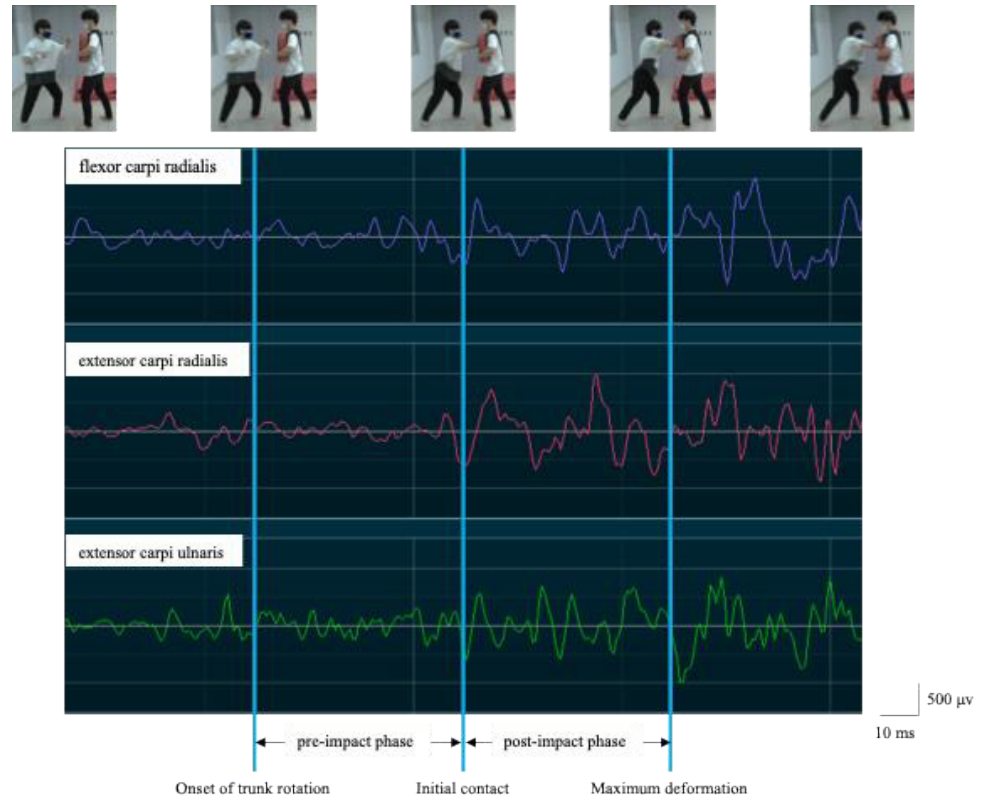
After completing the task, participants rated the ease of performing the punching movement under each condition using an 11-point numerical rating scale (NRS; 0 = *extremely difficult*, 10 = *extremely easy*). Furthermore, the receiver evaluated the impact force of the participants' punches under each condition using the same scale (0 = *extremely weak*, 10 = *extremely strong*). The NRS has been widely used as a valid and reliable measure of subjective perception (Hawker et al., 2011).

### Statistical analysis

For statistical analysis, the normality of data distribution was assessed using the Shapiro–Wilk Test prior to inferential testing. Differences in muscle activity among taping conditions and movement phases, as well as differences in subjective evaluations, were analysed using the Wilcoxon Signed-Rank Test.

Statistical significance was set at 5%. All analyses were conducted using SPSS Statistics for Windows, version 28.0 (IBM Corp., Armonk, NY, USA).

Figure 2. Representative synchronised video frames and raw electromyography (EMG) signals illustrating the phase division procedure during a punch



**Notes:** The vertical lines define the boundaries for the pre-impact and post-impact phases based on synchronised video recordings: the first line indicates the onset of trunk rotation, the second line marks the initial contact of the fist with the focus mitt, and the third line corresponds to the maximum deformation of the mitt. The three continuous waveforms represent the raw EMG signals recorded simultaneously from the forearm muscles.

### 3. RESULTS

The measurement outcomes are presented in Tables 1–3. In comparisons between conditions, muscle activity values for the FCR, ECU, or ECR did not differ significantly during the pre-impact phase. In contrast, no significant differences in ECU or ECR activity were found during the post-impact phase; however, FCR activity was significantly higher in the tape condition than in the no-tape condition ( $p < 0.05$ ). In comparisons between phases, both conditions showed significantly higher FCR, ECU, and ECR activity in the post-impact phase than in the pre-impact phase ( $p < 0.05$ ).

Regarding the ease of performing the punching movement, participants rated the tape condition significantly higher than the no-tape condition on the 11-point numerical rating scale (0 = *extremely difficult*, 10 = *extremely easy*;  $p < 0.01$ ). Of the 26 participants, 25 reported that punching was easier with taping, citing greater force generation and a greater sense of stability, whereas one participant reported a feeling of compression with taping. Similarly, receiver-rated punch impact force scores were significantly higher in the tape condition than in the no-tape condition on the same scale (0 = *extremely weak*, 10 = *extremely strong*;  $p < 0.01$ ).

Table 1. Comparison of normalised IEMG values of the forearm muscles under different taping conditions ( $N = 26$ )

|     | Pre-Impact Phase       |                       |        |         | Post-Impact Phase      |                        |        |         |
|-----|------------------------|-----------------------|--------|---------|------------------------|------------------------|--------|---------|
|     | Tape                   | No-Tape               | Z      | P-Value | Tape                   | No-Tape                | Z      | P-Value |
| FCR | 20.65<br>(12.30–36.23) | 22.65<br>(9.53–41.48) | −0.041 | 0.967   | 35.30<br>(18.30–68.05) | 34.75<br>(18.15–61.33) | −0.127 | 0.899   |
| ECR | 13.70<br>(8.03–30.65)  | 13.95<br>(6.65–26.58) | −0.211 | 0.833   | 22.50<br>(11.78–54.08) | 14.85<br>(7.48–34.48)  | −1.480 | 0.139   |
| ECU | 18.05<br>(10.13–51.28) | 19.05<br>(8.30–37.35) | −1.562 | 0.118   | 37.75<br>(16.48–62.08) | 27.55<br>(10.63–56.83) | −2.769 | 0.006   |

**Notes:** FCR, flexor carpi radialis; ECR, extensor carpi radialis; ECU, extensor carpi ulnaris. Data are presented as median and interquartile range (IQR) of normalised IEMG values. Normalised IEMG values were calculated by dividing the IEMG recorded during punching by the corresponding IEMG obtained during quiet standing. Comparisons between the tape and no-tape conditions were performed using the Wilcoxon Signed-Rank Test.

Table 2. Comparison of normalised IEMG values of the forearm muscles across different movement phases ( $N = 26$ )

|     | Tape                   |                        |        |         | No-Tape               |                        |        |         |
|-----|------------------------|------------------------|--------|---------|-----------------------|------------------------|--------|---------|
|     | Pre-Impact Phase       | Post-Impact Phase      | Z      | P-Value | Pre-Impact Phase      | Post-Impact Phase      | Z      | P-Value |
| FCR | 20.65<br>(12.30–36.23) | 35.30<br>(18.30–68.05) | −5.081 | <0.001  | 22.65<br>(9.53–41.48) | 34.75<br>(18.15–61.33) | −4.977 | <0.001  |
| ECR | 13.70<br>(8.03–30.65)  | 22.50<br>(11.78–54.08) | −4.321 | <0.001  | 13.95<br>(6.65–26.58) | 14.85<br>(7.48–34.48)  | −2.432 | 0.015   |
| ECU | 18.05<br>(10.13–51.28) | 37.75<br>(16.48–62.08) | −3.861 | <0.001  | 19.05<br>(8.30–37.35) | 27.55<br>(10.63–56.83) | −2.189 | 0.029   |

**Notes:** FCR, flexor carpi radialis; ECR, extensor carpi radialis; ECU, extensor carpi ulnaris. Data are presented as median and interquartile range (IQR) of normalised IEMG values. Normalised IEMG values were calculated by dividing the IEMG recorded during punching by the corresponding IEMG obtained during quiet standing. Comparisons between the pre-impact and post-impact phases were performed using the Wilcoxon Signed-Rank Test.

Table 3. Comparison of numerical rating scale scores under different taping conditions

|             | Tape                | No-Tape             | Z      | P-Value |
|-------------|---------------------|---------------------|--------|---------|
| Participant | 2.00<br>(1.25–3.00) | 0.00<br>(0.00–2.00) | −5.586 | <0.001  |
| Pad holder  | 3.00<br>(2.00–3.00) | 0.00<br>(0.00–1.00) | −6.108 | <0.001  |

**Notes:** Data are presented as median and interquartile range (IQR). Ease of punching was rated by the participants using an 11-point numerical rating scale (0 = *extremely difficult*, 10 = *extremely easy*). Impact force was rated by the receiver using the same scale (0 = *extremely weak*, 10 = *extremely strong*). Comparisons between the tape and no-tape conditions were performed using the Wilcoxon Signed-Rank Test.

#### 4. DISCUSSION

The current study primarily aimed to measure forearm muscle activity during punching movements and clarify the effects of wrist taping with an RT on forearm muscle activity. Our results revealed no significant differences in FCR, ECU, or ECR activity during the pre-impact phase between the tape and no-tape conditions. In contrast, during the post-impact phase, FCR activity was significantly higher in the tape condition than in the no-tape one. When comparing phase outcomes, both the tape and no-tape conditions demonstrated significantly higher muscle activity in all measured muscles during the post-impact phase than during the pre-impact phase. Subjective evaluations indicated that participants found punching easier under the tape condition than under the no-tape condition. Additionally, the receiver perceived greater impact force in the former than in the latter. These findings suggest that wrist taping with an RT can enhance the activity of forearm muscles, contributing to wrist stability, particularly in the FCR, during the impact phase of punching. Although taping likely improved wrist stability, the observed increase in muscle activity may be attributed to not only enhanced stability but also increased punching force or changes in the effective attachment or mechanical leverage of forearm muscles. In the current study, the higher muscle activity detected in the tape condition during the post-impact phase may be explained by the enhanced proprioceptive input resulting from the stimulation of cutaneous receptors and muscle spindles (Macefield et al., 2016; Riemann & Lephart, 2002). Applying an RT circumferentially around the wrist may have transmitted rapid joint displacement at impact to sensory receptors as cutaneous stretch and pressure. Consequently, greater afferent information related to the wrist may have been available in the tape condition than in the no-tape condition, potentially facilitating reflexive muscle activation and enhancing neuromuscular responses, as previously reported following adhesive taping interventions (Lohrer et al., 1999).

Previous studies have described the role of the interosseous membrane between the radius and ulna, as well as the stability and congruency of joints. Arimitsu et al. (2011) demonstrated that a specific portion of the interosseous membrane, namely the distal oblique bundle, functions to connect the radius and ulna, restrict joint play, and enhance stability. Olerud et al. (1988) reported that joint congruency is influenced by ligament

attachment sites, indicating that physical structures promote joint stability. Wrist taping may mechanically restrict excessive motion around the distal radioulnar joint, potentially contributing to greater joint stability and congruency. Consequently, instability of the rotational axis during forearm pronation–supination can be minimised, which may facilitate more efficient muscle activation. Furthermore, enhanced joint congruency can potentially increase wrist stiffness, thereby allowing force generated in the forearm to be transmitted to the fist with less energy loss, as efficient force transmission through the wrist is strongly influenced by joint alignment and mechanical stability (Polovinets et al., 2018). During punching, the wrist is displaced towards palmar flexion and ulnar deviation (Gatt et al., 2024). The higher FCR activity observed in the tape condition than in the no-tape condition during the post-impact phase can be explained by the role of the FCR as a primary muscle resisting these movements. Therefore, the FCR activation may have been the strongest indicator of the supportive effect of taping.

Compared to the pre-impact phase, both flexor and extensor muscle activities were increased during the post-impact phase regardless of the taping condition. This finding may be attributed to the external force at impact acting as a stretch stimulus to the tissues, potentially eliciting long-latency reflexes, followed by co-contraction of the involved muscles (Basmajian & De Luca, 1985; Shemmell et al., 2010). These reflex responses may have increased wrist stiffness. Notably, this response was more pronounced under the taping condition than under the no-taping condition. This finding may be explained by the enhanced transmission of joint displacement at impact to muscle spindles with rigid taping, which may have facilitated stronger co-contraction (Riemann & Lephart, 2002). These findings suggest that taping can amplify neuromuscular responses. The subjective findings, namely improved ease of punching for participants and increased perceived impact by the receiver, are also noteworthy and may be explained by enhanced wrist stability due to taping, which likely reduced participants' anxiety regarding the potential wrist injury (Sawkins et al., 2007), thereby enabling punches with greater acceleration. In other words, taping not only provides mechanical stabilisation of the wrist but may also enhance dynamic support through increased neuromuscular activation of the forearm muscles (Lohrer et al., 1999). Thus, the efficiency of force transmission during impact

may have improved. When the wrist is unstable, a portion of the punching force is dissipated through joint displacement. The synergistic effect of taping and increased muscle activity likely increased wrist stiffness, allowing more efficient transmission of the force to the mitt. The findings of the current study suggest that wrist taping in combat sports can not only provide mechanical stabilisation but also improve the quality of punching performance. In particular, increased FCR activity during the impact phase under rigid taping may have played a crucial role in stiffening the wrist and minimising energy loss during punching.

Clinically, these results indicate that taping for athletes with wrist concerns can serve not only as a physical support but also as a source of psychological reassurance and a facilitator of effective muscle contraction. Consequently, this can be a useful strategy for the prophylaxis of chronic wrist pain and maintaining performance during return-to-sport phases. Future studies should examine different levels of expertise and types of punches and incorporate multimodal assessments, such as ultrasonography and motion analysis. This would enable simultaneous evaluation of movement patterns, speed, changes in the wrist joint space during impact, and muscle activity. Such approaches can also provide deeper insights into punching techniques that minimise wrist stress and optimise efficient force transmission.

The results of this study revealed that wrist taping using an RT significantly increased the activity of the FCR immediately after impact during punching. This change can be attributed to the enhanced proprioceptive input and increased joint stiffness induced by taping, which likely improved muscle responsiveness. Furthermore, the observed improvements in the subjective ease of punching and increased perceived impact by the receiver suggest that taping can be employed not only as a protective measure for the wrist but also as an effective strategy for optimising performance. However, one participant reported a sensation of compression associated with taping. Therefore, in practical applications, it is important to consider individual subjective responses when taping is applied.

### Limitations

This research has some limitations. First, the experiment was conducted as a single task in a controlled environment, which does not reflect sport-specific situations involving interpersonal interaction or continuous movements. Moreover, it

remains unclear whether the observed increase in muscle activity represents an efficient force transmission or a compensatory contraction. Second, variations in taping materials and application techniques were not examined. Although an RT was utilised in this study, different materials, such as elastic tape or bandaging alone, may have altered cutaneous receptor stimulation and joint stabilisation, potentially influencing muscle activity. In addition, the latter was assessed with surface EMG, which does not allow the evaluation of deep muscle activity, intermuscular coordination, or intra-articular dynamics. The potential impact of crosstalk cannot be completely excluded. Third, the participants were healthy young men, which limits the generalisability of the findings to populations with different skill levels, sexes, and ages. In particular, the results may differ in skilled athletes. Fourth, the effects of long-term taping use, repetitive movements, and muscle fatigue were not investigated. In real competition conditions, repeated punching is likely to induce fatigue in forearm muscles; however, the measurements in this study were obtained under non-fatigued conditions. Whether taping can compensate for fatigue-related declines in muscle activity remains to be determined. Fifth, the mechanical characteristics of punching (e.g. fist velocity, acceleration, and impact force) were not directly measured; therefore, the relationship between muscle activity and performance was evaluated only indirectly. Finally, although the subjective assessment with NRS reflects psychological factors, it may be influenced by placebo or expectation effects.

## 5. CONCLUSIONS

This study investigated the effects of wrist taping with an RT on forearm muscle activity during punching movements. The results demonstrated that in the post-impact phase immediately after a contact, taping significantly facilitated muscle activity, particularly in the FCR. This increase in muscle activity can be attributed to enhanced congruency of a distal radioulnar joint and augmented afferent input from sensory receptors, leading to long-latency reflexes and subsequent co-contraction. These mechanisms likely contributed to increased wrist stiffness, thereby minimising energy loss at impact and improving subjective ease of punching, as well as the efficiency of a force transmission. These findings suggest that wrist taping not only provides mechanical stabilisation but also optimises protective neuromuscular responses, potentially contributing

to performance enhancement. Future studies should examine its effectiveness under fatigued conditions and across different levels of athletic performance to establish evidence-based taping strategies that balance injury prevention and performance optimisation.

**Author Contributions:** Conceptualisation, Y.O. and S.Y.; methodology, Y.O. and S.Y.; validation, Y.O.; resources, Y.O. and S.Y.; data curation, Y.O. and S.Y.; writing—original draft preparation, Y.O.; writing—review and editing, S.Y.; supervision, S.D.; project administration, S.D. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

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

**Ethical Approval:** This study was approved by the Research Ethics Committee for Human Subjects at Osaka University of Human Sciences (Approval No. 2022-5).

**Acknowledgements:** The authors of this study are thankful to students who volunteered to participate in the investigation.

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

**Data Availability Statement:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

**AI Use Statement:** No generative AI and AI-assisted technologies were used in the research or the drafting of the manuscript.

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Received on May 16, 2026  
Accepted on June 29, 2026