J.Phys. Ther. Sci
24: 465-469, 2011

Comparisons of Respiratory Function and Activities of Daily Living between Spinal Cord Injury and Stroke Patients and Normal Elderly People

JEONGAE YOON, MS, OT[1)], JUNGSEO PARK, MS, PT[2)], DAEHEE LEE, PhD, PT[2)], HYOLYUN ROH, PhD, PT[3)]

[1)] *Department of Occupational Therapy, Youngdong University*
[2)] *Major in Physical Therapy, Department of Rehabilitation Science, Graduate School Daegu University*
[3)] *Department of Occupational Therapy, Kangwon National University: Hwango-ri, Samcheok-si, Gangwondo, 240-907 Republic of Korea.*
TEL: +82 33-540-3481, FAX: +82 33-540-3489, E-mail:withtry@kangwon.ac.kr

Abstract. [Purpose] The aim of this study was to analyze and compare respiratory function and activities of daily living (ADL) of spinal cord injury (SCI) and stroke patients and normal elderly people, as well as to examine the relationship between respiration and ADL in these groups. [Subjects and Methods] This study's subjects were patients with spinal cord injury (n=30) and stroke (n=31), one year or longer after onset of their conditions, and a control group of ordinary elderly people (n=30). Measurements were made of their vital capacity (VC), forced vital capacity (FVC), forced expiratory flow (FEF), forced expiratory volume at one second (FEV1), FEV1/FVC, peak cough flow (PCF), and activities of daily living (ADL). [Results] The SCI and stroke groups had lower VC than the control group; the SCI group had the lowest value. The stroke group had the lowest FVC. There were no significant differences among the three groups in FEF, FEV1, or FEV1/FVC. The ADL of the SCI group showed significant differences according to the SCI level. Regarding the relationship between respiratory function and ADL, in the SCI group, the better their respiratory function was, the better their ADL became; there was no relationship between the two variables in the stroke group. The control group of healthy elderly was better able to climb stairs when they had better respiratory function. [Conclusion] We consider a physical therapy program accompanied by breathing execercise is necessary for SCI patients to improve ADL, and for stroke patients to prevent respiratory complications.

Key words: Activities of daily living, Respiratory function, Spinal cord injury

(This article was submitted Jul. 11, 2011, and was accepted Aug. 27, 2011)

INTRODUCTION

Due to mechanization and the aging of the population, the number of stroke and SCI patients is on the rise. These patients are apt to suffer from chronic sequelae or complications. In particular, complications resulting from respiratory weakness are known to have severe negative effects for family members, as well as on the patients themselves[1)]. For proper respiration, cooperation of the muscles engaging in respiration and adequate movement of the thorax area are necessary[2)]. However, the majority of patients with central nervous system diseases succumb to restrictive pulmonary diseases with decreased function of the lungs and thorax and reduced vital capacity, due to respiratory muscle dysfunction[1)]. In particular, cardiopulmonary function in stroke patients is directly or indirectly influenced by decreased movement of the thoracic wall and reduced electrical activity in the affected side of the body[3)]. Such cardiopulmonary dysfunction in stroke patients is directly related to their survival[4)]. Furthermore, patients whose central nervous system has been damaged have weakened cough function and sputum removal ability, resulting from paralysis of their respiratory muscles. This condition may lead to the accumulation of secretions in the respiratory tract, causing various respiratory complications, such as pneumonia and atelectasis[5)]. It has been reported that, among SCI patients, those with cervical spinal cord injury, thoracic spinal cord injury, and lumbar spinal cord injury have 46%, 82%, and 80% of normal average vital capacity, respectively[6)]. Overall, their average vital capacity decreases by more than 70% compared to their vital capacity before the spinal cord injury. In particular, their ventilator capacity and ability to discharge secretions degenerate, and numerous respiratory complications are triggered by weakened respiratory muscles, e.g. the external intercostal muscles, internal intercostal muscles, and abdominal muscles[7)]. Respiration provides oxygen for ADL, and as a result, respiratory disturbances influence patients' ADL[8)]. Therefore, respiratory problems in patients with central nervous system injuries are crucial factors in their rehabilitation and survival[9,10)], and evaluation of the functions and conditions of such patients' respiratory systems is a useful method for ascertaining and assessing their current health condition[11) .

Accordingly, this study analyzed and compared the respiratory function and ADL of SCI and stroke patients and those of normal elderly people, and examined the relationship between their respiration and ADL.

SUBJECTS AND METHODS

The subjects of this study were 31 chronic stroke patients, 30 SCI patients and 30 normal elderly people, who visited C hospital, who had no cardiopulmonary disease, and were capable of independent ADL. The subjects were selected from among those whose mini-mental state examination-Korean version score was 24 or higher and could fully understand and comply with therapists' instructions. After the selection of the subjects, the study's method and purpose were explained to the subjects and their guardians, and their voluntary consent was obtained. All subjects signed an agreement to participation before the start of the study. Regarding the general characteristics of the subjects, the control group of ordinary elderly patients had the oldest average age, the SCI group had the highest average height, and the stroke group had the heaviest average weight (Table 1).

A MicroPeak peak flow meter (Micro Medical, Ltd. UK) was used to measure the subjects' vital capacity (VC), forced vital capacity (FVC), forced expiratory flow (FEF), forced expiratory volume at one second (FEV1), FEV1/FVC, and peak cough flow (PCF). The subjects received sufficient education in the instrument's use before measurement. They were seated on a comfortable chair in a forward-facing posture, and they were measured three times, with the highest measurement being recorded. Prior to measurement, the subjects did not engage in any activities that could affect their respiration, such as exercising or climbing stairs. They rested for about 10 minutes in quiet environment, then participated in the measurement. The measurement of each item for vital capacity was performed by the same experienced examiner. The Modified Barthel Index (MBI) was used to measure the subjects' ADL. The MBI is designed to measure the degree of independence in subjects' ADL and consists of 15 specific ADL motions. For each motion, one of four different grades is assigned, giving a maximum possible total score of 100. Scores of 0~20 indicate complete dependence, 21–61 indicate severe dependence, 62–90 indicate moderate dependence, 91–99 indicate mild dependence, and 100 indicates perfect independence[12)]. SPSS 12.0 for Windows was used to analyze the collected data, and the one-way ANOVA test was performed to compare the respiratory function and ADL of the SCI and stroke patients with the control group. For a post hoc analysis, Scheffé's method was employed. The correlation between the participants' respiratory function and ADL was examined with Pearson correlation coefficients. Findings were considered statistically significant at p values of less than 5%.

Table 1. General Characteristics of the Subjects

Variables	SCI (n=30)	Stroke (n=31)	General (n=30)
Age (years)	46.0 ± 12.8	61.9 ± 10.9	66.8 ± 8.0
Height (cm)	170.9 ± 6.1	166.0 ± 5.3	166.9 ± 5.1
Weight (Kg)	61.0 ± 10.8	67.1 ± 7.1	64.6 ± 12.6

RESULTS

The results of the VC comparison among SCI and stroke patients and ordinary elderly people show that there were significant differences among the three groups ($p<0.01$), with the SCI group recording the lowest average value. Scheffe's test indicated that the control group of ordinary elderly people had the highest average VC value. There were also significant differences in FVC among the three groups, with the stroke group recording the lowest average value. The average FVC of the control group was highest according to Scheffe's test. There were no significant differences in FEF or FEV1/FVC among the three groups. However, the three groups showed significantly different PCF results ($p<0.01$). According to Scheffe's test, the stroke group had the lowest PCF (Table 2). The comparison of ADL among the three groups showed that there were significant differences ($p<0.01$), with the control group recording the highest value, followed by the stroke group, and then the SCI. The SCI group was severely dependent, the stroke group was moderately dependent, and the control group was mildly dependent according to MBI (Table 2).

The ADL and respiratory function were compared by SCI level. Respiratory function showed no significant differences, according to the SCI level. In ADL, grooming ($p<0.001$), bathing ($p<0.001$), feeding ($p<0.01$), toilet use ($p<0.001$), dressing ($p<0.001$), transfers from bed to wheelchair and back ($p<0.001$), and transfers from bed to chair and back ($p<0.001$) showed significant differences (Table 3). VC showed positive correlations with grooming ($r=0.409$), feeding ($r=0.472$), and transfers from bed to wheelchair and back ($r=0.378$). FVC showed positive correlations with grooming ($r=0.413$), bathing ($r=0.366$), feeding ($r=0.482$), transfers from bed to wheelchair and back ($r=0.396$), and transfers from bed to chair and back ($r=0.389$). Their PCF had positive correlations with grooming ($r=0.469$), bathing ($r=0.436$), feeding ($r=0.443$), toilet use ($r=0.464$), dressing ($r=0.478$), transfers from bed to wheelchair and back ($r=0.488$), and transfers from bed to chair and back ($r=0.540$). There were some items without any correlation in the SCI group, but the better their respiratory function was, the better their ADL was (Table 4).

In the stroke group, there was a positive correlation between FEF and transfers (from bed to wheelchair and back) ($r=0.372$) only; there was no correlation between VC or FVC and ADL (Table 5). The VC of the control group showed a positive correlation with stairs ($r=0.377$); their FVC showed positive correlations with dressing ($r=0.398$) and stairs ($r=0.478$); and their PCF showed positive correlations with bathing ($r=0.367$), toilet use ($r=0.417$), and stairs ($r=0.626$). Regarding difficult motions such as using stairs, the control group's ADL was good when they had good

Table 2. Comparison of Respiratory Function and ADL among the SCI and Stroke Groups and the Control Group (M ± SD)

Variables	SCI (n=30)[a]	Stroke (n=31)[b]	General (n=30)[c]	Scheffé
VC (%)**	55.5 ± 22.4	57.8 ± 18.7	76.8 ± 18.4	a, b <c
FVC (*l*)*	2.5 ± 1.0	2.3 ± 0.9	2.9 ± 0.8	b, a <c
FEF (*l*/s)	91.1 ± 72.4	105.5 ± 56.2	87.7 ± 50.7	–
FEV1/FVC (%)	55.2 ± 20.5	59.9 ± 18.7	52.8 ± 16.5	–
FEV1 (*l*)	1.3 ± 0.5	1.4 ± 0.7	1.5 ± 0.5	–
PCF (ml)**	335.3 ± 137.5	211.0 ± 99.1	309.0 ± 115.7	b <a, b <c
MBI (point)***	46.2 ± 21.5	74.2 ± 21.4	92.0 ± 3.7	a <b <c

* p<0.01, ** p<0.05, *** p<0.001, VC: vital capacity, FVC: forced vital capacity, FEF: forced expiratory flow: FEV1/FVC: forced expiratory volume in 1 second / forced vital capacity, FEV1: forced expiratory volume in 1 second, PCF: peak cough flow, MBI: modified Barthel index.

Table 3. Respiratory Function and ADL in the SCI Level

Variables	CI (n=13)[d]	TI (n=10)[e]	LI (n=7)[f]	Scheffé
VC (%)	50.0 ± 18.4	50.5 ± 25.5	72.7 ± 17.7	–
FVC (*l*)	2.3 ± 0.8	2.3 ± 0.8	3.3 ± 0.8	–
PCF (*l*/s)	285 ± 120	362 ± 153	415 ± 126	–
Grooming***	2.62 ± 1.9	5.0 ± 0	4.9 ± 0.4	d> e,f
Bathing***	1.8 ± 2.3	4.1 ± 1.0	4.3 ± 1.9	d> f, e
Feeding**	5.9 ± 4.0	10 ± 0	10 ± 0	d> e,f
Toilet use***	4.6 ± 4.2	10 ± 0	8.6 ± 3.8	d> f, e
Dressing***	4.9 ± 3.9	10 ± 0	10 ± 0	d> e,f
Bowels	0.6 ± 2.2	0.2 ± 0.6	1.7 ± 2.4	–
Bladder	0.2 ± 0.6	0.8 ± 2.5	0	–
Transfers (bed to wheelchair and back) ***	3.2 ± 1.2	5 ± 0	4.7 ± 0.8	d> f, e
Transfers (bed to chair and back) ***	7.2 ± 5.6	14 ± 2.3	15 ± 0	d> f, e

** p<0.05, *** p<0.001, VC: vital capacity, FVC: forced vital capacity, PCF: peak cough flow, CI: cervical injury, TI: thoracic injury, LI: lumbar injury.

Table 4. Correlation between Respiratory Function and ADL in the SCI Group

Variables	VC (%)	FVC (l)	PCF (l/s)
Grooming	0.409*	0.413*	0.469**
Bathing	0.321	0.366*	0.436*
Feeding	0.472**	0.482**	0.443*
Toilet use	0.323	0.359	0.464**
Dressing	0.321	0.356	0.478**
Bowels	0.083	0.077	0.073
Bladder	–0.157	–0.160	–0.039
Transfers (bed to wheelchair and back)	0.378*	0.396*	0.488**
Transfers (bed to chair and back)	0.341	0.389*	0.540**

* p<0.01, ** p<0.05, VC: vital capacity, FVC: forced vital capacity, PCF: peak cough flow.

Table 5. Correlation between Respiratory Function and ADL in the Stroke Group

Variables	VC (%)	FVC (*l*)	FEF (ml)
Grooming	0.043	0.042	0.129
Bathing	0.213	0.140	-0.010
Feeding	0.168	0.216	0.010
Toilet use	0.244	0.197	0.148
Dressing	0.238	0.223	0.013
Bowels	–0.132	0.080	0.119
Bladder	–0.046	0.003	0.069
Mobility (on level surfaces)	0.075	–0.021	–0.229
Transfers (bed to wheelchair and back)	0.124	0.170	0.372*
Transfers (bed to chair and back)	0.255	0.231	0.178

* p<0.01, VC: vital capacity, FVC: forced vital capacity, FEF: forced expiratory flow.

Table 6. Correlation between Respiratory Function and ADL in the Control Group

Variables	VC (%)	FVC (l)	PCF (l/s)
Grooming	0.288	0.276	0.295
Bathing	0.082	0.061	0.367*
Toilet use	0.139	0.268	0.417*
Dressing	0.308	0.398*	0.350
Stairs	0.377*	0.478**	0.626**
Bowels	0.007	0.010	–0.059
Bladder	0.065	0.111	0.265
Mobility (on level surfaces)	0.010	–0.065	0.290
Transfers (bed to chair and back)	0.170	0.242	0.256

* p<0.01, ** p<0.05, VC: vital capacity, FVC: forced vital capacity, PCF: peak cough flow.

respiratory function (Table 6).

DISCUSSION

This study was conducted to compare and analyze the respiratory function and ADL of SCI patients, stroke patients, and a control group of healthy elderly, and to examine correlations among them. In this study, the SCI group recorded the lowest VC, and the stroke group recorded the lowest FVC. Kim et al.[13] reported that the average VC and FVC of patients with stroke were reduced to 79% and 76% of normal levels, respectively. As a result, most stoke patients tended to have restrictive pulmonary diseases. In a study of healthy people and stroke patients, Leslie et al.[14] reported that the stroke patients had shorter respiratory cycles and higher respiratory rates than the healthy subjects, results which are similar to those of this study. We consider the reason VC was low in the SCI group while FVC was low in the stroke group is because of increased muscle and chest wall rigidity and difficulty in voluntary movements[15].

In this study, there were no significant differences in FEV1, FEV1/FVC, or PEF among the three groups, probably because the stroke and SCI groups were younger than the control group and although the control group had no problems with their cardiopulmonary function, their relatively older age was a likely contributory factor. PCF was low in the stroke group and numerically at a dangerous level. In order to generate efficient coughs that are essential for removing secretions, inhalation of sufficient air should precede normal contraction of the expiratory muscles to sufficiently increase pressure in the chest wall[16]. However, in the stroke group, weakened intercostal muscles accompanied by increased chest wall rigidity decreases movement of the ribs and lowers the distending pressure that expands the lungs, ultimately leading to reduced lung capacity[15]. This study's result that the stroke group showed reduced FVC and PCF supports the conclusions of studies that stroke patients' survival is directly affected by their weakened cardiopulmonary function [4]. SCI levels, ADL items of grooming, bathing, feeding, toilet use, dressing, and transfers showed significant differences among and cervical injury gave the lowest scores. The SCI group had the lowest ADL scores. This result is inconsistent with the results of Jeong and Park[17] who studied patients hospitalized in an acute state. They reported that the ADL of their SCI group was higher than that of their stroke group. We attribute the difference to the fact that most of the SCI patients who participated in the present study used a catheter to void; therefore, restricted urination and defecation control lowered their ADL scores. Conversely, the stroke group consistently took part in rehabilitation treatment and, as a result, their functional levels greatly improved. According to our present results, the higher VC the SCI patients had, the better their ADL was, whereas in the stroke group the correlation between VC and ADL was low. In the control group of ordinary elderly people, there was correlation between their VC and ADL when performing difficult motions such as using stairs. Whereas Leslie et al. [14] asserted that there was no relationship between respiration at rest and ADL, Lee et al. [18] presented a result similar to this study's; patients with chronic obstructive pulmonary diseases with symptoms of dyspnea saw their ADL decrease, and those with central nervous system diseases had their ventilation affected and their inefficient neuromuscular activities increased fatigue during respiration and obstructed their daily life. Our present results were in agreement with those of Ryu et al.[19], who found that there was a significant relationship between improved respiratory function and enhanced ADL in SCI patients. However, our present results were not consistent with those of Kim et al.[20], who found a correlation between respiratory function and ADL in stroke patients. Our results indicate that the respiratory function of the SCI group influenced their ADL. In addition, FVC and PCF, which are considered causes of respiratory complications, were low in the stroke group[7]. Therefore, we consider a treatment program that provides breathing exercise is necessary to enable SCI patients to enhance their ADL and for stroke patients to prevent respiratory complications.

The limitations of this study were that the subjects were patients of a single hospital, the number of participants was small, and we did not analyze and verify differences in accordance with degrees of SCI. Thus, future research of differences resulting from varying degrees of spinal cord injury will be necessary.

REFERENCES

1) William M, Fowler JR: Rehabilitation management of muscular dystrophy and related disorders: II. comprehesive care. Arch Phys Med Rehabil, 1982, 68: 322–328.
2) Frownfelter D: Breathing exercise and retraining chest mobilization exercise. In: Chest Physical Therapy and Pulmonary Rehabilitation: an

Interdisciplinary Approach (2nd ed.). Chicago: Mosby-Yearbook, 1987, pp153–178.
3) Frownfelter D, Dean E: Cardiovascular and pulmonary Physical Therapy-Evidence and Practice(4th ed.). Philadelphia: Mosby, 2006, pp704.
4) Skinner JS: Exercise Testing & Exercise Prescription For Special Cases : Theoretical Basis & Clinical Application (3rd ed.). Philadelphia: Lippincott Williams & Wilkins, 2005.
5) Fugl-Meyer AR, Linderholm H, Wilson AF: Restrictive ventilatory dysfunction in stroke: its relation to locomotor function. J Scand Rehabil Med, 1983, 9: 118–124.
6) Kang CH, Park YO, Kim DO: Respiratory function in chronic spinal cord injuries. J Korean Acad Rehabil Med, 1984, 8: 161–168.
7) Reines HD, Harris RC: Pulmonary complications of acute spinal cord injuries. Neurosurgery, 1987, 21: 193–196.
8) Plum E: Neurological integration of behavioural and metabolic control of breathing. In: Parker R, ed. Breathing: Hering-Breuer centenary symposium. Churchill: Wiley, 1970, pp 314–326.
9) Roth EJ, Nussbaum SB, Berkowitz M, et al.: Pulmonary function testing in spinal cord injury: correlation with vital capacity. Paraplegia, 1995, 33: 454–457.
10) Teixeira-Salmela LF, Parreira VF, Britto RR, et al.: Respiratory pressures and thoracoabdominal motion in community-dwelling chronic stroke survivors. Arch Phys Med Rehabil, 2005, 86: 1974–1978.
11) Kim K, Seo KC: The effect of pulmonary function and chest length in the stroke patients after feedback breathing exercise among position changes. J Special Education & Rehabil Science, 2010, 49: 57–74.
12) Mahoney FI, Barthel DW: Functional evaluation: The Barthel index. Md Med J, 1965, 14: 61–65.
13) Kim JH, Hong WS, Bae SS: The Effect of Chest Physical Therapy on improvement of Pulmonary Function in the Patients with Stroke. J Korean Soc of Physi Ther, 2000, 12: 133–144.
14) Leslie P, Drinnan MJ, Ford GA, et al.: Resting respiration in dysphagic patients following acute stroke. Dysphagia, 2002, 17: 208–213.
15) Estenne M, De Troyer A: The effect of tetraplegia on hest wall statics. The American Review of Respiratory Disease, 1986, 134: 121–124.
16) Scanlan C, Myslinski MJ: Bronchial hygiene therapy. In Egan's fundamentals of respiratory care (7th ed), St. Louis: Mosby, 1999, pp 792–793.
17) Jeong HS, Park HS: The relationship between activity daily living and powerlessness of spinal cord injury patient's. J Korean Rehabil Nurs, 2004, 7: 197–206.
18) Lee RN, Graydon JE, Rose E, et al.: Effect of psychological well being, physical status, and social support on oxygen-dependent COPD patients' level of functioning. Research in Nursing & Health, 1991,323–328.
19) Ryu SR, Shin AY, Han JY, et al.: The effectiveness of pulmonary rehabilitation program on functional improvement in patients with spinal cord injury. J Korean Acad Rehabil Med, 2008, 32: 32–37.
20) Kim BR, Chun MH, Gang SH: Change of respiratory function following rehabilitation in acute hemiplegic stroke patients. J Korean Acad Rehabil Med, 2009, 33: 21–28.