ORIGINAL ARTICLE

Effects of Modified Pen Grip and Handwriting Training on Writer's Cramp

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ABSTRACT. Baur B, Fürholzer W, Jasper I, Marquardt C, Hermsdörfer J. Effects of modified pen grip and handwriting training on writer's cramp. Arch Phys Med Rehabil 2009;90: 867-75.

Objective: To evaluate the use of a modified pen grip and subsequent handwriting training in patients with writer's cramp (WC).

Design: Handwriting performance with normal and modified pen grip was examined once in healthy controls and repeatedly in patients with WC (2 baseline tests before training, directly after training, after a 3-month follow-up).

Setting: Ambulatory care for motor writing disorders.

Participants: Patients with WC (n=26) and healthy controls (n=14).

Intervention: Seven sessions of handwriting training with various motor exercises were conducted by an occupational therapist. During training, the patients always used a modified pen grip (stabilized between index and middle finger).

Main Outcome Measures: Writing frequency and fluency, grip force on the pen, writing pressure, Fahn dystonia scale, visual analog scales for impairment and pain.

Results: Patients with WC showed increased writing pressure and grip force before training. Using the modified pen grip caused in both patients with WC and controls a decrease in pressure and grip force. Handwriting training resulted in a further improvement of both parameters in patients with WC. Grip force reduction remained stable over follow-up.

Conclusions: Results suggest that patients with WC benefit from the use of the modified pen grip in combination with handwriting training.

Key Words: Hand strength; Handwriting; Rehabilitation.

WRITER'S CRAMP IS a focal dystonia that is characterized by involuntary muscle overactivation during handwriting. The individual pattern of writing disorder and its severity vary a lot among patients with WC. Typical symptoms are the exertion of inadequately high pressure on pen and desk and an abnormal writing posture. Handwriting is exhausting, often even painful for the affected patients. The writing process is frequently slower and less fluent than in normal writers.[1-3] The disease can either be restricted to handwriting (simple WC) or involve one or more other fine motor activities such as typing, using a computer mouse, using cutlery or tools, sewing, shaving, or putting on make-up (dystonic WC[4]). WC can handicap people severely in their professional lives.

There is a lively discussion about the pathophysiology of WC. Standard clinical neurologic assessment typically reveals no additional neurologic symptoms in patients with WC. However, a number of imaging studies point to particularities in the brain activity of patients with WC. Ceballos-Baumann et al[5] found reduced activity in the primary motor cortex paralleled by increased activity of the frontal association cortex in a PET study. In a study by Ibanez et al,[6] patients with WC showed reduced activity of the premotor cortex and reduced activity of the primary sensory and primary motor areas during handwriting. In contrast, a newer PET approach by Lerner et al[7] revealed overactivity of primary motor and primary sensory areas in patients with WC and suggested that WC might be caused by a major sensory problem. However, the interpretation of abnormalities in brain activity is difficult because of the diversity of imaging results in focal dystonia. Further, abnormal brain activity in WC can be considered as either a primary phenomenon (the reason for the writing disorder) or a secondary entity, namely the brain correlate of the particular handwriting style of patients with WC. The authors who found an abnormal responsiveness of the motor cortex hand area to transcranial magnetic stimulation in patients with WC[8-10] emphasize the role of impaired inhibitory mechanisms and maladaptive neuroplasticity. Electroencephalography aberrations in patients with focal dystonia suggest problems in movement preparation.[11]

Abnormalities on the behavioral level that exceed the writing disorder were also found: some patients with WC showed sensory dysfunctions,[12,13] and selective impairment of mental hand rotation was recently detected in patients with focal hand dystonia.[14]

Treatment of WC was long dominated by botulinum toxin injections, which can be accompanied by negative side effects. The treatment effects are always of a transient nature and satisfactory in only a subgroup of patients.[15-18]

In past years, several behavioral treatment approaches were developed and evaluated that were based on pathophysiologic assumptions of sensory dysfunction, overuse, and cortical dedifferentiation caused by maladaptive neuroplasticity. Zeuner et al[19] tried sensory training in the form of Braille reading in a sample of 10 patients with WC. They found a clear improvement in tactile spatial acuity after 8 weeks of training, and a significant amelioration of the Fahn dystonia rating scale,[20] but

List of Abbreviations

ANOVA	analysis of variance
PET	positron emission tomography
WC	writer's cramp

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no significant changes in objective measures of handwriting performance (time needed to copy a standard paragraph). Two patients in the sample who continued Braille reading after the 8-week period showed slight further improvement in time needed for the standard paragraph at the 1-year follow-up examination.[21]

In light of overuse and enlargement of cortical representations as underlying mechanisms of WC, Priori et al[22] examined the effect of limb immobilization for 4.5 weeks on average in 7 patients with musician's cramp and 1 patient with WC. The patient group improved in the Arm Dystonia Disability Scale[20] and in subjective ratings. Quality and speed of handwriting in the patient with WC were also judged as ameliorated. Pesenti et al[23] found afterward improvement of dystonic symptoms in the hand grip test in some of the patients of a mixed sample of patients with WC and musician's cramp, but did not provide handwriting data.

Zeuner et al[24] conducted a 4-week motor training program for individualized fingers (by splinting) based on the etiologic hypothesis of cortical dedifferentiation. Half of their patients showed an improvement in the Fahn dystonia score. Kinematic handwriting analyses revealed improvement of the stroke frequency in basic finger movements and in producing superimposed squiggles, whereas writing velocity and pressure while writing a test sentence were not influenced by the treatment.

In summary, the evaluation of the aforementioned behavioral treatment approaches revealed that they can influence single aspects of handwriting or slightly improve dystonic symptoms but do not lead to completely satisfying results.

A further behavioral treatment approach is the handwriting training developed by Mai et al[25,26] that focuses on direct training of handwriting movements. This treatment approach is based on the assumption that WC is at least partly caused by maladaptive behavioral compensation mechanisms (like enhancement of attention on writing and increase of finger forces). Such inappropriate writing strategies should be changeable by systematic training. The training approach comprises the application of various motor exercises to retrain efficient writing techniques as well as the temporary alteration of writing conditions (eg, altered pen, pen grip, writing pad) to reduce the occurrence of dystonic movement patterns.[1,3,25,26] A first evaluation by Schenk et al[1] in 50 patients with WC showed that this treatment approach as a whole can lead to permanent improvement of kinematic handwriting measures, but did not examine precisely the effect of pen grip alterations. The direct effect of a modified pen grip between the proximal phalanges of index and middle finger (fig 1A) was studied later in 23 patients with WC by Baur et al.[2] They reported that the change of pen grip did not influence kinematic writing

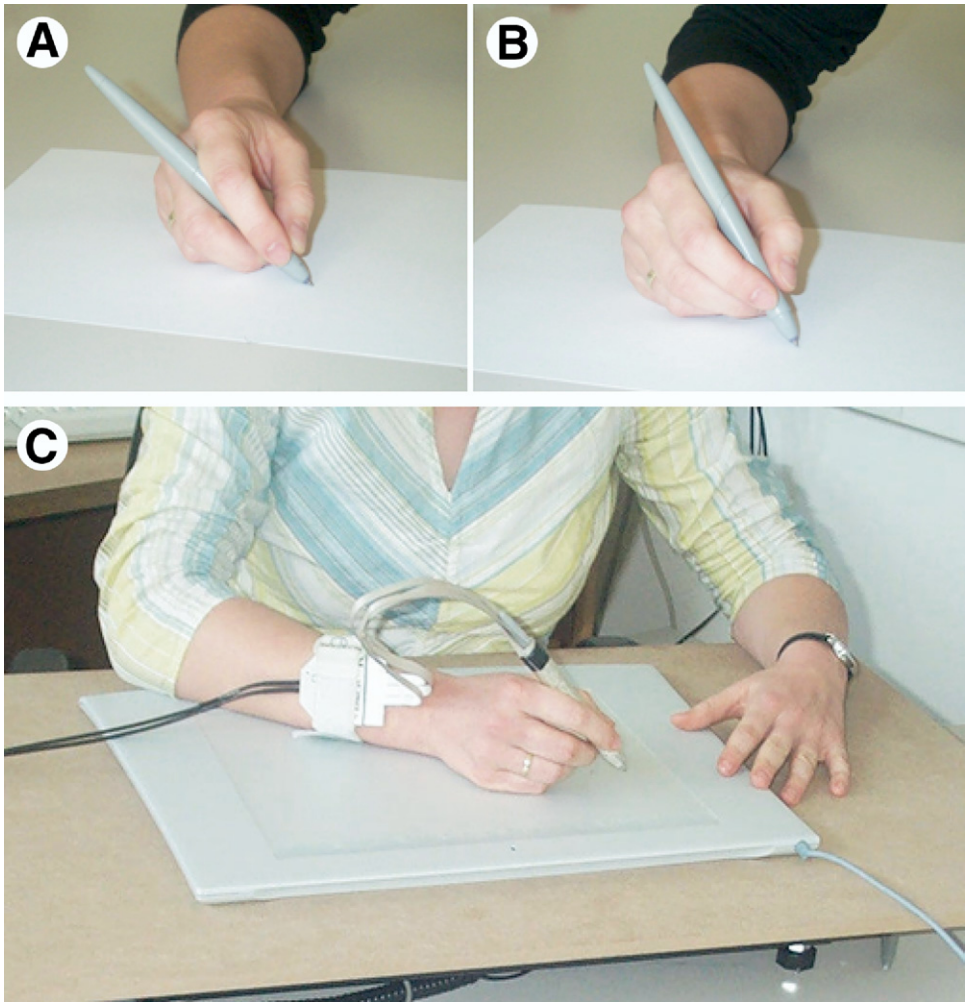

Fig 1. (A) Modified and (B) conventional (normal) pen grip demonstrated by a healthy control subject. (C) Experimental setting.