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Original Article

Comparison of upper extremity function, pain, and tactile sense between the uneffected side of hemiparetic patients and healthy subjects

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Abstract. [Purpose] The aim of this study was to compare the unaffected upper extremity of patients with hemiparesis with that of healthy subjects in terms of function, pain, and tactile sense. [Subjects and Methods] Upper extremity evaluation parameters of 20 patients with hemiparesis were compared with an age-matched control group of 20 healthy subjects. A shorter version of the Disability of Arm and Shoulder Questionnaire, Upper Extremity Functional Index, and Simple Shoulder Test were used to evaluate the upper extremity functionality. The Visual Analog Scale was used to measure pain severity at rest, at night, and during activity. Tactile sensation levels were assessed by Semmes-Weinstein monofilaments at four palmar areas. [Results] A statistically significant difference was found in the upper extremity functionality between the groups. Pain severity at rest was significantly higher in the hemiparetic group. There was no significant difference in night and activity pain severities or tactile sensation levels between the groups. [Conclusion] According to our results, the unaffected side of patients with hemiparesis differs in functionality and pain at rest compared with that of healthy persons. Studies with larger sample size and various evaluation tests are needed to further investigate the unaffected side of patients with hemiparesis.
Key words: Hemiplegia, Upper extremity, Sensation

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INTRODUCTION

Stroke involves rapid loss of brain function resulting from a disturbance in the blood supply to the brain; it often profoundly affects upper limb stability and movement capacity. Stroke is the third leading cause of death worldwide, and it is the leading cause of severe disability in patients in the developed world[1–3)].

Stroke adversely affects the quality of life of surviving patients. After a stroke, a person can suffer from paralysis of an arm; even if some movement control remains, patients use the affected arm less than the unaffected arm[4, 5)].The paralysis makes arm movements, such as reaching, grasping, and manipulating objects, difficult. Generally, patients with hemiparesis compensate for restricted movement and muscle weakness by primarily using the non-paretic side. As a result, the unaffected upper extremity mostly controls the activities of daily life[6, 7)].

As the patient's unaffected hand plays a significant role in everyday life, whether or not the function of the unaffected hand following stroke is affected is directly related to the patient's survival and quality of life. Therefore, it is important to

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determine whether the function of the unaffected hand is changed in patients with stroke[8].

The unaffected side is often considered a reference point, and it is, therefore, assumed that this side has no deficit. Nevertheless, previous research suggests or tends to show diminished strength in the unaffected upper extremity (UE)in stroke survivors compared with healthy subjects, although two previous studies did not find any differences between the unaffected UE strength of patients with stroke and the same UE side of healthy subjects[9–13]. However, Bi Seng et al. compared the reaction time of healthy subjects and patients with stroke and found that the reaction times of wrist flexion and extension in the affected sides of patients following stroke were significantly longer than those in their unaffected sides and those of normal subjects[14].

The main objective of the present study was to compare the sensorimotor performance of the unaffected UE of subjects with post-stroke hemiparesis with that of a group of age-matched healthy subjects without UE deficits.

SUBJECTS AND METHODS

Twenty individuals with prior stroke and 20 healthy subjects were included in this study. The study was approved by the local Ethics Committee and conformed to the standards set by the Declaration of Helsinki. Written informed consent was obtained from all patients prior to data collection. The inclusion criteria were (1) age between 45 and 75 years; (2) hemiparesis due to ischemic or hemorrhagic stroke 1 month or longer before enrolment. Patients having cognitive impairment, dementia, or an acute brain lesion that caused consciousness problems were excluded.

UE physical function and symptoms were assessed using the Short form of the Disabilities of the Arm, Shoulder and Hand Score (QDASH), Upper Extremity Functional Index (UEFI), and Simple Shoulder Test (SST). Measurement of pain at activity, at rest and at night, was done using the Visual Analog Scale (VAS). A Semmes-Weinstein Monofilament Examination (SWME) (Semmes-Weinstein Monofilaments; North Coast Medical, Inc., Gilroy, CA, USA) was performed for light touch sensory assessment at four palmar areas.

The QDASH Outcome Measure is a self-report questionnaire designed to measure physical function and symptoms of the UE during that week the test was done[15]. UEFI is a self-report questionnaire that consists of 20 items rated on a 5-point Likert scale. The purpose of the questionnaire is to evaluate UE functional status in a variety of activities. Total scores ranges from 0 (lowest functional status) to 80 (highest functional status)[16]. The SST comprises of a series of 12 “yes” or “no” questions that the patient answers about the function of the involved shoulder (unaffected side of hemiplegic, and dominant side of healthy subjects). It is important that the patient answer these questions without assistance: it is the patient’s own evaluation of his or her shoulder function that is required[17]. The VAS is a one-dimensional measure of pain intensity. Using a ruler, the score is determined by measuring the distance (mm) on a 10-cm line between the “no pain” anchor and patient’s mark, providing a range of scores from 0–100. A higher score indicates greater pain intensity[18, 19]. The SWME is a noninvasive, low-cost, examination that provides rapid results; it is often used in clinical testing. The monofilaments are applied perpendicular to the test site until they bend, for about 1 s. In our study, we started with the 2.83 mm filament. If there was no response to the first application, a maximum of 3 attempts was performed, which is the recommended procedure to ensure that 1 of 3 stimuli is the intended threshold. If the filament was not sensed by the participant, a thicker filament was used, and if the filament was sensed, a thinner filament was used. The thinnest monofilament that could be sensed was recorded. The subjects closed their eyes during the examination. Testing points were distributed in 4 areas in the following order: the thenar area, thumb’s palmar surface, third finger’s palmar surface, and hypothenar area[20–22].

The patients’ descriptive variables, including age, gender, body mass index, duration of stroke, and affected side were recorded. The results were analyzed using the SPSS 20.00 software program. The variables are presented as the mean ± standard deviation (X ± SD). The differences between groups were tested using the Mann-Whitney U Test. A 95% level of confidence (α=0.05, or the margin of error) was assumed to identify the differences in the variance analysis.

RESULTS

Demographic properties of subjects are shown in Table 1. A statistically significant difference was found in QDASH, UEFI, and SST scores between groups ($p<0.001$) (Table 2). Pain severity at rest was significantly higher in the hemiparetic group ($p=0.046$). There was no significant difference in the nighttime ($p=0.973$) and daytime activity ($p=0.759$) pain severities between groups (Table 2). There was no difference in the tactile sensation levels between groups ($p>0.05$) (Table 2).

DISCUSSION

Because the unaffected UE of a patient plays an important role in their daily life, if the unaffected side were in fact affected, the patient’s quality of life would decline. According to our study, the unaffected side of patients with hemiparesis, when compared with healthy people, is different in terms of functionality and pain at rest.

Desrosiers et al.[11] compared the sensorimotor performance of the unaffected UE of elderly patients with stroke with that of healthy elderly people and found significant deficits in the unaffected UE of the hemiplegic/paretic group in gross manual dexterity, fine manual dexterity, motor coordination, global performance, and kinesthesia parameters. Zhang et al.[23]

revealed that the finger-tapping frequency of the unaffected hand of patients with central nervous system injury was different compared to those with peripheral nerve injury and dominant hands of healthy individuals. Moreover, in children with hemiplegic cerebral palsy, Feng et al.[24] found that the 'unaffected' side may not be completely unaffected because in the full-body gait analysis, the energy recovery factor was lower when both the affected and the unaffected leg trailed than in typically developing children.

Hemi-cerebral injury can cause a movement disability of the ipsilateral limb. The disability of the ipsilateral limb is often hidden by hemiplegia in the opposite limb and sensation disorders, neither of which can be measured in a conventional clinical examination. Moreover, the ipsilateral cerebral hemisphere affects the ipsilateral limb function. With respect to neuroanatomy, 80% of nerves on one side of the precentral gyrusin the cerebral cortex cross over to the other side and control the opposite limb, whereas the left uncrossing nerves are situated directly in the anterior corticospinal tract to control the ipsilateral limb. As a result, the ipsilateral cerebral hemisphere has an effect on the ipsilateral limb function. In addition, when one side of the cerebral hemisphere is damaged by stroke, the patients' ipsilateral UE and hand function might also be influenced because of the existence of the uncrossed nerve fibers[25].

In patients with hemiparesis, the frequency of hand use decreases in daily life. Furthermore, family members always want to do everything for patients, and their direct help deprives the patients of the opportunity and desire to participate in daily activities[26].

We found no sensory reduction in the unaffected ipsilateral side in our study subjects. Sherwood noted that there were only few sensory neuron fibers following the ipsilateral cerebral cortex[27]. No study has investigated the pain on the unaffected side of patients with stroke. In our study, pain severity at rest was significantly higher in the hemiparetic group. However, there was no difference in pain during activity and at night between the groups. This result supports the finding that there was no sensory difference between the groups in our study. The pain at rest may be the result of decreased function of unaffected side.

The findings of this study reinforce the need, as revealed by other researchers, to not consider the ipsilateral UE as "unaffected"[28, 29]. Kitsos et al.[30] conducted a literature review on the sensory-motor deficits in the ipsilesional UE after stroke and recommended the use of the terms "most affected" for the contralesional UE and "less affected" for the ipsilateral UE.

When people suffer from stroke, they often ignore the movement disability of hemiparalysis and rehabilitation of the normal UE, and therefore, cannot obtain an accurate and comprehensive assessment and treatment. However, it is noteworthy that it is erroneous to equate the patients' "unaffected side" with a healthy person's "normal side". Therefore, rehabilitation therapists should intensify the functional activities of the normal UE. The limitations of this study are small sample size and not including the lower extremities. Further studies are needed to investigate the unaffected UE of patients with hemiparesis,

Table 1. Demographic properties of subjects

	Hemiplegic group x ± SD		Control group x ± SD
Age (years)	63.6 ± 13.2		59.2 ± 7.1
Height (cm)	166.8 ± 8.9		164.2 ± 7.1
Weight (kg)	76.4 ± 15.2		77.0 ± 10.5
BMI (kg/m^2)	27.5 ± 4.7		28.5 ± 3.4
Duration of the disease (days)	Min 30	Max 2,100	–

BMI: body mass index

Table 2. Comparing test results of the groups

	Hemiplegic group x ± SD	Control group x ± SD
QDASH	41.47 ± 22.92*	9.89 ± 9.21*
UEFI	39.90 ± 21.93*	72.50 ± 10.02*
SST	7.55 ± 2.06*	9.50 ± 1.10*
VAS rest	1.41 ± 1.98**	0.27 ± 0.69**
VAS night	0.66 ± 1.44	0.77 ± 1.69
VAS activity	1.91 ± 2.81	1.01 ± 1.55
Semmes–Weinstein Monofilament Test 1st area	2.30 ± 0.97	2.55 ± 0.88
Semmes–Weinstein Monofilament Test 2nd area	2.15 ± 1.03	1.90 ± 0.78
Semmes–Weinstein Monofilament Test 3rd area	2.10 ± 0.96	1.95 ± 0.88
Semmes–Weinstein Monofilament Test 4th area	2.10 ± 1.25	2.40 ± 0.82

*p<0.001, **p<0.05.
QDASH: Short form of the Disabilities of the Arm, Shoulder and Hand Score, UEFI: Upper Extremity Functional Index, SST: Simple Shoulder Test, VAS: Visual Analogue Scale

with a larger sample size, using various evaluation tests, and to explore the "unaffected" lower extremities. In addition, a more sensitive tool may be required in further studies to detect the sensory dysfunction in the unaffected side of patients with stroke.

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