Low typing endurance in keyboard workers with work-related upper limb disorder

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Summary

Objective To compare results of typing endurance and pain before and after a standardized functional test.

Design A standardized previously published typing test on a standard QWERTY keyboard.

Setting An outpatient hospital environment.

Participants Sixty-one keyboard and mouse operating patients with WRULD and six normal controls.

Main outcome measure Pain severity before and after the test, typing endurance and speed were recorded.

Results Thirty-two patients could not complete the test before pain reached VAS 5 and this group only typed a mean of 11 minutes. The control group and the remaining group of 29 patients completed the test. Two-tailed student T test was used for evaluation. The endurance was significantly shorter in the patient group that could not complete the test ($P < 0.00001$) and the pain levels were also higher in this group both before ($P = 0.01$) and after the test ($P = 0.0003$). Both patient groups had more pain in the right than the left hand, both before and after typing.

Conclusions Low typing endurance correlates statistically with more resting pain in keyboard and mouse operators with work-related upper limb disorder and statistically more pain after a standardized typing test. As the right hands had higher pain levels, typing alone may not be the cause of the pain as the left hand on a QWERTY keyboard does relative more keystrokes than the right hand.

Upper limb pain in keyboard workers is a common problem though the causes are debated. In the USA cumulative trauma disorders account for 60% of all occupational injuries and the estimated prevalence of these injuries is approximately 30% and the incidence is rapidly increasing.[1] This type of injury was previously known as RSI or cumulative traumatic disorder suggesting that the repetitive nature of the job was causative in developing the problems observed. Indeed some papers suggest that adopting a lower typing speed may compensate for keyboards with stiffer keys.[2] However one study has shown that healthy typists who typed for long periods developed increasing pain but that this did not lead to a reduction in the typing speed[3]

suggesting that most typists have a fixed speed and will have to rest completely in order to recover from the discomfort. As our department has used a standard typing test[4] as part of the clinical evaluation of keyboard workers with work-related upper limb disorder (WRULD) for more than 5 years, it was therefore of interest to know if there was an association between typing endurance, pain and typing speed in keyboard workers with WRULD.

Material and Methods

Sixty-one keyboard-working patients with upper limb pain and six normal controls were investigated.

The participants subjectively located their pain to right, left or both hands and scored their pain intensity on a scale from 0–10. Patients with pain levels at 5 or above were excluded in order to avoid unacceptable levels of post-typing pain. The objective assessment included a standardized typing test which has been described previously[4,5] which was conducted at a standardized workstation using a standard QWERTY keyboard.

At the start of the test the patient was requested to score their 'resting pain' on a VAS scale 0–10. They would then start to type a standard document at their own speed for a maximum of 30 min or until pain reached 5 (VAS 0–10). If they managed the 30 min they would then score their pain level or 'typing pain'. For these individuals the typing component of the test was considered completed. If however before completion of the 30 min of typing their pain reached a level of 5, they were instructed to stop typing and the length of the typing period was recorded – 'endurance'. On the computer the typing speed in words/min was then calculated and the test was then considered completed.

Statistics

Two-tailed student T-test with P value at 0.05 was used for evaluation.

Results

Twenty-nine patients completed the test ('completion group', Table 1). The remaining 32 patients could not complete the test ('low endurance group', Table 2) before pain reached 5 and they only achieved a typing endurance of 11 (+/−5.6) min which was significantly shorter than the 'completion group' and the control group (Table 3) which both completed the 30-min test (P <0.00001). The pain levels were significantly higher in right hand of the low endurance group compared with the completing patient group both before ($P = 0.01$) and also after the typing test ($P = 0.0003$). There was no statistical difference in pain levels of the left hand between the two patient groups either before or after typing however in the low endurance group the right hand was significantly more painful at rest ($P = 0.01$) and after typing ($P = 0.003$). There was no side difference in the completion group. The control group typed the fastest at an average 36 (+/−3.8) words/min and the completion group typed with an average 25.6 (+/−9.6) words/min, the low endurance group typed a little faster with 27 (+/−10.3) words/min. The typing speed was not significantly different between the two patient groups. The control group typed significantly faster with significantly less pain both before and after the test than the two patient groups.

Discussion

This study indicates that keyboard workers with a diagnosis of WRULD who have lost typing endurance to the extent that they can no longer carry out a simple stress-free typing task[5] also developed significantly more severe constant musculoskeletal pain, particular in the right arm, than those who were able to complete the test. This finding is important as previous studies have shown that high pain ratings predict treatment failure in chronic occupational musculoskeletal disorders.[6] The reason for such a development could be found in the execution of the typing task, particularly the typing speed, as Gerrard *et al.*[2] suggested that a lower typing speed may compensate for keyboards that are more likely to give rise to musculoskeletal pain. This would suggest that there would be a difference between the patient groups so that those who could reduce the speed could type for longer and this would be reflected in lower typing speeds in the group who could type the longest. The test results in this paper

Table 1
Results from the completion group

	Resting pain			*Typing pain*	
Number	*Right hand*	*Left hand*	*Endurance (min)*	*Right hand*	*Left hand*
1	2	2	30	5	5
2	1	1	30	5	5
3	2	0	30	4	0
4	1	0	30	5	5
5	3	2	30	5	3
6	1	1	30	2	2
7	0	0	30	5	0
8	3	1	30	3	5
9	0	2	30	0	3
10	0	0	30	0	2
11	0	0	30	2	1
12	0	0	30	5	5
13	1	0	30	4	0
14	2	3	30	3	4
15	0	0	30	1	0
16	2	0	30	2	0
17	2	0	30	1	0
18	3	3	30	5	5
19	3	0	30	5	0
20	2	0	30	4	0
21	0	0	30	0	0
22	0	0	30	3	0
23	2	0	30	4	0
24	0	0	30	0	0
25	0	3	30	0	5
26	0	1	30	0	4
27	1	0	30	4	0
28	2	0	30	3	0
29	0	0	30	0	0
Mean	1.137931034	0.655172414	30	2.75862069	1.862068966
SD	1.125171032	1.044573121	0	1.975839287	2.183119294

showed a marginally lower typing speed in the group who could complete the typing test, but this difference was not significant. The explanation for this could be found in the observation by Huey-Wen Liang *et al.*[3] who found that healthy typists who typed for long periods and developed increasing pain did not reduce their typing speed suggesting that most typists have a fixed speed regardless of the pain experienced. Such a suggestion is indirectly supported by the typing speed recorded in the control group which had a significantly higher typing speed than either of the patient groups ($P < 0.001$) suggesting that lower typing speed is not a benefit regarding endurance. Lower typing speed could also be seen as a risk factor in developing WRULD in combination with other factors of an ergonomic nature as a lower typing speed will cause a lower work capacity which could lead to stress in an outcome driven environment as the overall productivity is lower in this employee group than in those workers with a naturally higher typing speed. This observation is important as several studies have suggested that a stressful work environment is associated with higher risk of developing WRULD.[7,8]

Turning now to the pain experience after the typing test, the statistical analysis of the results of the normal control group after typing supports the earlier statement that the functional test

Table 2
Results of the low endurance group

	Resting pain			*Typing pain*	
Number	*Right hand*	*Left hand*	*Endurance (min)*	*Right hand*	*Left hand*
1	3	0	15	4	0
2	0	0	10	5	0
3	3	0	24	5	0
4	3	3	10	5	5
5	4	0	19	5	0
6	4	2	10	2	5
7	0	0	5	5	0
8	0	1	12	0	5
9	2	0	7	5	0
10	3	3	8	5	5
11	2	3	20	5	5
12	0	0	10	5	5
13	1	1	8	5	5
14	4	1	5	5	2
15	2	0	8	5	0
16	2	3	12	4	5
17	4	0	15	5	0
18	4	0	8	5	0
19	3	0	5	5	0
20	0	2	23	0	5
21	1	1	20	5	5
22	3	0	5	5	0
23	0	0	10	5	0
24	4	0	10	5	2
25	3	3	10	5	5
26	0	0	5	5	5
27	3	3	5	5	5
28	0	0	20	5	5
29	2	4	8	4	5
30	3	3	17	4	5
31	0	0	15	5	5
32	2	2	12	5	5
Mean	2.03125	1.09375	11.59375	4.46875	2.9375
SD	1.513048088	1.352640786	5.621728439	1.319442086	2.422175775

situation used in this paper, which has previously been published,[4] was simple and involved minimal stress for the participants as no significant pain developed in either hand in any of the control group participants, suggesting that significant increase of pain after this typing test should be considered pathological. The group of patients who completed the test recorded increased pain in the right hand from VAS 1.1 (+/−1.1) to 2.8 (+/−1.9) this increase was significant ($P = 0.0003$). In the left hand of this same patient group, the pain increased after typing from VAS 0.6 (+/−1.0) to 1.8 (+/−2.1) which also was a significant increase ($P = 0.01$). Though the pain increase was higher in the right than the left hand, this difference was not significant neither before nor after typing in the completion group. In the group with low endurance, the pain increased to a higher level after typing in both sides compared with the completion group. This increase was significant in the right side ($P < 0.0003$) but not in the left ($P = 0.07$). Considering that on a standard QWERTY keyboard the left hand performs approximately 60% of the keystrokes, the finding that the right hands in these

Table 3
Control group

		Pain (VAS)			
Number	*Side*	*Resting*	*Typing*	*Endurance (min)*	*Speed (wpm)*
1	R	0	0	30	31
	L	0	0		
2	R	0	0	30	33
	L	0	0		
3	R	0	0	30	34
	L	0	1		
4	R	0	0	30	42
	L	0	0		
5	R	0	0	30	36
	L	0	0		
6	R	0	0	30	40
	L	0	0		
Mean					36
SD					3.8

keyboard operators had a higher base level of pain suggest that factors additional to exclusive keyboard use must be considered causative in the development of the pathological level of resting pain. The causes of this may be multifactorial, involving of both leisure and occupational causes, but as none of the participants in this study were exclusive typists, it is likely that occupational activities such as mouse use and hand writing may be contributing factors. When analysing which hand that developed most pain after the typing test it transpire that of all but four patients (table1: 4; table 2: 11, 24, 29) of the 61 participants ended up with most VAS increase of pain in the hand that had the highest start level of VAS pain. This suggests that the start level of pain was a more significant determinate of pain increase than the 40/60% split in keystroke intensity between the right and left hand on a standard QWERTY keyboard that was used in this study. These findings suggest that keyboard workers are likely to develop more severe WRULD in the right upper extremity, and that this development is more significant in patients with low typing endurance. This observation has not previously been reported.

Conclusion

Keyboard workers with WRULD and low typing endurance have more severe pain both before and after a standard typing test than patients with normal typing endurance. Their typing speeds were not different from those patients with normal typing endurance but were significantly lower than those of normal controls. High resting pain levels indicate a more severe form of WRULD leading to lower work capacity and risk of significantly elevated post-activity pain. As the right hands were statistically more affected both at rest and after the typing test on a standard QWERTY keyboard, this suggests that keyboard use alone may not be the only cause of WRULD in this patient group.

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