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Original Article

Effect of ankle proprioceptive exercise on static and dynamic balance in normal adults

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Abstract. [Purpose] The present study was conducted to investigate whether ankle proprioceptive exercise affects static and dynamic balance in normal adults. [Subjects and Methods] Twenty-eight normal adults were recruited to measure their static and dynamic balancing before and after the proprioceptive exercise. A subject stood with bare feet on the round supporting platform of the device for measuring balance, and the investigator entered the age and the height of the subjects and set his/her feet on the central point of the monitor screen. Training of ankle proprioceptive sense for the movements of plantar-flexion and dorsiflexion was performed. In the training of joint position sense in plantar-flexion and dorsiflexion, the plantar-flexion and the dorsiflexion were set as 15°, respectively. [Results] The static balancing did not show significant differences in average, while the dynamic balancing showed significant differences. [Conclusion] Ankle proprioceptive exercise can affect dynamic balance.

Key words: Ankle, Proprioceptive exercise, Balance

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INTRODUCTION

Balancing, as an ability of poising the body, significantly affects all activities of daily living, being maintaining by organs of proprioceptive sense, vision, and vestibular sense that produce stability through coordination among muscular contraction in the lower limb[1, 2)]. Proprioceptive sense and vision are mainly used to control postural sway in a standing posture, which are divided into the motor sensation detecting movements of the limbs and the joint position sense detecting static locations of the limbs, playing more significant roles than pain in terms of injury prevention, etiology of chronic impairment, and degenerative diseases of the joints. When the proprioceptive sense, which is input by appropriate reactions based on movements, is declined due to abnormality of periarticular structures caused by etiological factors or disorders, balance ability may be declined in posture control, protective reflex, and handling sway of exercise ability posture in the joints[3, 4)]. Ability to control the hip and the ankle joints is considerably significant in order to provide stability for body balancing. As for strategies of the ankle, muscular contraction occurs from the distal to the proximal, and the center of mass is maintained on the ankle while moving by the strength[5)]. Insufficient control of the ankle joint during walking may cause various problems such as weakened ankle dorsiflexor, stiffened and passively spastic plantarflexor, and injury in the ankle joint[6)], inducing energy consumption, reduction in endurance, and possibility of fall[7, 8)]. Training of proprioceptive sense has been much used in treatment in order to increase gaiting ability, and importance of exercise methods to enhance the proprioceptive sense in the lower limbs as well as the ankle joints has been more emphasized recently.

The present study was conducted to investigate whether ankle proprioceptive exercise affects static and dynamic balance in normal adults.

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SUBJECTS AND METHODS

The subjects of this study were twenty-eight normal adults (14 males and 14 females) in their twenties who did not have external injury in the ankle joints nor movement limit by joint abnormality. Their mean age, height, and weight were 22 (± 1.59) years, 168 (± 7.83) cm, and 63.86 (± 13.99) kg, respectively. All subjects were informed of the purpose of this study and provided their written informed consent prior to their participation. This study adhered to the ethical principles of the Declaration of Helsinki. Static and dynamic balances of subjects were measured before and after the proprioceptive exercise. The exercise was performed after the balancing measurement, immediately followed by balancing measurement. BALANCE SYSTEM SD (Biodex Medical System Inc., USA) was used to measure balancing. The force plate of the device was connected by computer software, which sent objective balance indexes. The present study selected the overall balance index (OBI). A subject stood with bare feet on the round supporting platform (55 cm in diameter) of the device for measuring balance, and the investigator entered the age and the height of the subjects and set his/her feet on the central point of the monitor screen. The static balancing was measured on the static supporting platform which swayed from side to side but not back and forth. When the subject moved his/her center of the trunk without changing the location of the feet, the movement of the central point for 20 seconds was recorded while the central point was maintained on the center of the monitor screen. Numbers from 0 to 9 were collected as the result values; 0 indicates stability and 9 indicates instability.

The dynamic balancing was measured on the dynamic supporting platform which swayed from side to side and back and forth. The center of the trunk was moved with eight circles to measure the balancing. The subjects were allowed to grab the handle to recover their balancing when they lost it during measurement, but they were asked to keep their balance without grabbing the handle as much as possible. During the measurement, the subjects had to concentrate one's mind in a way that their body center did not deviate from the center area of the mark on the monitor while seeing it. The greater the result value is, the better the dynamic balancing is.

Using the Biodex, we performed training of ankle proprioceptive sense for the movements of plantar-flexion and dorsiflexion. In the training of joint position sense in plantar-flexion and dorsiflexion, the plantar-flexion and the dorsiflexion were set as 15°, respectively. The subjects were blindfolded during the measurement in order to exclude their visual ability. The angular velocity of the training was 30°/sec. The measurements were performed three times at each location. After the subjects remembered the location of the joints while staying at the set angle for 10 seconds, we pushed a button to stop the action at the remembered location of the joints. In order to exclude effects of fatigue between the training sets, 30 seconds of rest was allowed. Paired t-test was used to examine effects of ankle proprioceptive exercise on static and dynamic balance. Statistical analyses were performed using SPSS ver. 21.0, and statistical significance was set at $p<0.05$.

RESULTS

In the present study, before and after the exercise of proprioceptive sense, the static balancing did not show significant differences in average ($p>0.05$), while the dynamic balancing showed significant differences ($p<0.05$) (Table 1).

DISCUSSION

Balancing indicates an ability of moving or keeping the posture in a standing position while maintaining the weight, covering stability with which a given posture can be kept using the minimal postural sway, symmetry with which the weight can be distributed evenly to the left and to the right in the basement, and factors of dynamic stability with which the body can be moved while keeping balance[2]. In particular, the ankle strategy is important to provide stability for balance control[5]. However, the ankle joints show most common occurrence of musculoskeletal injury, and decreased balance control may be induced by ankle injury[9, 10]. The effect of proprioceptive exercise on ankle joint has attracted attention in many studies. It was reported that a multi-station, low-frequency exercise program can affect ankle instability[11]. In addition, an exercise of proprioceptive sense was reported to be effective on prevention of recurrent ankle injury[12]. The present study showed that there was no significant difference before and after ankle proprioceptive exercise in static balance ($p>0.05$). However, significant difference was found in dynamic balance ($p<0.05$). Proprioception plays a role in providing sensory feedback

Table 1. Effects of ankle proprioceptive exercise on static and dynamic balance

	Pre	Post
Static balance	1.01 ± 0.36	0.93 ± 0.29
Dynamic balance	28.32 ± 11.38	37.61 ± 13.45*

Values are reported as the Mean ± SD.
*Significant difference ($p<0.05$)

from the body to the nervous system. Among subordinate concepts of proprioception, joint position sense is known as the ability to recognize the joint location. Furthermore, it has an influence on body alignment as well as joint stability. In this regard, it is suggested that increased joint stability resulting from proprioceptive exercise may affect dynamic balance[13]. It is suggested that further study is necessary to clarify the effect of the period of exercise on static and dynamic balance.

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