The Relationship between Walking Speed and Muscle Strength for Knee Extension in Hemiparetic Stroke Patients: A Follow-Up Study

RYUICHI NAKAMURA, SAYURI WATANABE, TAKETOSHI HANDA and ISAMU MOROHASHI

Institute of Rehabilitation Medicine and Narugo Branch Hospital, Tohoku University School of Medicine, Narugo 898-68

NAKAMURA, R., WATANABE, S., HANDA, T. and MOROHASHI, I. The Relationship between Walking Speed and Muscle Strength for Knee Extension in Hemiparetic Stroke Patients: A Follow-Up Study. Tohoku J. exp. Med., 1988, 154 (2), 111-113 —— Walking speed and isokinetic strength of knee extension were examined in 18 hemiparetic stroke patients prior to, and 4 and 8 weeks after gait training. Although increase of the walking speed did not coincide with that of the isokinetic strength of the affected and non-affected sides, regression analyses revealed that the strength of the affected side was the primary determinant of the walking speed and the variance explained by it gradually increased with a period of the training. ——— hemiparesis; walking speed; muscle strength

Recent studies have indicated that walking ability of patients with spastic hemiparesis is closely related to muscle strength for knee extension of the affected side (Hamrin et al. 1982; Nakamura et al. 1985). There remains a question whether the gain of muscle strength brings about the increase of walking capacity reflected on variables of walking cycle and walking speed during physical rehabilitation of hemiparesis. In this study we examined the maximum walking speed and the maximum isokinetic strength for knee extension of both affected and non-affected sides in patients with post-stroke hemiparesis successively for 8 weeks, and attempted to solve the question above mentioned.

Eighteen hemiparetic stroke patients, 9 males and 9 females aged from 49 to 68 years, participated in the study. The mean duration from onset of stroke to the start of gait training was 13 (range: 1-25) months. At that time all patients could stand and walk, some assisted by cane and/or brace. Measurements of the maximum walking speed and the maximum isokinetic strength for knee extension of the affected and non-affected sides were performed prior to the start, in the middle and at end of the 8 week physical therapy program. The patients were
prescribed usual physical therapy program including gait training for about 1 hr 4 or 5 times weekly. The method and apparatus to measure the walking speed, time (sec) required to walk 10 m as fast as possible on flat floor, and the isokinetic strength during knee extension movements starting from 90 degrees flexion with a constant angular velocity of 30 deg/sec, were previously reported (Nakamura et al. 1985).

Fig. 1 presents means ± s.d. of the walking speed and the knee extension strength during 8 weeks for all patients. The difference of walking speed was statistically significant between the measurement prior to training and 4 weeks after, but not between 4 and 8 weeks. The increase of walking speed was prominent only during the first 4 weeks. The knee extension strength of affected side increased continuously for 8 weeks, whereas that of non-affected side did not increase significantly until after the first 4 weeks of training. The increase of walking speed took place in the early phase of training and was definitely related to increase of the knee extension strength of affected side but not to that of non-affected side. Step-wise regression analyses, using age, sex, affected-side (left or right), duration from the onset of stroke to the first examination, and the knee extension strength of affected and non-affected sides as variables, on the first step of the equation revealed that: (1) the strength of affected side was the primary determinant of walking speed; and (2) the variance explained by it gradually increased with a period of training (0 week, R² = 0.25; 4 weeks, R² = 0.44; 8 weeks, R² = 0.50).

The present results confirmed the previous hypothesis that measurement of muscle strength for knee extension was a valid means for estimating walking speed.
capacity in patients with spastic paresis (Nakamura and Sajiki 1985; Nakamura et al. 1985), although it was not determined whether weakness of the knee extensors caused decreased walking capacity or was merely a corollary manifestation of central nervous system lesions. At the start of training the knee extension strength of affected side as a determinant could explain only 25% of the variance in walking speed. Eight weeks after training the strength of affected side explained 50% of the variance, becoming twice as large as that at the start of training. In the early phase of training some patients had poor standing balance which limited walking capacity. Clinically, hemiplegic patients start to walk with or without cane and brace as soon as weight-bearing on the affected side becomes possible (Mizrahi et al. 1982). According to Bohannon (1987), the standing capacity of hemiplegic patients is predictable by the strength of the paretic muscle groups, especially that of the hip, the knee and the ankle extensors. Walking speed at the early phase could be determined partly by the strength of muscles other than the knee extensor. This assumption was supported by the fact that the contribution ratio of the knee extension strength of affected side became greater than 0.40 within 4 weeks after training, at which time the stability of standing increased moderately in most patients. On the other hand, the gain in strength of both sides during 4 to 8 weeks of training could be due to gait practice. At the early phase of training patients could not walk so well that they did not walk enough to prevent disuse atrophy of the muscles of non-affected side. After 4 weeks of training, patients often walked around the ward as well as to and from the physical therapy department, which further strengthened the knee extensors of both affected and non-affected sides.

References