

Effect of Stabilizing Reversal Technique of Proprioceptive Neuromuscular Facilitation and Taping Convergence on Wrist Pain and Grip Strength

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고유수용성신경근촉진법의 안정적 반전기법과 테이핑 융합이 손목통증과 악력에 미치는 영향

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Abstract This study investigated the effect of wrist taping (WT) after application of stabilizing reversal technique (SRT) of proprioceptive neuromuscular facilitation (PNF) on pain and grip strength (GS) in patients with wrist pain (WP). Twenty patients with WP were randomly assigned to an experimental group (n=10) that received WT after application of SRT, and a control group (n=10) that received WT after application of stretching. The total intervention time consisted of a maximum of 10 minutes including breaks, and was performed 5 times a week for 2 weeks. Pain reduction was measured using a visual analogue scale. GS was measured using a dynamometer. Within group changes in pain and GS were significant in both experimental and control groups ($p<0.01$). Between group changes in pain and GS were greater in the experimental group than in the control group ($p<0.01$). This findings indicate that SRT of PNF and WT convergence can be an effective intervention for patients with WP. Continued development of convergence interventions for patients with WP various conditions in practice, is suggested.

Key Words : Grip strength, Proprioceptive neuromuscular facilitation, Stabilizing reversal technique, Taping, Wrist pain

요 약 본 연구의 목적은 고유수용성신경근촉진법의 안정적 반전기법 후에 손목테이핑 적용이 손목통증환자의 통증과 악력에 미치는 영향을 융복합적으로 알아보기 위해 실시하였다. 손목통증환자 20명을 대상으로 안정적 반전기법 후에 손목 테이핑을 적용한 실험군(n=10)과 스트레칭 후에 손목테이핑을 적용한 대조군(n=10)으로 무작위 배정하였다. 전체 중재시간은 휴식시간 포함 최대 10분으로 구성, 주 5회 2주간 시행하였다. 통증정도는 시각적상사척도로 측정하였고, 악력은 악력계로 측정하였다. 중재결과, 집단 내 통증과 악력은 두 군 모두 유의한 변화가 있었고($p<0.01$), 집단 간 통증과 악력은 실험군이 대조군보다 효과적인 통증의 감소와 악력의 향상을 보였다($p<0.01$). 그러므로 고유수용성신경근촉진법의 안정적 반전기법과 손목테이핑 융합은 손목통증환자를 위한 효과적인 중재로 활용될 수 있으며, 다양한 손목통증환자를 위한 지속적인 융합중재개발이 요구된다.

주제어 : 악력, 고유수용성신경근촉진법, 안정적 반전기법, 테이핑, 손목통증

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1. Introduction

Musculoskeletal impairment results from pain in the neck, shoulder, elbow, wrist, low back, pelvis, knee, and ankle is due to accumulation of injuries to muscles, bones, joints, ligaments, and nerves. Insufficient rest and application of excessive force with incorrect posture ultimately lead to impairment and pain [1]. Overuse injury is the result of direct or indirect effects on microvascular structures. In combination with tissue oxygen deficits, these injuries cause microdamage to collagen tissue during supramaximal exertion. Wrist overuse syndrome due to sports participation is very common. Overuse is the cause of injury in 20% to 50% of athletes [2], and is common in racket sports (e.g., badminton and tennis), rowing, volleyball, handball, and gymnastics [3]. About 25% of all sports-related injuries occur in the fingers or wrists [4]. The most common result of wrist overuse is increased pain and muscle weakness due to sprain injury in 89.1% of cases [5,6].

In a study on patients with wrist pain (WP), Michlovitz et al. [7] were able to reduce pain and improve grip strength (GS) using continuous, low-level heat-wrap therapy. Choung et al. [8] were able to reduce pain and improve range of motion using self-mobilization with a strap. Hincapie et al. [9] were able to reduce pain in patients with chronic WP and improve neuromuscular control and functional outcomes following ligament injuries using proprioceptive realization and joint position sense retraining.

Proprioceptive neuromuscular facilitation (PNF) as a physical therapy technique can improve function by stimulating proprioceptive sense in muscles, tendons, ligaments, and joints [10]. PNF increases muscle strength, flexibility, and balance [11], and improves physical and motor function [12-14]. PNF is widely used for treatment of muscle, bone, and joint disorders, as well as central nervous system disorders following stroke [15-17]. Among PNF techniques, the stabilizing reversal technique (SRT) is based on Sherrington's principle of successive induction. SRT induces alternate

or co-contraction of agonists and antagonists without triggering motion or movement against resistance. SRT is used to reduce pain caused by joint instability [18]. Sports taping (ST) can also stimulate proprioceptive sense, and promotes reattachment after muscle elongation [19]. On review of previous studies, Lee et al. [20] suggested that ST may reduce pain and improve GS in patients with thumb metacarpophalangeal injuries. Park and Kim [21] showed improved GS and muscle activity with ST in adult women with lateral epicondylitis. Shamsoddini and Hollisaz [22] showed reduced pain and improved GS with ST in patients with tennis elbow. Kim and Kim [23] showed improvement in GS with application of ST to wrist extensor muscles in normal adults.

Accordingly, ST is considered useful for pain reduction and improvement in range of motion, strength, and muscle activity. Therefore, ST can be used for treatment of wrist pain and impaired GS. Most previous studies assessed ST for elbow pain, with few examining its use for the wrist. There are no reports of PNF treatment technique for the wrist. Therefore, this study aimed to provide basic data by investigating the effect of wrist taping (WT) after application of SRT of PNF on wrist pain and GS.

2. Materials and Methods

2.1 Participants

G-power software was used for the power analysis (G-Power software 3.1.2; Franz Faul, University of Kiel, Kiel, Germany). Data obtained from a pilot study involving three subjects from each group showed that a sample size of 8 subjects per group was required to achieve a power of 0.97 and an effect size of 2.04 at an α level of 0.05.

This study was conducted for 2 weeks from November to December, 2017 in 20 participants from the D hospital badminton club in J city. The subjects who consented to participate following explanation of

the study were randomly assigned to an experimental group (n=10) that received WT after application of SRT of PNF and a control group (n=10) that received WT after application of stretching. The study was approved by the Institutional Review Board of the Sahmyook University (IRB No. 2-1040781-AB-N-01-2017113HR) in Seoul.

The inclusion criteria for participation were: (1) persistent symptoms for more than 3 months; (2) tenderness and pain around the wrist; (3) a positive Shuck test, with painful resistance to finger extension [24]; and (4) a positive sitting hands test, with wrist pain when pushing off the armrests of a chair to suspend the body using only the hands for support [25]. Patients were excluded for the following: (1) past history of arm fracture; (2) wrist osteoarthritis; or (3) oral administration or injection of anti-inflammatory agents to reduce wrist pain. Table 1 summarizes patient data.

Table 1. General patient characteristics

Variables	Experimental (n=10)	Control (n=10)	p
Sex (male/female)	3/7	3/7	1.000
Age (y)	30.30±2.26	30.50±2.37	0.453
Height (cm)	167.30±9.03	167.10±8.50	0.511
Body weight (kg)	61.70±13.09	62.10±11.62	0.072
Body mass index (kg/cm ²)	21.84±2.61	22.14±2.91	0.356
Affected side (right/left)	9/1	9/1	1.000

Values are presented as mean±standard deviation.

2.2 Outcome Measurements

2.2.1 Pain

Pain reduction was measured with a visual analogue scale during wrist movement or wrist weighting during activity; 10 indicated severe pain and 0 indicated no pain, using a paper scale marked at 1-cm intervals. This tool has high intra-rater and inter-rater reliability (Intraclass Correlation Coefficient=0.96) [26].

2.2.2 Grip strength

GS in the sitting hands test was measured using a dynamometer (Jamar Hydraulic Hand Dynamometer, Preston, USA), starting with the wrists in neutral position, the elbows at 90° flexion, and shoulders internally rotated with slight abduction [27]. This tool has high intra-rater and inter-rater reliability (Intraclass Correlation Coefficient=0.98) [28]. The mean value was determined from 3 measurements of 5 seconds without pain.

2.3 Intervention and Procedure

2.3.1 Stabilizing reversal technique

The SRT of PNF was performed with the subject in a hook-lying position on a treatment table, with the shoulder in 90° flexion, upper arm in neutral position, elbow extended, and forearm and wrist in neutral position. The therapist applied diagonal 1 (radial flexion and ulnar extension) and diagonal 2 (ulnar flexion and radial extension) techniques. Alternating SRT was performed starting with the flexors using a range of resistance that did not cause pain. SRT for the wrist was performed for 20 seconds, and repeated 5 times for each diagonal. The total intervention time consisted of a maximum of 10 minutes including rest time, 5 times a week for 2 weeks.

2.3.2 Stretching

Stretching was performed with the subject in a hook-lying position on a treatment table, with the shoulder in 90° flexion, upper arm in neutral position, elbow extended, and forearm and wrist in neutral position. The therapist again applied diagonal 1 and diagonal 2 techniques. Alternating stretching was performed using a range of elongation that did not cause pain. Stretching for the wrist was performed for 20 seconds, and repeated 5 times for each diagonal. The total intervention time consisted of a maximum of 10 minutes including resting time, 5 times a week for 2 weeks.

Table 2. Pain and grip strength before and after intervention

		Experimental (n=10)	Control (n=10)	Difference (post-pre)		t (p)
				Experimental	Control	
Visual analogue scale (score)	Pre	4.29±1.47	4.33±1.19	3.76±1.67	1.57±0.90	-3.655 (0.002)
	Post	0.53±0.40	2.76±0.89			
	t (p)	7.126 (0.000)	5.527 (0.000)			
Grip strength (kg)	Pre	28.60±10.05	29.20±9.89	-3.70±0.95	-1.80±0.92	4.549 (0.000)
	Post	32.30±10.06	31.00±9.93			
	t (p)	-12.333 (0.000)	-6.194 (0.000)			

Values are presented as mean±standard deviation.

2.3.3 Wrist taping

WT was performed using one elastic tape (Benefact tape, NIPPON SIGMAX, Japan) about 15 cm long and two elastic tapes about 60 to 80 cm long. Elastic tape length varied according to forearm diameter. WT was performed with the subject in a hook-lying position on a treatment table, with the shoulder in 90° flexion, upper arm in neutral position, elbow extended, and forearm and wrist in neutral position. The therapist attached an elastic tape (60 to 80 cm long) to the affected side wrist in elongated posture of diagonal line 1 (radial flexion with finger flexion and finger extension) and diagonal line 2 (ulnar flexion with finger flexion and radial extension with finger extension). Elastic tape about 15 cm long was wrapped around the wrist starting 3 cm from the snuffbox, with the wrist in isometric contraction in neutral position.

2.4 Statistical analysis

Statistical analysis was performed using SPSS/PC Statistics 18.0 software (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to verify normal distribution of data. A paired t-test was performed to compare changes in pain and GS before and after intervention. An independent t-test was used to compare differences between experimental and control groups. Statistical significance was set at a p value of less than 0.05.

3. Results

3.1 Comparison of pain changes

Within group changes in pain were significant in both experimental and control groups ($p < 0.01$). Between group changes in pain were greater in the experimental group than in the control group ($p < 0.01$) (Table 2).

3.2 Comparison of grip strength changes

Within group changes in GS were significant in both experimental and control groups ($p < 0.01$). Between group changes in GS were greater in the experimental group than in the control group ($p < 0.01$) (Table 2).

4. Discussion

This study was conducted in 20 adult male and female badminton players who complained of discomfort due to excessive wrist use. We divided the subjects into an experimental group of 10 that received WT after SRT of PNF, and a control group of 10 that received WT after stretching. The interventions were performed 5 times a week for 2 weeks, and the effects on pain and GS were assessed.

Excessive use of joints results in increased stress and damage to bones, ligaments, muscles, tendons, and nerves, as well as pain and reduced joint stability [29]. SRT of PNF technique can increase strength and

stability by enhancing cross resistance between agonist and antagonist muscles using very small motions in joints with pain due to instability with movement, or when joint stability and balance are reduced because of absence of isometric contraction between agonist and antagonist muscles [18,30]. Kim and Jung [31] were able to activate transversus abdominis and internal oblique abdominal muscles as well as lumbar deep muscles using PNF stabilization technique. PNF stabilization technique is considered an appropriate intervention to reduce pain and improve functional movement by increasing the stability of deep muscles in patients with low back pain. This study also showed reduced pain and improved GS in the experimental group using WT after application of SRT of PNF. These results suggest that SRT of PNF may reduce weakness of the wrist antagonist muscles and improve stability and muscle strength as a result of pain reduction.

Lee et al. [20] showed significant reduction in pain in a comparison between groups after 2 weeks of ST intervention in 28 patients with thumb metacarpophalangeal joint injuries. Ro [32] showed significant reduction in pain after intervention with 4 weeks of ST in 40 patients aged 65 years or older with shoulder pain. Shamsoddini and Hollisaz [22] showed significant reduction in pain after intervention with ST in 30 patients with tennis elbow. In this study, pain was significantly reduced after intervention in the experimental group using WT after SRT of PNF and in the control group using WT after stretching. This result shows that the WT method in this study produced waves in the muscles attached to the tape when the attachment to the extensors and flexors of the wrist returned to normal position in the elongated posture of wrist movement in 4 directions. Muscle wave generation increased the space between skin and muscle, improving blood and lymphatic circulation [33]. It is thought that tension on the myotendinous junction helped to relax the muscles, and may have contributed to pain reduction. There was a significant reduction in

pain in the experimental group using WT after SRT of PNF compared to the control group. These results alternately activated wrist extensors and flexors with SRT of PNF, and the balance between agonist and antagonist muscles normalized with SRT of PNF [18]. Therefore, SRT of PNF seems to be more effective than stretching.

Kim et al. [34] used ST, Activator Methods Chiropractic Technique, and combined treatment in 30 patients diagnosed with lateral epicondylitis. After 2 weeks, GS showed significant improvement in all treatment groups. Kim and Kim [23] showed a significant improvement in GS after ST application to wrist extensors in 20 normal adults. Lemos et al. [35] divided 75 adult women in to ST, tension ST, and control groups. After 24, 30, and 48 hours, GS was significantly improved in the ST group. In this study, GS improved significantly after intervention in both experimental groups using WT after SRT of PNF and in the control group using WT after stretching. There was a significant difference in GS in the experimental group using WT after SRT of PNF compared to the control group. These results indicate that subjects in this study had difficulty with GS due to wrist pain. However, as the intervention proceeded, pain decreased and GS improved. Park and Kim [21] showed significant improvement in GS with ST in 22 patients with lateral epicondylitis. Muscle strength was improved with reduced muscle pain and facilitation of muscle activation with ST. This study and its application areas show different but valid results.

Thus, it was confirmed that WT after SRT of PNF effectively for reduced pain and improved GS. Therefore, the application of WT after SRT of PNF for overuse WP will have a positive effect by reducing pain and improving GS. In general, PNF is thought to be useful for patients with central nervous system disorders. However, PNF is also applicable to patients with other disorders. Further research is needed to clarify these results.

5. Conclusion

This study effectively reduced pain and improved GS by applying WT after stretching or SRT of PNF in badminton players with WP due to overuse.

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