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## Changes in sitting posture after adjusting a wheelchair

— An interventional case approach in VDT work —

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### Abstract

The employment of disabled persons has increased since this became mandatory. On the other hand, adapting the work environment for the disabled has not been made compulsory for employers, so that some disabled employees complain of fatigue or physical pain after working. Disabled people with trunk impairments find that they cannot adjust to a comfortable sitting posture and therefore suffer from long periods of sitting. We implemented an intervention to adjust a work environment, focusing especially on the electric wheelchair. The subject was a 26-year-old female who has quadriplegia and sigmoidicity scoliosis. She works in a private company while suffering from lumbago. We evaluated her sitting posture and the wheelchair, made a new back-support cushion, and changed the wheelchair controller for one that opens to the side. After the intervention, sitting posture and lumbago improved, and the reach distance at her work desk was extended. This intervention improved her complaint by adjusting the work environment to her condition, without need of physical treatment.

**Key words :** Disabled people, Sitting posture, Adjustment to work environment

### Introduction

Since the Law for Employment Promotion, etc., of the Disabled was established in 1960, employment of the disabled became compulsory for employers, and the rate of employment has been increasing. The legally required employment rate was set at 1.8% of all employees; the actual rate in 2012 was 1.69%. The Ministry of Health, Labor and Welfare reported that 46.8% of the companies concerned had achieved the legal employment rate in 2012, which was 1.5% higher than in 2011 (Ministry of Health, Labor and Welfare 2012).

The required employment rate was increased to 2.0% in 2013 for private companies, and actual employment might increase due to efforts by those companies. On the other hand, adapting the work environment to the disabled has not been made compulsory. Clearly, the level and nature of handicaps vary, making it difficult to adjust for each disabled person. The feasibility of adapting a

work environment, therefore, depends on the specific problems of the disabled person, and many such persons still complain of pain or the fatigue of trying to adjust to an environment. In a study of secondary disabilities of adults with cerebral palsy (CP), it is reported that many of them work in companies, but almost half of those have physical and psychological troubles (Kajiura, 1998).

Persons with trunk impairments, in particular, suffer from sitting in an uncomfortable posture for long periods of time. Even healthy people using visual display terminals (VDT) stare at the display in the same position and notice eye strain or neck and low back stiffness and pain after working for a long time (Iwakiri et al. 2004).

Employers should be required to improve the working environment so as to facilitate a comfortable posture for disabled persons who find difficulty in correcting their posture or sitting position. More generally, to enable disabled persons to continue in their job, and to prevent fatigue and

secondary disorders, the working environment should be adjusted to them. Tujimura, et al. maintain that this measure has not been done in Japan (Tujimura et al. 2009). The first step needed is reducing the physical and psychological burdens involved in the job of each disabled individual (Tujimura et al. 2011).

In our study, we intervened to adjust the sitting posture of a disabled person with lumbago working in a private company.

### Subject and Method

The subject was a 26-year-old female who has quadriplegia sequelae caused by traumatic brain injury. Before intervention, we explained to the subject and her employers the purpose and the method of the intervention. We then implemented the measures of intervention in her office four times. The subject had had a traffic accident at age six. After the traumatic brain injury, she suffered from quadriplegia, hydrocephalus, and sigmoidicity scoliosis, which presented a left side convexity on the thoracic spine and a right side convexity on the lumbar spine. At the age of 14, she had an operation for scoliosis fixation and received a metallic implant. At 16 she had a re-operation for a better fixation. A VP shunt operation was done for hydrocephalus at 18. She usually uses an electric wheelchair and has been working part-time in the same office 4 days a week for the past 2 years, with mainly filing and VDT work. She drives to work on her own, and uses an electric wheelchair at work and in her daily life.

Her chief complaint was lumbago and fatigue. She is seated in the electric wheelchair for 7 hours when at work. After working, her erector spinae muscle and shoulder girdle muscles (Trapezius and Elevator scapulae) and neck muscles became severely stiff. As a result, she complained of lumbago, which seemed to crush her left lumbar vertebral column. She also felt exhaustion and needed to rest after returning home.

Her spine alignment in a sitting posture was as follows: the thoracic spine (Th) had a left side convexity and right rotation; the lumbar spine had a right side convexity, left rotation and lordosis; the pelvic bone was on anteverision and left rotation.

The spine from Th1 vertebra to the pelvic bone was fixed with a metallic implant. Only the cervical spine was able to move, although the active range of rotation to the right and left was only 5 degrees. The adductor muscles and the triceps calves of both legs presented spasticity, easily

causing hyper tonus not only while moving, but also merely with some weight bearing on the soles of her feet.

We took digital photos of her sitting posture in the wheelchair and then evaluated her posture and the wheelchair. Her reach distance at the desk was also measured. After 1 week of intervention, we interviewed her for her subjective opinion.

### Evaluations of the wheelchair sitting posture and the desk environment

The wheelchair sitting posture was as follows: she leaned to the right with arms on the elbow rests. As she did VDT work, the trunk and pelvis were in anteversion, and the right elbow was not on the desk.

The electric wheelchair which she uses in the office was made 6 years ago and had not been serviced for 4 years. It had some problems: 1. the back support was loose; 2. the centre of the seat surface was depressed; 3. the back of seat cushion was depressed; 4. the back support cushion did not adjust to her spinal curve, and the lateral supports were not functioning as a trunk supporter; 5. the controller of the electric wheelchair had been set on the top of the arm rest, which interfered with approaching the desk by not allowing the wheelchair to be rolled under the desk.

There was a personal computer (PC) in the center of her desk, and a laptop computer on the right side of the desk.

The distance from the desk edge to the PC keyboard was 26.0 cm while she was doing VDT work; the distance from her eyes to the display was 62.0 cm; and from abdomen to desk edge 13.0 cm. The reach distance was also measured. The left hand reaching to the front was 56.0 cm, the right hand reaching to the front was 53.0 cm, the right hand reach diagonally to the right was 58.0 cm (Table 1).

From these observations we judged the following to be causes of fatigue and lumbago: the loose back support and the depression of the seat surface and of the seat cushion made her lower trunk fall into the back of the wheelchair while sitting, and the unadjusted back support cushion prevented a comfortable sitting; and dysfunctional lateral support caused the body to slide to one side. Also, the wheelchair controller was an obstacle to approaching the desk, so that the person had to lean the trunk and pelvis forward and approach the desk diagonally. As a result, the right elbow was not on the desk, and sitting

Table 1 Changes in the working environment before and after intervention

	Desk environment (cm)		Reach distance (cm)		
	Before	After		Before	After
Desk-keyboard	26.0	30.0	Lt. hand (front)	56.0	60.0
Eyes-Display	62.0	53.0	Rt. hand (front)	53.0	56.0
Abdomen-Desk	13.0	7.0	Rt. hand (diagonally right)	58.0	61.0

posture showed more of a leaning to the right. To solve these problems, we implemented the intervention.

**Intervention**

To solve the above problems 1 to 5 of the wheelchair, the following measures were taken: for problem 1, while the person was sitting in the wheelchair, we fastened an appropriate Velcro. For 2 and 3, the depression of the seat surface was flattened with a curved cushion. For the back support cushion of 4, urethane foam was carved to conform to her scoliosis shape; and lateral supports on both sides of the back support were attached in order to maintain posture while working (Figure 1).

The seat surface was thereby heightened, so that we also raised the foot plate by 4 cm and the arm rest by 1cm.

After these adjustments, the trunk was stabilized and the person could lean on the back support comfortably, and, with the lateral supports, lean the trunk less to the right. The forced sitting posture when shifting to the right was thereby alleviated (Figure 2). For problem 5, we changed the controller for one which opens to the side.

This shortened the distance to the desk by 7 cm, eliminating the need of resorting to anteversion of the trunk and pelvis; and her reach distance was thereby extended (Table 1). She was then able to put her right elbow on the desk, which facilitated maintaining a comfortable posture.

Thus, after this adjusting, the problem of trunk and pelvis leaning to the right was overcome. The back support and lateral support cushions adjusted to her back and trunk meant more comfortable sitting; and the controller opening to

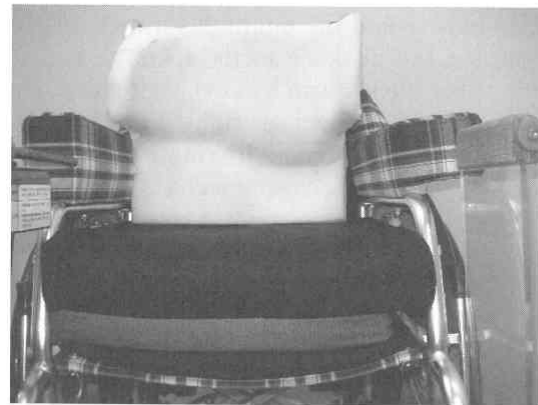


Figure 1 Back Support cushion with Side Supports



Before



After

Figure 2 A Frontal view of the changes in sitting posture before and after intervention

the side enabled approaching the desk easily.

She could thereby do VDT work comfortably while sitting and could reach further. We interviewed her 1 week later. She felt that her trunk had become more stable, and she had no complaints about low back pain. She could also feel that her hip joint moved more easily. One week was too short to decrease fatigue, but she had no other pain or complaint.

## Discussion

Before intervention, the back support and the seat surface were loose, and the seat cushion was depressed, so that the person's lower trunk fell into the back of the wheelchair. The wheelchair controller on top of an elbow rest interfered with approaching the desk. Even with a limited spinal range of motion, she had to lean trunk and pelvis forward with excessive contraction of the erector spinae muscle and the multifidus muscle in order to shorten the distance to the monitor for VDT work. Also, the left arm had to be extended to use the keyboard without a right elbow support, which caused the trunk to rotate to the right while she also leaned to the right.

The original lateral supports could not prevent leaning to either side, so that she had to maintain her posture with muscle contraction. So, hyper-tonus of the muscles must have been the cause of the lumbago. The lateral supports which fit the curve of her rib cage providing a wide contact area which would press more lightly upon the thorax. These supports thereby facilitate stabilizing the trunk (Engstrom, 1997). Also, the lateral supports are effective for controlling the spinal alignment (Cooper, 2000). The new lateral supports, therefore, can support the person's posture during VDT work and contribute to comfortable sitting.

Generally, the hyper-tonus of the muscles of the lower extremities (L/E) is a consequence of the kinetic chain, since the trunk and pelvis are in anteversion while sitting. Furthermore, this posture loads her weight onto the anterior part of the foot, promoting hyper tone of the triceps calf. The pressure applied to the sole of the foot affects many joints (Engstrom, 2003). This person has spasticity of the triceps calf and adductor muscles, therefore, VDT work posture facilitated L/E hyper-tonus.

Thus, the original state of the wheelchair created an uncomfortable sitting posture, leading to the muscle hyper-tonus and causing fatigue and lumbago. To solve these problems, we intervened

in the environment, focusing on the electric wheelchair. After intervention, the person no longer needed anteversion of the trunk and pelvis, eliminating the hyper-tonus of L/E and back muscles. Also, she can now put both elbows on the desk, so, the trunk shift was decreased. Without physical treatment, therefore, we were able to solve much of her problem by adjusting her work environment.

This study indicates, more generally, that the physical complaints of a disabled person on the job can at times be treated by focusing on the working environment, thus facilitating a healthier life.

This was a case involving physical handicaps only. The results indicate that more people with disabilities that are strictly physical can be hired if the work environment is adjusted to their needs.

Although it is possible in childhood to have wheelchair service and medical support to accompany growing up, for a working adult, it is less common. For this reason, perhaps, many disabled people are unaware of a connection between an uncustomized wheelchair and problems of posture; and this could be a cause of secondary disorders. "A multidisciplinary approach is essential in finding solutions for wheelchair users who would otherwise be hindered from performing their jobs in environments that are not appropriately modified" (Troy et al. 1997).

Given the wide range of handicaps people suffer, it is difficult to adjust the environment for each person. Employers will need to provide the suitable assistance in each case.

It is also crucial to clarify the role of physical therapists in the task of improving a working environment and to provide physical therapists in private companies, specifically, with the necessary instruction and training for this effort. In the future, the physical therapist should be required to prevent secondary disorders in disabled people and thereby facilitate their long-term employment.

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