Review Article

Physical Activity and Stroke

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Cerebrovascular disease is a major cause of death in Taiwan and in Western countries. This article reviews the recent research on stroke in Taiwan, in comparison with evidence from other countries. We also discuss the relationship between stroke (also known as cerebral hemorrhage) and the extent of physical activity, the disease mechanism and risk factors, and exercise programs for the stroke patient, which may include aerobic fitness, muscular fitness and flexibility. Some research has found a significant relationship between stroke and extent of physical activity, but other studies have found no such relationship. Our results indicate that although stroke patients are mostly elderly people, the condition will eventually affect the younger population because of the modern lifestyle. It is important, therefore, to implement preventive programs, especially with respect to hypertension and the hypokinetic lifestyle. Education programs should be offered to increase public awareness on such risk factors as high blood pressure, poor physical condition, smoking, alcohol consumption, obesity and lack of exercise. Research suggests that the relationship between the amount of physical activity and stroke was not clearly defined as significant; however, the maintenance of an active lifestyle and an increase in the amount of physical activity would not only promote physical fitness, but also decrease the rate of decline of physical function and retard the aging process. For stroke patients, rehabilitation is important to provide them with greater quality of life.

Keywords: physical fitness, rehabilitation, chronic diseases, health

Introduction

The cerebrum is the most important control center of the nervous system, affecting all cognitive activities, such as movement, sensory perception, thinking, language, memory and decision making. Disease of the cerebral blood vessels is usually caused by stroke, resulting in increasing blood flow resistance, hypoxia in the brain, and dysfunction. Symptoms of cerebral disease, such as headache, vomiting, difficulty swallowing, loss of vision, loss of balance, paralysis, uncontrolled defecation and urination, and diminished consciousness are sometimes overlooked and/or ignored. In some instances, ignoring these symptoms can lead to a fatal outcome.

The World Health Organization defines stroke as the clinical symptoms of local or overall dysfunction developed as a result of a disturbance of the cerebrum, which have lasted for more than 24 hours (Stewart 1999). It was further suggested that the possibility of the first stroke might gradually increase with age. For example, between 55 and 59 years, there is a 5% per year increase, but between 80 and 84 years the risk of stroke increases by 25% per year (Thompson & Furlan 1996).

In 2003, a total of 12,404 persons died as a result of cerebral blood vessel disease in Taiwan (Department

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of Health, Executive Yuan, Taiwan 2005). The reported mortality prevalence for men was 8.95%, and 10.51% for women, and stroke was the second greatest killer in Taiwan. Reports from other countries suggested that it was the second or third greatest killer (National Center for Health Statistics 2004; Menotti et al. 1990). Stroke is thus a global health problem affecting millions of people. Research in Taiwan revealed the new trend in neurology of health-related quality-of-life research and showed that it has eight distinct domains: physical functioning, role limitations due to physical problems, role limitations due to emotional problems, vitality, physical pain, social functioning, mental health, and general health perceptions (Fuh 2002). William et al. (1999) reported 12 items that affect the quality of life of stroke patients, including range of movement, vitality, upper-body function, task ability, emotions, self-care, social role, family role, vision, language, thinking and personality. Duncan et al. (1999) revealed that there are eight distinct influences on stroke patients' quality of life: strength, hand function, ability to carry out functions of daily living, range of movement, communication ability, memory, emotions, and ability to participate socially.

Because the cells of the cerebrum cannot regenerate after a stroke, disease of the cerebrum and its blood vessels can not only affect our daily life but can also be fatal (Chen et al. 2002).

Mechanism and risk factors for stroke

Stroke is a disease of the cerebrum and its blood vessels; acute symptoms of stroke have also been called cerebral apoplexy. It is a complex disease involving rupture or blockage of blood vessels affecting unique areas of the cerebrum (Caplan 1993). According to this explanation of pathologic physiology, functional damage of cells and nerves can cause stroke, leading to a limited blood supply, causing damage to the cells and affecting the function of the cerebrum (Stewart 1999).

Stroke can be categorized into ischemic stroke and hemorrhagic stroke, accounting for 10% and 90% of the reported cases, respectively (Stewart 1999). Hemorrhagic stroke occurs when blood flows into the outer space of the cranial cavity or into the tissue of the cerebrum. Hemorrhage can damage the cerebrum, block circulation, and cause pressure damage locally or more generally to brain tissue (Caplan 1993). Ischemic stroke is due to thrombotic or embolic embolism. Thrombus formation may take place within the stenosis, where blood velocity and shear forces are highest, or it may take place or extend post-stenotically, where flow separation, recirculation, and turbulence prevail. Platelet aggregation within the stenosis is responsible for the primary flow obstruction.

Arteriosclerosis of the internal or external cranial cavity can lead to blockage and cause stroke. Smoking and high blood pressure are the probable basis for this pathologic condition and the main risk factors of stroke (US Department of Health and Human Services 1996). Patients suffering from stroke have dysfunction and are always under the influence of their physiologic and psychological condition. It has been suggested that more than 50% of stroke patients develop serious depression; moreover, an unhealthy lifestyle increases the chance of a second stroke (Kelly 1990). Stroke can be prevented, and it is very important to control the risk factors and identify the preventive measures (Table; Rimmer & Nicola 2002).

Physical activity and stroke

In a 1967 study to explore the relationship between physical activity and stroke, Paffenbarger and Williams surveyed 50,000 Stanford University alumni for

Table. Risk factors of stroke

Ischemic stroke
Atherosclerosis: hypertension, smoking, hyperlipemia, diabetes, and sedentary lifestyle
Hypothyroidism
Oral contraceptives
Sickle cell disease
Coagulation disorders
Induced erythrocythemia
Arthritis
Dehydration combined with the above factors
Hemorrhagic stroke
Hypertension
Arteriovenous deformity
Anticoagulants, antithrombotic therapy
Cocaine, amphetamine, or alcohol misuse

precursor symptoms of stroke. They found that the survival rate from stroke was 2.3 times higher in university sports-team members than among other university students (Paffenbarger & Williams 1967). In a follow-up study, Paffenbarger (1972) investigated the relationship between the mortality rate from stroke and the amount of physical activity in a group of longshoremen. The results suggested that the mortality rate in workers other than porters was 1.11 times higher than in porters. However, these studies depended only on surveys and were not experimental in nature. In 1984, Paffenbarger et al. evaluated 16,936 university alumni in a longitudinal study and found that the subjects who performed stair-climbing, walked, and participated in other active forms of recreation, and consumed 2,000 kcal per week, had a lower mortality rate due to stroke (Paffenbarger et al. 1984).

Menotti and Seccareccia (1985) investigated 99,029 male Italian ironworkers 40–59 years of age and found a U-form relationship between amount of physical activity and stroke incidence. Both excessive and insufficient physical activity will result in the increase of stroke. Therefore, only the optimal amount of physical activity induces the lowest likelihood of a stroke, and that a greater amount of physical activity was not beneficial in avoiding stroke.

Lapidus and Bengtsson (1986) compared 1,462 Swedish females 38–60 years of age from 1968 through 1981. They divided subjects into four levels of work and amount of recreational activity. Their results showed that, with a smaller amount of work, the prevalence of stroke was 7.8 times greater than with a comparatively larger amount, and that with a smaller amount of recreational activity, the prevalence of stroke was 10.1 times greater than in cases of larger amounts of recreational activity ($p < 0.05$). Harmsen et al. (1990) investigated the amount of physical activity of 7,495 Swedish males 47–55 years of age and found that in the group with a smaller amount of physical activity, the prevalence of stroke was higher than in the group with more physical activity, but the difference was not significant. Kiely et al. (1994) investigated thousands of Framingham males and females in a longitudinal study, relying on subjects' self-assessment of their amount of physical activity. They found that there were no significant differences in the prevalence of stroke in subjects with different life-styles and amounts of physical activity.

It would seem from a review of the literature that there is no significant relationship between amount of physical activity and stroke. However, Thompson and Furlan (1996) showed that males have a greater prevalence of stroke than females in early life (30%), but that the pattern reverses later in life. This trend may be due to changes in lifestyle, such as social role with advancing age.

Hypertension is a major risk factor for stroke (US Department of Health and Human Services 1996). It is thus important to develop preventive measures in this aspect. Duncan et al. (1985) suggested that 33% of the population aged ≥ 65 years have hypertension. They reported that hypertension could reduce the ability of vessel extension and cause insufficient blood supply, affect the blood interaction of systole and diastole periods, and increase or decrease the heart's stroke volume due to peripheral resistance (Wasserman & Whipp 1975). Duncan et al. (1985), Jennings et al. (1986), Urata et al. (1987), and others found that 4–16 weeks of aerobic-exercise training could reduce systolic blood pressure by 7–13 mmHg, and diastolic blood pressure by 4–7 mmHg. If exercise training could reduce blood pressure by 10–15 mmHg, then it has far-reaching implications with respect to the need for medical care. However, the effects of training in adults and youth varied, indicating the need for more research in this area (Tipton 1984; Linder et al. 1983; Hagberg et al. 1983, 1984; Fisher & Brown, 1982; Laird et al. 1979).

Stroke is related to blood vessel disease, obesity, cardiac coronary vessel disease, and irregular exercise. Therefore, the responses to strenuous exercise may affect the cardiac coronary artery (Macko et al. 1997; Potempa et al. 1996). In a meta-analysis of published research findings, it was found that the peak V_{O_2} range of stroke patients ranged from 13.3 mL kg^{-1} min^{-1} (Potempa et al. 1995) to 16.6 mL kg^{-1} min^{-1} (Rimmer et al. 2000). A lower aerobic capacity would result in a decreasing volume of motor units and decreasing oxidation ability of paralyzed muscle (Potempa et al. 1996). Rimmer et al. (2000) indicated that most stroke patients led a sedentary lifestyle. Potempa et al. (1995) investigated the intervention of 10 weeks exercise training on peak $\dot{V}o_{2,}$ with an increase from 0–35.7% mL kg^{-1}

min^{-1}. Rimmer et al. (2000) studied stroke patients and found that after 12 weeks of exercise training intervention, the average peak V_{O_2} increased 8.2% mL kg^{-1} min^{-1}. They suggested that stroke patients who have single-side paralysis should receive special attention. In assessing the muscle strength of young stroke patients with the muscle index of 10 repetition maximum workload, it was found that the performance of bench press was 11.8 lb, seated leg press 66.8 lb, nonparalyzed limb 14.0 lb, and paralyzed limb 9.3 lb; these results were lower than the 10^{th} percentile rank when compared with the performance norms of a normal population (American College of Sports Medicine 2000).

Considerations for exercise in stroke patients

Traditional treatment of stroke calls for 18 months of rehabilitation (Fujitani et al. 1999; Rimmer & Hedman 1998). However, many researchers support the use of exercise to improve symptoms, thus promoting independence and preventing or reducing disease and the effects of functional damage (Fujitani et al. 1999; Duncan et al. 1998; Monga et al. 1988). The major objective is to speed up the return to normal life and maintain fitness. Therefore, exercise should include aerobic fitness, muscle fitness and flexibility.

Aerobic fitness

Depending on the patient's age, degree of dysfunction, motivation, types of complications, and severity of disease, implementation of endurance training must be carefully supervised. In addition to typical strength and step training, as well as walking, it is desirable to include training directed toward cardiovascular fitness, pulmonary ventilation, and metabolic improvement (Rimmer et al. 2000; Teixeira-Salmela et al. 1999).

Popular because it can improve endurance and ability to live normally, aerobic exercise is usually set at submaximal exercise intensity (Potempa et al. 1996). In the hospital or community activity center, aerobic exercise training can last 1 hour, three times per week. The use of assistive equipment is recommended during the prerehabilitation period (2–4 weeks), allowing stroke patients time to become accustomed to training and achieving the beneficial effects (American College of Sports Medicine 2000).

Stroke patients differ and thus should have their individual exercise prescriptions based on the stress test. Rimmer et al. (2000) concluded that prescribing exercise intensity based on the value of peak V_{O_2} entailed a potential risk and suggested the use of a respiratory quotient of 1.00 in addition to the heart rate. Smith et al.(1999) investigated light- and middle-level stroke patients working with a treadmill three times per week for 3 months at 40% heart rate reserve for the initial stage of exercise intensity, and gradually increasing it to 60–70%. Teixeira-Salmela et al. (1999) investigated stroke patients with a higher functional level by using 70% of HR_{max} for exercise training, but patients had to perform a cardiac ultrasonic test to eliminate the risk of heart disease. If stroke patients have an abnormal response, such as in blood pressure (systolic blood pressure ≥ 220 mmHg or diastolic blood pressure ≥ 110 mmHg), they should be closely monitored during exercise. Rimmer et al. (2000) reported that if the rate pressure product, which is the product of heart rate and systolic blood pressure divided by 100, is higher than 200, the patient is not suited to exercise. When the diastolic blood pressure is ≤ 100 mmHg, the patient can be allowed to exercise. Aerobic exercise includes cycling, walking and stepping, and should be adapted according to the stroke patient's condition.

Muscular fitness

Patients with half-body paralysis, difficulty in controlling movement, and arthritis due to loss of muscular function may not be able to participate in exercise training. In the initial stage of muscular fitness training, protective equipment, such as resistance belt or weighting protector, should be used. Training workload might consist of resisting the gravitational force for 5–10 seconds as the lowest standard, and increased gradually (Rimmer & Nicola 2002).

Teixeira-Salmela et al. (1999) recognized that, with the use of the free weight of dumbbells or barbells as a resistance instrument, the patient's daily lifestyle should be taken into account. They also emphasized that, during weight training, the stability of trunk and specific weaknesses in movement control must be considered. The availability of an assistant would be desirable for

safety reasons (Rimmer & Nicola 2002).

Flexibility

Stroke patients often have manifestations of paralysis, such as weakness in the control of muscles and limitation in the range of movement. Therefore, they should perform stretching exercises, which can be combined with aerobic exercise — before, during, and after.

Conclusions

Stroke is also known as cerebral hemorrhage or cerebral disease. Stroke patients are mostly elderly people but, with the modern lifestyle, this condition will eventually affect the younger population. It is important to conduct preventive programs, especially for those with hypertension and a hypokinetic lifestyle. Education programs should be offered to increase public awareness about such risk factors as high blood pressure, poor physical condition, smoking, alcohol consumption, obesity, and lack of exercise.

Although the relationship between the amount of physical activity and stroke is still not clearly defined, the maintenance of an active lifestyle and an increase in the amount of physical activity would not only promote physical fitness but also decrease the rate of functional decline and improve the quality of life.

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