대한물리의학회지 제7권 제1호, 2012년 2월
Vol.7, No.1, February 2012. p.119~124

The Study of Functional Independence and Bone Mineral Density in Athletes With Spinal Cord Injury

Hwa-kyung, Shin, PT, PhD, Youn-joung, Kim, PhD[1]

Department of Physical Therapy, Catolic University of Daegu

척수 손상을 가진 운동선수와 비운동선수의 일상생활 기능과 골밀도 비교연구

신화경 · 김연정

대구가톨릭대학교 물리치료학과

〈초록〉

목적 : 본 연구는 척수손상환자들 중 신체활동 정도가 급격하게 차이 나는 운동 선수군과 비선수군의 일상생활 동작과 골밀도를 비교 분석하는데 그 목적이 있다.

방법 : 본 연구를 위해 20명(선수 10명, 비선수 10명)의 SCI 환자가 실험에 참가하였다. 골밀도 측정을 위해 이중에너지 방사선골밀도 측정기(Lunar Prodigy, GE Healthcare. England)를 이용하여 종골부위(calcaneus)의 골밀도를 측정하였다. 척수손상환자의 일상 생활 기능을 측정하기 위해 자조관리(self care), 호흡과 괄약근 조절(respiration and sphincter management task), 이동(transfer)의 세 영역으로 나누어진 SCIMⅡ(Spinal Cord Injury Measurement Ⅱ)을 이용하였다.

척수손상환자들 중 운동 선수군과 비운동 선수군의 일상생활 동작과 골밀도를 비교 하기 위해 SPSS 14.0 통계 프로그램의 independent t-test를 이용하여 통계분석을 실시하였고 일상생활 동작과 골밀도의 상관관계는 Pearson correlation을 실시하였다. 유의수준은 α=.05로 통계처리 하였다.

결과 : 검사 결과 선수군이 비선수군보다 통계적으로 유의하게 큰 SCIM 점수와 T-score를 보여주었다.

결론 : 일상생활동작을 측정하기 위하여 SCIMⅡ(SpinalCordIndependenceMeasureⅡ) 척도를 사용하였는데 선수군이 비선수군에 비해 유의하게 높은 SCIMⅡ 총점을 나타내어 운동을 통한 훈련이 척수손상환자의 기능적 활동을 향상시킬 수 있다고 사료된다. 그리고 골밀도 측정 결과 선수군이 비선수군에 비해 통계적으로 유의하게 높은 골밀도를 나타내었다. 이 역시 강도 높은 훈련이 척수손상환자에게 나타날 수 있는 신체구성을 강화시켜 줄 수 있을 것으로 사료된다. 운동을 통한 재활 중에서 그 강도가 높을수록 신체의 구성적, 기능적 측면 뿐 아니라 신경의 가소성 측면에서도 증가를 기대해 볼 수 있을 것으로 판단된다.

교신저자 : Kim Youn-joung, E-mail: chris0125@daum.net.
논문접수일 : 2012년 01월 19일 / 수정접수일 : 2012년 01월 26일 / 게재승인일 : 2011년 02월 22일

Key Words : Spinal cord injury, Bone mineral density, SCIM

Ⅰ. Introduction

Since spinal cord injury [SCI] causes nerve damage within the spinal canal, it deteriorates the message passing function of the spinal cord to the body system that controls autonomic motor function. Therefore, it not only causes the loss of motor function and sense but also accompanies the loss of autonomic function related to urination and defecation as well as sexual function. Such outcomes bring diverse impact in terms of the psychology and social aspect of the people having SCI. (Choi Young Tae et al., 1992; ACSM, 1997).

Regular and continuous physical activities are known to alleviate vessel disease among those with SCI while increasing the life quality of ordinary people as well as the disabled as such activities increase cardiopulmonary endurance and bone density. (Kalrsson, 1993).

According to a study, however, the level of cardiorespiratory fitness among the national athletes with SCI was shown to be lower than a group of ordinary people in similar age. Such is due to the physical defect of those with SCI, who had low cardiorespiratory fitness; however, it is also due to the lack of opportunity for activities and absence of recognizing the necessity of physical activity owing to the lack of awareness of this fact among themselves. Reduced physical activity can increase disability and especially, those with SCI who have sedentary life tend to have increased body fat and cardiovascular disorders besides noticeable decrease in bone mineral content in the paralyzed lower limbs. In consideration of such facts, physical activity among people with SCI is believed to be essential (Figoni, 1993; Wilmet et al, 1995; Kocina, 1997).

Thus, it is thought to stress importance to physical activity among those with SCI and provide effective exercise method by examining the effect of bone mineral density, which is the key factor in terms of the physical activity among those with SCI, as well as physical independence. This study aims to access the ordinary movement and bone mineral density of those with SCI by comparing and analyzing the group of athletes and group of non-athletes that display radical difference in terms of physical activity.

Ⅱ. Methods

1. Subjects

Twenty men subjects with SCI (athletes=10 played as wheelchair basketball player and table tennis, non-athletes=10) were recruited for this study.

Table 1. Subjects anthropometric data (Mean±SD)

group	athletes(n=10)	non athletes(n=10)
age(yrs.)	43.92±8.02	34.25±8.34
hight(cm)	171.23±8.48	173.25±5.21
weight(kg)	64.38±12.36	67.33±11.96
injury level	T3 - L4	T4 - L2
time since injury(yrs)	15.90±9.64	9±7.05

2. Instruments and Measurements

1) Methods of ADL test

For the measurement of the aimed function in terms of ordinary life among those with SCI, SCIM II was used. SCIM II is an instrument that was developed for the people with SCI by Catz et. Al. (2001) after supplementing weaknesses of SCIM, and it is divided into three areas, such as self-care, respiration and sphincter management task, and transfer. The access of self-care is classified into 4 areas including meal, bath, changing clothes, washing face and making up, and the total score is 20 points. The respiratory muscle and sphincter management task include 4 areas, such as breathing, control of bladder sphincter, control of intestine sphincter, and handling after stool, and the total scores are 40 points. The last is the function of transfer, and it is composed of total 40 points. Mainly, it is divided into the items for the transfer from a room to the toilet and the transfer to indoor and outdoor(Shin, Young IL et al, 2007). In the items of transfer from a room to the toilet, 3 subcategories, such as transfer to a wheelchair from a bed, transfer from a wheelchair from the toilet, and transfer to a bathtub, are implemented. In the items of transfer to indoor and outdoor, 5 subcategories are used including indoor transfer within 10m, transfer in moderate level up to 100m, transfer to outdoor more than 100m, transfer through stairs, and transfer from a wheelchair to a vehicle.

2) Methods of body mineral density test

The test result of bone mineral density was expressed through Z-score or T-score. T-score is the value derived from the comparison between the average bone mineral density and that of the subjects from a group of young adults in same age frame while Z-score is the values that corrected the difference depending on age and sex by comparing the average bone mineral density and that of the subjects from a group of young adults in same age frame.

In this study, OsteoPro (BM Tech, Korea), which is quantitative ultrasound measurement system, was used for the measurement. The measured area was calcaneus, and the subjects participated in the measurement while comfortably sitting.

3. Analysis

Independence T-test was used to compare the group of athletes with group of non-athletes in bone mineral density(BMD) and motor function in individuals with SCI (SPSS ver. 14.0, $\alpha = .05$). Pearson correlation was used to find the relationship of BMD loss and functional independence after SCI. Normality of factors were tested by QQ-plot (satisfied).

Ⅲ. Results

1. ADL

The results derived from SCIM II (Spinal Cord Injury Measurement II) that was surveyed to measure the function of daily life of those with SCI are as follows (Table 2 & Figure 1). When comparing the group of athletes and that of non-athletes, self-care task was shown to be 16.14 (±2.34) and 10.25(±3.37), and the group of athletes had statistically significant value ($p<.05$). For respiration and sphincter management task, the group of non-athletesshowed slightly higher score than that of group of athletes having 21.00(±8.81) and 20.57(±1.71) respectively. However, statistical significance was not shown. Regarding indoor & out door transfer, the group of athletes had 9.29 (±2.28) while scoring 6.12(±2.17) for the group of

Table 2. ADL test(SCIM Ⅱ) for SCI athletes and non athletes

group	athletes(n=10)	non athletes(n=10)
self-care task	16.14±2.34*	10.25±3.37*
respiration and sphincter management task	20.57±1.71	21.00±8.81
indoor & out door transfer	9.29±2.28*	6.12±2.17*
total score	46.00±3.26*	37.37±8.19*

Note. *significant difference between athlete and the non athlete at p<.05

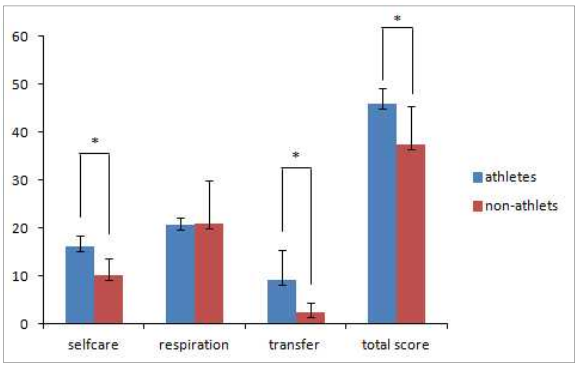


Figure 1. ADL test (SCIM Ⅱ)

non-athletes, showing statistically and significantly higher score in the group of athletes (p<.05). In the total score, the group of athletes showed 46.00 (±3.26) while the group of non-athletes scored 37.37(±8.19) and as you can see, the group of athletes showed statistically higher scores than that of the group of non-athletes (p<.05).

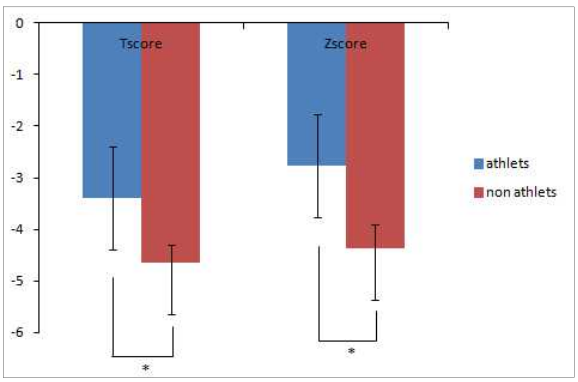
2. Body mineral density

The results derived from the bone mineral density between the group of athletes and group of non-athletes who were the people with SCI are as follows (Table 3 & Figure 2). In T-test that is frequently used for the evaluation of bone mineral density in general, the group of athletes showed significantly higher bone mineral density scoring -3.39(±1.01) than the group of non-athletes, which had -4.65(±0.36). According to the results of Z-score in consideration of the athletes' age, the group of athletes and group of non-athletes resulted

Table 3. BMD test(bone mineral density) for SCI athletes and non athletes

group	athletes(n=10)	non athletes(n=10)
T-score	-3.39±1.01*	-4.65±0.36*
Z-score	-2.76±1.29*	-4.37±0.46*

Note. *significant difference between athlete and the non athlete at p<.05, Standard deviation in parentheses.



Figrue 2. BMD test (bone mineral density)

-2.76(±1.29) and -4.37(±0.46) respectively, implying that the bone mineral density of the group of athletes was higher than that of the group of non-athletes, and the results were statistically significant(p<.05).

In the correlation between the ordinary movement and bone mineral density among the subjects, the P-value of each item was p<.05 implying that no correlation existed between those them.

Ⅳ. Discussion

This study compared and examined the relationship between the ordinary movement and bone mineral

density as well as the bone mineral density between the group of athletes and non-athletes that had relatively higher active mass among the people with SCI. The patients with SCIshow characteristics in terms of physical composition, such as increased body fat and decreased bone mineral density due to the reduced physical activity after the injury and sedentary life that relies onto a wheelchair (Ki, Seung-su et al., 2003; George et al., 1988; Wilmet et al., 1995). It is said that physical activity itself can increase or maintain the muscular strength while increasing the physical work efficiency (Kofsky, Shepard, Davis & Jackson, 1984).A study also said that 8-week exercise program for muscular strength contributed the ordinary movement of the patients with SCI by significantly increasing the total score of SCIM II (Sin, Yeong-il et. Al., 2007).

Kim, In-ae (2010) said that the group of athletes had significantly low subcutaneous fat than that of non-athletes among the people with SCI. Also, Kim, Seong-su et al., (2003) and Hwang, Bu-geun (2003) reported that the group of athletes with SCI showed no difference in terms of bone mineral density in comparison with general people. Moreover, a study said that the regular and powerful training that is given to the group of athletes with SCI showed positive effect to their cardiovascular system in comparison to the group of non-athletes (Yi, Dong-hui, 2003).

In this study, the group of athletes showedsignificantly higher SCIM II scores than the group of non-athletes among the people with SCI besides the score of bone mineral density measured through T-score and Z-score.

The rehabilitation exercise to people with SCI was a way to maximize their independent living in the ordinary life and improve their life quality by strengthening fine muscles (Jo, Byeong-mo, 2005 Warren, 2001). The maximum oxygen consumption, heart rate, and cardiac output are shown to be low with the severity of the SCI however, it is reported that such physiological reaction was not related to the degree of injury as the patients with SCI get intensive training (Coutts, 1983). Moreover, a study said that intensive training that is as hard as the exercise given to professional athletes can reinforce the neuroplasticity while bringing positive effects to the physical functions and composition (Rojas Vega et al., 2008).

Ⅴ. Conclusion

This study intended to compare and examine the ordinary movement and bone mineral density between the group of athletes and non-athletes among the people with SCI. For the measurement of the ordinary movement, SCIM II (Spinal Cord Independence Measure II) that was developed by Catz, et. al. (2001) was used. Since the group of athletes showed significantly higher scores in the total SCIM II compared to the group of non-athletes, the training utilized exercise is considered to improve the functional activity of the people with SCI.

In addition, the results derived from T-score and Z-score for the measurement of bone mineral density showed that the group of athletes had statistically and significantly higher bone mineral density than that of the group of non-athletes. Such outcome of intensive exercise is also considered to reinforce the physical composition that can be shown in the people with SCI. Among the rehabilitation through exercise, intensive training is expected to not only increase the compositional and functional aspect of the body but also neuroplasticity among the patients with SCI.

Acknowledgment

This work was supported by research grants from the Catholic University of Daegu in 2010.

References

ACSM.. Exercise management for persons with chronic disease and disabilities. Champaign IL; Human kinetics.;1997.

Catz A, Itzkovich M, Agranov E et al. The spinal cord independence measure (SCIM): sensitivity to functional changes in subgroups of spinal cord lesion patients. Spinal Cord., 2001;39(2):97-100.

Cho, Byeong-Mo. The Effect of Functional Strengthening Training by Elastic Band on the Upper Extremity functions in the Spinal Cord Injury Patients. Unpublished doctoral thesis. Keimyung University; 2005.

Choi Young-Tae, Kim You-Chol, Cho En-Soo et al. Social Adaptation in Korean Spinal Cord Injuried Patients. The journal of Korean Academy of Rehabilitation Medicine. 1992;16(4),473-81.

Coutts KD, Rhodes EC, McKenzie DC. Maximal exercise responses of tetraplegics and paraplegics. Journal of. Applied Physiology. 1983;55(2), 479-482.

Figoni SF. Exercise responses and quadriplegia. Medicine and Science of Sports and Exercise, 1993;25(4), 433～41.

Gass GC, Camp EM. Physiological characteristics of trained Australian paraplegic and tetraplegic subjects. Medicine and Science Sports. 1979;11 (3):256-9.

George CM, Wells CL, Dugan NL. Validity of hydrodensitometry for determination of body composition in spinal injured subjects. Human Biology. 1988;60(5):771-80.

Hwang Boo-Geun. The levels of body composition and bone mineral density, and catecholamine response to maximal exercise in individuals with spinal cord injury. Unpublished doctoral thesis. Korea University. 2003.

Kim In-Ae. The level of body composition by physical activity in persons with spinal cord injury. Unpublished master's thesis. Korea National Sports University. 2010.

Kim Hye-Nam. The correlation between sports training, menstrural cycle, eating habits, and body composition on bone mineral density in female university athletes. Unpublished master's thesis. Ewha Women's University. 2005.

Karlsson AK, Elam M, Friberg P et al. Regulation of lipolysis by the sympathetic nervous system: a microdialysis study in normal and spinal cord-injured subjects. Metabolism. 1997;46(4):388-94.

Kocina P. Body composition of spinal cord injured adults. Sports Medicine. 1997;.23:48-60.

Kofsky PR, Shepard RJ, Davis GM et al. Fitness classification tables for lower limb disabled individuals. In C. Sherrill(Ed.), The 1984 Olympic Scientific Congress Proceedings: Vol. 9 Sports and disabled athletes. Chanpaign, IL: Human Kinetics. 1984;147-55.

Lee Dong-Hee. The comparisons of cardiovascular responses and cardiac functions on spinal cord injured and able-bodied athletes. Unpublished doctoral thesis. Korea University. 2003.

Rojas Vega S, Abel T, Lindschulten R et al. Impact of exercise on neuroplasticity-related proteins in spinal cord injured humans. Neuroscience. 2008; 153(4):1064-70.

Shin Young-IL, Le, Hyoung-Soo, Jan, Yong-Soo. The effect of group exercise program on the activities of daily living and muscle strength in the spinal cord injury person. Journal of Rehabilitation Research. 2007;11(3):77-95.

The Korean Society of Bone Metabolism. Diagnosis of Osteoporosis. In Osteoporosis, 3rd. Seoul: Hanmibook. 2006.

Warron, M. Evaluation and treatment of visual deficits. L. W. Pedritti, Ed., Occupational Therapy. Baltimore; Mosby. 2001.

Wilmet E, Ismail AA, Heilporn A et al. Longitudinal study of the bone mineral content and of soft tissue composition after spinal cord section. Paraplegia. 1995;33(11):674-7.