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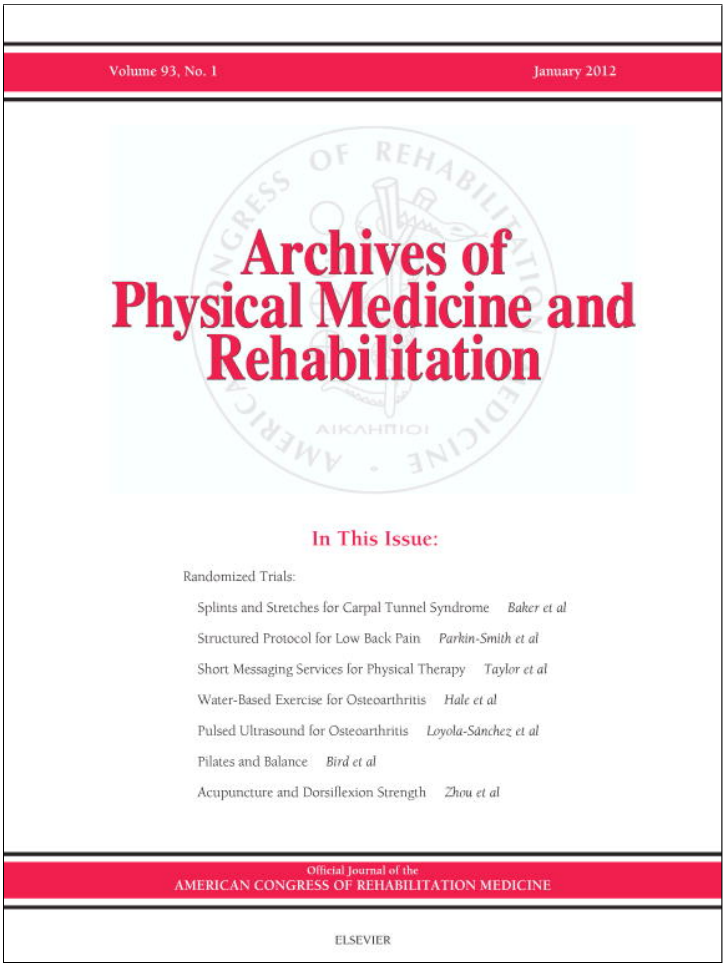

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ORIGINAL ARTICLE

Physical Rehabilitation With Ergonomic Intervention of Currently Working Keyboard Operators With Nonspecific/Type II Work-Related Upper Limb Disorder: A Prospective Study

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ABSTRACT. Povlsen B. Physical rehabilitation with ergonomic intervention of currently working keyboard operators with nonspecific/type II work-related upper limb disorder: a prospective study. Arch Phys Med Rehabil 2012;93:78-81.

Objective: To evaluate the effect of a physical training program in combination with ergonomic changes in a group of keyboard operators with nonspecific/type II work-related upper limb disorder (WRULD).

Design: Prospective study.

Setting: Hospital department.

Participants: Pain-free controls (n=6) and currently working patients with WRULD (n=17) were included.

Interventions: Participants were taught how to self-rehabilitate according to a previously published physical exercise program, in addition the patients requested maximal ergonomic assistance from their employer according to British law.

Main Outcomes Measures: Pain at rest and after a standardized functional typing test, before and after rehabilitation, with recording of endurance and calculation of typing speed during the tests. Statistical evaluation: Student *t* test, paired, and 2-tailed.

Results: After the rehabilitation program, the patients as a group had significantly less pain both at rest ($P=.009$) and after the typing test ($P<.001$). The typing endurance improved significantly ($P=.027$) and became similar to the healthy control group ($P=.09$). The typing speed improved significantly in the patient group after rehabilitation ($P=.032$) and became similar to the normal control group ($P=.058$).

Conclusions: Currently working keyboard operators with nonspecific/type II WRULD can benefit significantly from a combination of an individualized self-administered physical rehabilitation program and ergonomic work place improvements. Randomized control studies are needed to further investigate the long-term effect of this encouraging finding.

Key Words: Human engineering; Rehabilitation.

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A RETROSPECTIVE COHORT study[1] of keyboard operators with work-related upper limb disorder (WRULD) showed that those with poor fitness levels were more severely clinically affected, and the study concluded that these types of patients should be encouraged to enter fitness programs. Physiotherapeutic interventions have been shown to have an effect on symptoms in the neck and shoulder region,[2-5] but it is unclear how effective such interventions are for complaints in the hand and forearm.[2,6] Specific physical training of painful muscles in the neck and shoulders may also be superior to general fitness training in reducing existing pain and for prevention of later pain development.[3-5] Ergonomic workstation modification has also been considered important in treating painful upper-limb problems in keyboard operators. Most publications have reported that such interventions make no difference to patients who have already developed problems,[6-8] unless they have pain in the neck and shoulder.[3,9] A recent article has described a specific physical, predominantly self-administered, rehabilitation program for keyboard operators suffering from nonspecific/type II WRULD of the hand and/or forearm.[10] The physical part of the rehabilitation program concentrated on stretching and strengthening the affected muscles, taught and reviewed by a trained occupational hand therapist, approximately 4 times over a minimum 3-month period supported by self-exercises several times a day at the workstation during mini breaks. A previous article has described a functional typing test, which could be used for testing keyboard operators' development of pain during work, their typing endurance and typing speed, under standardized circumstances, both before and after interventions to treat WRULD.[11] This article therefore aims to evaluate prospectively whether currently working keyboard operators with nonspecific/type II WRULD, who have had pain in their hands and/or forearms for a minimum of 3 months, have less pain and better performance during a standardized functional typing test when tested after a minimum 3-month program of a combination of self-administered physical training and employer-provided ergonomic workstation improvements.

METHODS

Participants were selected from a cohort of patients who had been referred to a tertiary referral center specializing in hand and upper-limb problems. The patients included in this study would have at least 1 and sometimes several symptoms of pain from the muscles of the volar or dorsal aspect of the forearm or

List of Abbreviations

HSE	Health and Safety Executive
VAS	visual analog scale
WRULD	work-related upper limb disorder

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the flexor or extensor tendons of the hand or wrist in a nonspecific anatomical location. Patients with pain from specific anatomical locations of tendonitis as exemplified by medial epicondylitis caused by inflammation of the common flexor tendon insertion at the medial epicondyle of the humerus were excluded. Patients who were currently working keyboard operators, who had been given a diagnosis of nonspecific WRULD affecting the hand and/or forearm and who had had pain for a minimum of 3 months, were invited to participate in a previously published rehabilitation program.[10] Patients with nonspecific WRULD, also known as type II WRULD,[12] are a very small part of our patient group as approximately 99% of the patients in our practice with WRULD suffer from the specific types (type I), for example carpal tunnel syndrome, trigger digit, de Quervain, and epicondylitis. Patients with hypermobility, fibromyalgia, nerve entrapments, osteoarthritis, hormonal abnormalities, and biochemical confirmation of autoimmune inflammatory conditions were therefore also excluded. Patients who were not working keyboard operators during the whole of the rehabilitation period or did not complete the follow-up functional typing test were also excluded. Patients who had "rest pain" on a visual analog scale (VAS) of 5 or more at the time of the typing test were excluded, as department policy discouraged such patients from continuing to type at work before pain is better controlled by other means.

Patients who fulfilled the inclusion criteria and accepted participation in the study underwent a functional typing test, which has previously been described and published.[11] The typing test was carried out at a standardized workstation that was compliant with the guidelines set by the Health and Safety Executive (HSE) of the United Kingdom.[13] Participants were then given an introduction to a rehabilitation program[10] by an occupational therapist specializing in hand and upper-limb disorders, which the patients would then self-administer for a minimum of 3 months. The physical part of the rehabilitation program concentrated on stretching and strengthening the affected muscles, taught and reviewed by a trained occupational hand therapist, approximately 4 times over a minimum 3-month period, supported by self-exercises several times a day at the workstation during mini breaks. In addition, participants were recommended to seek maximal ergonomic workstation modifications through their employer according to the guidelines set by the HSE.[13] The purpose of the HSE document is to assist employers in preventing the use of computer workstations from causing risk to the welfare of the operators. It provides good practice guidance regarding nature and timing of breaks, planning of activities, eyes and eyesight, provision of training, and provision of information and workstation requirements. Examples of ergonomic modifications that were implemented are: adjustment of monitor height, monitor positioning, improved leg room under the desk, alternative keyboard, adjustable chair, and provision of footrest. After a minimum of 3 months' physical self-rehabilitation, the participants were again evaluated with the standardized typing test, and the before and after results were statistically compared. Data from 6 healthy control keyboard operators from the department, who had never suffered from work-related hand or forearm pain at the time of investigation, were used for comparison.

Functional Typing Test

The functional typing test was first described by Povlsen et al[11] and was conducted at a standardized workstation that complied with HSE guidelines.[13] The test was carried out before the first treatment session and after completion of the occupational therapy exercise program. At the start of each test, the patients were requested to score their resting pain on a VAS (0–10; 0=no pain and 10=worst possible pain). The patients would then start to type a standard document at their own speed for a maximum of 30 minutes or until the pain reached a VAS score of 5, and they would then score their VAS level again. The typing endurance was recorded, and the typing speed during that period (words per minute) was then calculated.

Occupational Therapy Exercise Program

We used the exercise rehabilitation program as described by Povlsen and Lee-Rose,[10] which was designed to make patients aware of their posture, strength, and flexibility, as well as encourage them to move constantly and avoid prolonged static positioning. The exercises were simple and aimed to improve flexibility and strength. Specific forearm stretches were performed along with nerve glide exercises if peripheral sensitivity was observed.[14,15] Patients were encouraged to incorporate the exercises into their daily routine.

RESULTS

Seventeen patients (11 women) completed the treatment program and had a final functional typing test recorded. Approximately two-thirds of those who initially started the treatment program did not undertake the final test and were therefore not included in this study. However, statistical comparison of the results from the pretreatment typing test showed that there were no statistical differences between the completion group and the drop-out group regarding pretest pain (P=.37), typing endurance (P=.26), posttest pain (P=.21), or typing speed (P=.77). The main reason given by the patients for not attending the final test was that they no longer perceived themselves to have a problem and therefore lacked motivation to request further leave from work to attend the clinic. It is therefore being considered how to extract final outcome measures from the patient group who are no longer motivated to dedicate time to attend the clinic, as they may no longer have any complaints. Results of the typing tests of the completion group before treatment are seen in table 1. All the healthy controls had a pain score of 0 on the VAS at rest before the typing test, and they all could type for the full 30 minutes of the test. After the test, 1 control subject had a pain score of 1 on the VAS but all the other controls had a pain score of 0 on the VAS.

Patients had a final functional typing test 3 to 6 months after the rehabilitation program had started. Ergonomic improvements had also been put in place by the employer according to HSE guidelines. Results of the typing test after the self-administered physical exercise program and workstation improvements are found in table 1. Two-tailed, paired, Student t test with unequal variance was used for statistical evaluation of the test results of the patients before and after treatment.

Table 1: Results Before and After Rehabilitation of Pain (before and after typing), Typing Endurance (min), and Speed (words/min)

	Pain (VAS)		Typing Test	
Rehabilitation	Before	After	Endurance	Speed
Before				
Mean ± SD	1.55±1.37	4.00±1.40	23.86±8.52	25.88±8.15
After				
Mean ± SD	0.64±1.05	2.00±1.95	28.65±3.1	29.82±10.53
P	.009	<.001	.027	.032

NOTE. Pain is measured on a 10-point scale (0–10; 0=no pain, 10=worst possible pain).

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Pain Evaluation

When analyzing the group results before and after the rehabilitation program, there was significantly less pain both at rest ($P=.009$) and at the end of the test ($P<.001$) after the rehabilitation program. However, most patients continued to suffer from some degree of pain both at rest and after typing: 3 patients (nos. 4, 14, 15) became pain free in both arms and 2 patients (nos. 8, 12) in 1 arm, both at rest and after the typing test. Two patients (nos. 9, 12) had 1 arm improving and 1 arm getting worse both at rest and at the end of the test after the rehabilitation program, and 3 patients (nos. 3, 5, 7) did not have reduced pain after the rehabilitation program, neither at rest nor after typing. In summary, 12 of the 17 patients had reduced pain either at rest and/or after typing after the rehabilitation program: 3 patients had no pain reduction, 2 patients experienced 1 limb improving and 1 getting worse.

Endurance Evaluation

When analyzing the patients as a group, it is seen that their typing endurance improved significantly ($P=.027$) after the interventions. Before the interventions, 7 patients (nos. 3–7, 13, 16) could not type for the full 30 minutes of the test, but after rehabilitation all had improved their endurance, though 3 patients (nos. 5–7) fell short of the 30 minutes. As a group, the patients' endurance after rehabilitation was no longer statistically inferior to the control group ($P=.09$).

Typing Speed Evaluation

Typing speeds (words per minute) for our normal control group were 31, 33, 34, 42, 36, and 40, which as a group was significantly ($P=.001$) higher than the patient group at the start of the study. After rehabilitation, the typing speed for the patient group improved significantly ($P=.032$) and was no longer significantly ($P=.058$) slower than the normal control group. When evaluating individuals in the patient group, it was seen that all except 5 patients (nos. 11, 13–16) increased speed, and of those 5, only 3 patients (nos. 13–15) typed slower than before.

Summary of Evaluations

When the patients were evaluated as a group, after the combined physical rehabilitation and ergonomic interventions, significantly less pain both at rest ($P=.009$) and after the typing test ($P<.001$) was recorded, although still not normative compared with the control group. Typing endurance improved significantly ($P=.027$) for the patient group and was no longer significantly ($P=.09$) inferior to the control group. The typing speed for the patient group improved significantly ($P=.032$) and was no longer significantly ($P=.058$) slower than the control group.

Although the group as a whole improved in all of the measurements, when the patients were evaluated individually, after the combined physical rehabilitation and ergonomic interventions, only 3 (nos. 4, 14, 15) of the 17 patients could be considered cured of WRULD type II as they became pain free in both arms, both at rest and after 30 minutes of typing. Of the 12 patients who had arm pain at rest at the start of the study, 6 patients (nos. 2, 4, 11, 14–16) of the 10 patients who had unilateral problems, but none of those who had bilateral problems, became pain free at rest in both hands after rehabilitation. However, all the remaining patients improved in some aspects of their performance, either in their resting or posttyping pain, endurance, or typing speed.

DISCUSSION

The available literature is overwhelmingly pessimistic toward what benefit can be achieved from physical treatment and ergonomic intervention for patients who suffer from WRULD of the hands/forearms, because 2 large review studies have suggested that neither intervention is of significant benefit.[6,16] The benefits of this study are therefore threefold: (1) it investigates exclusively patients with nonspecific/type II WRULD for whom there are no generally accepted surgical treatment options available as for those who suffer from specific/type I WRULD conditions such as carpal tunnel syndrome[12,17]; (2) it investigates the response of currently working keyboard operating patients' to a specific reproducible and highly relevant occupational task; and (3) it demonstrates that physical rehabilitation in combination with employer-provided ergonomic interventions can significantly reduce work-induced pain in relation to that specific occupational task as well as the patients' nonworking day pain.

Studies by Ripat et al[7,18] suggest that for keyboard workers with predominantly specific/type I WRULD arm pain, a change of keyboard may provide lasting reduced symptoms, predominantly those associated with carpal tunnel syndrome. The present study expands on previous findings, as all the participants in the current study were classified as having nonspecific/type II WRULD conditions[12] and therefore, all patients with symptoms of carpal tunnel syndrome were excluded. Despite investigating a patient subgroup different from that previously described by Ripat et al,[18] this present study also found significant improvement after the interventions. However, as well as the different dominating symptoms and the methods of investigating the patients complaints in the 2 studies, there are also differences in which aspect of the patients' complaints improved. The main complaint for inclusion criteria in the present study was pain, either at rest prior to typing, or during prolonged typing, and it is therefore particularly significant that after the interventions described above, the group outcome analysis showed that this complaint was significantly improved, both at rest before typing ($P=.0088$) and at the end of the test ($P=8.2\text{E-}05$). A similar outcome was not achieved after provision of different keyboards alone, because pain severity during the day was not improved.[18]

This study construction and result differs in a number of ways from previous studies, which have shown a positive effect of interventions for workers with WRULD of the hand/forearm. The present study excludes patients with specific/type I WRULD as there are highly successful surgical cures for this condition.[17] It is therefore questionable in the U.K. to treat such patients with only workstation modifications of keyboards if they remain symptomatic, because carpal tunnel syndrome here is considered an industrial injury,[19] and the study population is therefore different from previous studies in that respect. The main finding in the present study is that for the first time, an interventional study of hand/arm WRULD type II has shown that interventions, as described above, can reduce both resting and activity-related pain. This is in contrast to the finding by Ripat et al,[18] who did not achieve any significant reduction of day pain but mainly achieved reduction in the clinical expression of carpal tunnel syndrome symptoms with night pain, disturbed sleep due to pain and numbness, numbness, and tingling.

There may be several other reasons for a successful outcome in this article, despite most previous studies having failed to produce an improvement.[6,8,16,18,20-22] One explanation could be found in the observations by Andersen et al,[4,5] who showed that treatment of neck and shoulder pain in keyboard operators

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focused specifically on the painful muscles was better than a program of general fitness training. The exercise program that was used in this study also focused on the painful muscle groups with a combination of stretching and strengthening exercises.[10] Other authors have shown that exercising the muscles that may have a high risk of becoming the cause of pain will benefit from specific training, both as a means of pain treatment but also as pain prophylactic.[3] Similarly, it could therefore be argued that the positive effect reported in this article's small series of patients with pain in the hand and/or forearm, is also likely to be because of treatment of the current pain in combination with a reduction of additional pain in other muscles that developed during the treatment period (see table 1). Whether the positive effect reported in this article was due to self-exercise, awareness of work posture, or improved positioning of the monitor, computer, or table and chair cannot be answered in this article. Previous studies have shown the benefit of such a combination of interventions for neck/shoulder pain[2] but not in a patient group with hand/arm pain. A final explanation for the beneficial effect of the intervention could be that there is a regression to the mean, as described by Blomqvist,[23] which is why the placebo group usually improves in randomized controlled trials.

Study Limitations

This study has a number of potential limitations: one being that there was no control group of patients. A study based on a randomized controlled trial comparing no intervention with the suggested program would have given a stronger support for the treatment program. However, after publication of the positive results found in this study, where each patient has acted as their own control, such a trial can now be proposed to local ethics committees regarding the physical rehabilitation program, although a control group of patients not receiving ergonomic intervention from their employer may be in breach of the law. Another weakness is that approximately two-thirds (32 participants) of the participants who initially started the treatment program did not undertake the final test. However, statistical evaluation showed that this dropout group was not statistically different from the completion group regarding pretest pain (P=.37), typing endurance (P=.26), posttest pain (P=.21), or typing speed (P=.77). As the main reason given by the patients for not attending the final test was that they no longer perceived themselves to have a problem, the impression is therefore that the actual outcome in the dropout group was as good or better than in the completion group.

CONCLUSIONS

It is reasonable to conclude, therefore, that keyboard operators with mild to moderate nonspecific/type II WRULD of the hand/forearm may derive significant benefit from a combination of ergonomic workstation modifications and a physical rehabilitation program but are unlikely to become cured. This study provides a basis for randomized controlled trials and for longer follow-up studies.

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