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ORIGINAL ARTICLE

Immediate Effects of Counterforce Forearm Brace on Grip Strength and Wrist Extension Force in Patients With Lateral Epicondylosis

Alireza Shamsoddini[1], Mohammad Taghi Hollisaz[2], Rahmatollah Hafezi[2] and Asadollah Amanellahi[3]

Objective: Although the effectiveness of counterforce braces has been reported in patients with lateral epicondylosis over the elbow, its immediate effect is limited. This research was to study the immediate effects of counterforce forearm brace on grip strength and wrist extension force in patients.

Methods: Fifteen patients (9 women and 6 men) with lateral epicondylosis ($M \pm SD$, 8.1 ± 1.1 weeks) on their dominant arm participated in this study. We tested grip strength, wrist extension muscle force and range of motion (ROM) wrist extension immediately after application of counterforce forearm brace in the affected and unaffected arms.

Results: Among the variables, significant differences were found in grip strength ($p = .02$) and wrist extension muscle force ($p = .001$), but changes in ROM of wrist extension were not statistically significant ($p = .98$).

Conclusion: Using the counterforce forearm brace increased the rate of grip strength and wrist extension muscle force in patients with lateral epicondylosis. However, our findings did not support the use of the counterforce brace in increasing ROM in wrist extension.

KEY WORDS: Counterforce forearm brace • Lateral epicondylosis • Muscle force • Orthotic rehabilitation

Introduction

Lateral epicondylosis (LE) is the most common complaint with complex aetiological and pathophysiological factors on the lateral side of elbow. It is characterized by pain at the lateral aspect of the elbow, commonly associated with resisted wrist or finger extension and gripping activities (Noteboom, Cruver, Keller, Kellogg, & Nitz, 1994; Stephens, 1995; Vicenzino & Wright, 1996). LE is also known as lateral epicondylitis, lateral epicondylalgia, tennis elbow, or tendinitis of the affected forearm extensor muscles (e.g. extensor Carpi radialis brevis tendonitis) (Bisset et al., 2007; Vicenzino & Wright). It affects 1–3% of the adult population, occurs mainly as episodes in the dominant arm of patients aged 35–50 years, and is equally distributed between men and women (Smidt et al., 2002; Stratford & Levy, 1994).

In the laboratory, two frequently used outcome measures of LE are pressure pain thresholds (Pienimaki, Siira, & Vanharanta, 1997; Stratford & Levy, 1993; Vicenzino & Wright, 1996;

[1]Department of Occupational Therapy, [2]Department of Rehabilitation, Faculty of Medicine, Baqiyatallah University Medical Sciences, and [3]Department of Rehabilitation, Baqiyatallah Hospital, Tehran, Iran.

Reprint requests and correspondence to: Dr. Alireza Shamsoddini, Department of Occupational Therapy, Faculty of Medicine, Baqiyatallah University Medical Sciences, Tehran, Iran.

E-mail: alirezaot@bmsu.ac.ir

Wright, Thurnwald, O' Callaghan, Smith, & Vicenzino, 1994) and pain-free grip strength (Stratford & Levy; Wright et al., 1994). These two tests mimic the clinic physical examination tests that are positive in the majority of cases of lateral epicondylosis. In most cases, there is also a deficit in strength in forearm extensor muscles (Buchbinder et al., 2002). Recent systematic structured reviews of randomized clinical trials of a range of interventions, including friction massage, ultrasound, acupuncture, orthotic therapy, shock wave therapy, oral nonsteroidal anti-inflammatory medication, and surgery have indicated that the literature does not support many of the recommended physical treatments of lateral epicondylosis (Green et al., 2002a, 2002b; Pienimaki, 2000; Pienimaki, Tarvainen, Siira, & Vanharanta, 1996; Struijs et al., 2002).

Counterforce forearm brace is one important orthotic device for treatment of this condition; it was initially used by Nirschl and Sorbel (1981). Researchers have suggested that pressure from the brace on the extensor muscles could lessen muscle-tendon tension at the lateral epicondylar region, thereby allowing the forearm muscles to contract more forcefully within a pain-free range of motion (Ng, 2005; Ng & Chan, 2004; Wadsworth, Nielsen, & Moffroid, 1989). Although the counterforce forearm brace is a popular choice of treatment for patients with lateral humeral epicondylosis, but there is no report whether the duration of use of the brace would affect its effectiveness. In most research, the long-term counterforce forearm brace is used (Ng; Norkin &White, 1995; Pienimaki et al., 1996; Wadsworth et al., 1989; Wuori, Overend, Kramer, & MacDermid, 1998), but only a limited number of studies have investigated the immediate effect of counterforce forearm brace on patients with LE (Jafarian, Demneh, & Tyson, 2009; Ng & Chan). In these studies, grip strength, wrist extension force and range of motion (ROM) were evaluated after the application of counterforce forearm brace in affected and unaffected arms. The purpose of this study was to determine if the application of a counterforce forearm brace for LE would have immediate effect on grip strength and wrist extensor muscle force.

Methods

This study was a quasi-experimental clinical trial with a pre/post study design. Fifteen patients (9 women and 6 men) referred to Baqiyatallah Hospital volunteered for this study. Diagnosis was made by physiatrist. All participants underwent an initial assessment by a qualified musculoskeletal occupational therapist. The etiology of injury for all subjects was nonsport related overuse. All of the patients had had symptom duration of less than 12 weeks. Inclusion criteria were: (a) experienced lateral elbow pain with gripping activities, or resisted wrist or finger extension; (b) one hand involved; and (c) disease be in acute phase. Exclusion criteria included: (a) surgery for LE within the last one year; (b) history of fracture of either radius or ulna that limited range of motion; and (c) history of rheumatoid disease or neurologic impairment including head injury or stroke. Ethical approval was granted for the study and informed consent statements were signed by all patients.

In the present study, parameters included grip strength, force and ROM of wrist extension, that tested both the affected and the unaffected arms with and without the use of a counterforce forearm band. Pretreatment (baseline) and posttreatment, that is, before and immediately after the patient put on the counterforce brace were evaluated. The unaffected arm served as a control. ROM was measured using a standard goniometer according to the techniques described by Norkin and White (1995). Wrist extension strength testing included the following: 10° shoulder abduction, 0° shoulder flexion and rotation; 90° elbow flexion, 85° forearm pronation; 0° wrist extension, 0° wrist deviation (Kuzala & Vargo, 1992; Vicenzino, Cartwright, Collins, & Wright, 1999; Wadsworth et al., 1989). Wrist extension force was measured with a hand-held dynamometer applied to the dorsum of the hand just proximal to the metacarpal heads. Distance from the application of the hand-held dynamometer to the radial styloid process was used to calculate wrist extension force (Wadsworth et al.). Grip strength was defined as the amount of grip force generated with an isometric contraction prior to the onset of pain. It was measured using a Jammar dynamometer (Sammons Preston, Bolingbrook, IL, USA) in pounds of force with the upper limb in a standardized position across all trials as recommended in the Wadsworth et al. study of the relationship of elbow position and grip strength. We adopted the following test protocol for grip strength testing: 10° shoulder abduction, 0° shoulder flexion and rotation; 90° elbow flexion, 0° forearm rotation; 20° wrist extension, 0° wrist deviation (Wadsworth et al.; Kuzala & Vargo; Vicenzino et al., 1999). In our study, the counterforce forearm brace used was made of nonelastic material with hard pad over (KS-22; Tehran, Iran) and was applied 0.8 inches (2 cm) distal to the lateral epicondyle over the extensor carpi radialis longus and brevis (Radpasand & Owens, 2009) (Figure 1).

Statistical Analysis

Independent sample *t* test was used for comparison of scores between the affected and the unaffected arms after use of counterforce forearm brace. For assessment of the effect of counterforce forearm brace in pre and post intervention, mean scores were analysed using a paired sample *t* test to determine whether there were any significant differences. Statistical analysis was performed with SPSS (version 15.0; SPSS Inc., Chicago, IL, USA), with *p* values less than .05 considered statistically significant.

Results

Six men and nine women (15 patients), aged between 35 and 50 years ($M \pm SD$, 42.53 ± 5.29 years) participated in this study. The $M \pm SD$ for the duration of their LE condition was 8.1 ± 1.1 weeks. Eighty percent of the participants presented with their dominant arm being the affected arm. Data from this study demonstrated positive changes in grip strength and wrist extension with the application of the counterforce forearm brace in the affected arms when compared with the unaffected arm. The effect of the counterforce forearm brace was assessed immediately after its application. In the affected arm, maximum improvement in grip strength and wrist extension force respectively were on average 3.07 N and 2.6 N at the 0-minute post application measurement time, whereas the maximum positive change in ROM of wrist extension was 1.2° and data did not show positive changes after application of the counterforce forearm brace. In the unaffected arm, very little change in scores was demonstrated on grip strength and other variables (Table 1). Appropriate use of *t* test requires that data fall within the typical normal distribution. Analysis by χ^2 test confirmed that data from the affected arms were not significantly different from the distribution defined by the normal or unaffected arms. Results from the student *t* test showed that there was a significant main effect for grip strength between the affected and the unaffected arm ($p = .02$). According to the results, the average difference between wrist extension muscle force in the affected and the unaffected arm was significant ($p = .001$). However, ROM of wrist extension was not significantly different between the affected and the unaffected arm at the 0-minute post application of counterforce forearm brace ($p = .94$) (Table 2).

Figure 1. *Nonelastic counterforce forearm brace.*

Discussion

This study examined the immediate effect of a counterforce forearm brace on the grip strength, wrist extension muscle force and ROM of wrist extension. Results revealed significant differences in grip strength but not in ROM of wrist extension. The significant differences in grip strength are comparable with the reports by Ng (2005) and Wadsworth et al. (1989) in which the authors reported that using a counterforce forearm brace could significantly increase the grip strength. However, in the study by Wuori et al. (1998), the counterforce forearm brace did not have any effect on grip strength. It is tempting to speculate the mechanism of action by which the counterforce forearm brace achieved its effects in improving grip strength. One possible explanation is that a direct mechanical effect on the muscles of the forearm somehow improved the internal

Table 2. Student *t* test analysis of the changes in strength and range of motion (ROM)

	Average difference in affected arm	Average difference in unaffected arm	*p*
Grip strength (N)	3.06	0.11	.02
Wrist extension muscle force (N)	4.53	1.1	.001
ROM of wrist extension	0.20°	0.18°	.98

Table 1. Change in variables in the affected and the unaffected arm

	Affected arm		Unaffected arm	
	Preapplication	Postapplication	Preapplication	Postapplication
Grip strength (N)	25.53	28.60	26.1	27.5
Wrist extension muscles (N)	8.93	11.53	9.2	10.7
ROM of wrist extension	43.94°	45.14°	45.6°	45.78°

ROM = range of motion.

muscle mechanics or protected the damaged tissue from excess force and, as a result, improved the grip strength. (Snyder-Mackler & Epler, 1989; Vicenzino, Collins, & Wright, 1996). The theory of the mechanical effect on muscle is similar to that postulated, but not proven, for other orthotic braces for this condition (Snyder-Mackler & Epler; Vicenzino & Wright, 1996; Vicenzino, Brooksband, Minto, Offord, & Paungmali, 2003).

The data of this study demonstrated that the application of a counterforce forearm brace improved wrist extension muscle force immediately after application in participants with LE. This study has shown such an effect because the counterforce forearm brace disperses stress generated by muscle contraction, thereby reducing painful inhibition and allowing the patient to contract the elbow more forcefully. The counterforce forearm brace may also facilitate muscle contraction by sensory skin stimulation and/or muscle belly pressure, as proposed by Stonecipher and Catlin (1984). Results from the current study is compatible with those of the study by Wadsworth et al. (1989) and Anderson and Rutt (1992), where the authors reported that patients with LE demonstrated a statistically significant increase in wrist extension force after use of counterforce forearm brace. An important clinical effect of this finding is that the counterforce forearm brace could be used to facilitate implementation of a better exercise rehabilitation program for LE (Flatt, 2008; Vicenzino et al, 1996; Vicenzino & Wright, 1996).

According to the present study, immediate effect of counterforce forearm brace on ROM of wrist extension in LE patients was not significant. Therefore, we conclude that the counterforce forearm brace had no immediate effect on ROM of patients with LE in wrist extension. Nirschl and Sorbel (1981) theorized that the counterforce forearm brace acted as a compressive force, restricting expansion of the muscle and thereby decreasing the ROM generated by the wrist extensors. According to the results of the present study and previous research (Jafarian et al., 2009; Ng, 2005; Nirschl & Sorbel; Wuori et al., 1998), the counterforce forearm brace for the lateral elbow, if effective in improvement of grip strength with forearm muscle activity, may be considered a useful adjunct to exercise in LE patients.

On the other hand, the effects of various wearing regime of the counterforce forearm brace to the grip strength and wrist extension force need to be investigated further. As the sample size of this study was small, further study with larger sample size are recommended.

Conclusion

Overall, measured grip and wrist extension muscle force improved significantly immediately following application of counterforce forearm brace. However, no difference in the scores on ROM of wrist extension was found. Therefore, we postulate that the counterforce forearm brace could increase grip strength and wrist extension muscle force in affected arms immediately by dispersing stress away from the lesion, thus reducing trauma and related inhibition mechanisms. Therefore, data from the present study suggest that this treatment modality may be a useful adjunct in the management of this condition where it would serve to optimize the imposed loads on the forearm muscles during exercise and functional rehabilitation. Since the sample size was small, to corroborate these findings, further study with larger sample size is recommended.

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