47. Stroke

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Summary

People with residual symptoms after a stroke are deconditioned and have reduced physical capacity. Many suffer varying degrees of disability after a stroke. However, many stroke patients are able to adapt and remain physically active. The benefits of strength and aerobic fitness training for stroke patients have previously been the subject of much debate. Exertion was considered contraindicated due to the risk of triggering spasticity. However, none of the studies published over recent years have been able to confirm that this is the case. Strength training of the lower extremities has been shown to yield significantly improved functions. Aerobic fitness training improves the tolerance for daily activities as it enables people who have had a stroke to carry out day-to-day activities with less exertion.

Definition

The World Health Organization (WHO) defines stroke as a condition characterised by rapidly developing symptoms that last for more than 24 hours or lead to death, with no apparent cause other than that of vascular origin. There are three main causes of stroke: 1) brain infarction, representing approximately 85 per cent of all strokes in Scandinavia and usually due to cardiac embolism (approx. 30%), macrovascular disease (approx. 25%)

and microvascular injury (approx. 20%). Other causes represent approximately 5 per cent of all strokes, and the remainder of unidentified causes. The other two most common causes are: 2) cerebral haemorrhage (10%), and 3) subarachnoid haemorrhage (5%), resulting from a ruptured arterial aneurysm. The third cause often presents completely differently than the first two, as the damage to the brain can be diffuse.

Prevalence/Incidence

Each year, approximately 30,000 people in Sweden suffer a stroke, of whom 20,000 for the first time (1). The average age of stroke victims is 75 years (men 73 years, women 77 years). However, stroke also affects younger age groups, with 20 per cent of strokes occurring in people under the age of 65. The incidence is also higher in men than women. This particular somatic disease group represents the highest number of clinical care days at Swedish hospitals and is the most common cause of neurological disabilities. The reported prevalence totals approximately 100,000, of whom 20,000 require considerable levels of assistance (1). Thus a large number of stroke sufferers are left with varying degrees of post-stroke disability. However, with some adaptation, many of these people can continue to be physically active.

Symptomatology

Different functions in the brain are affected depending on where the injury is located. It is common that the motor centre of the brain is affected, resulting in some degree of hemiparesis, along with reduced sensibility, impaired balance and coordination, as well as speech and vision disturbances. Stroke patients may also display reduced cognitive capacity, denial of the affected side of the body, depression and emotional disturbances, as well as different types of pain.

Treatment principles

Space does not permit a detailed description of the treatment principles associated with stroke here in this chapter. For this, the reader is referred instead to clinical guidelines on the topic (1–4). Recent research as clearly shown that the best initial treatment and early rehabilitation measures are those provided by special stroke units that use a multidisciplinary approach (5). The work of the stroke units should then be followed by an efficient chain of care that provides continued rehabilitation and medical follow-up at special rehabilitation centres, as well as in primary care, municipal care, and through home-care services. Physical activities should also be made easier for stroke patients, for example, by providing them access to primary care centres, gyms and health clubs where they can train to improve their strength, aerobic fitness, balance, coordination and relaxation, in enjoyable, modified exercise programmes.

Frequent physiotherapy may also be necessary. Despite paralysis/muscular weakness and loss of fine motor ability being typical residual symptoms after a stroke, there has been much uncertainty as to the benefits of strength and aerobic fitness training for stroke patients. Exertion was considered contraindicated due to the risk of triggering spasticity. However, no recently published studies have been able to confirm that this is the case (6–10). Strength training of the lower extremities has been shown to significantly improve functioning in stroke patients without leading to increased spasticity. The participation of different occupational groups is required in order to maintain the ability to take part in different home activities. Special rehabilitation programmes often enable younger stroke patients to return to work and even resume previous leisure activities.

Effects of physical activity

Once stroke patients have gone through the initial period of rehabilitation, an aerobic fitness training programme can improve their endurance and functional capacity. This can also result in increased self-confidence to activate themselves and take part in physical activities (10, 11).

Training on a treadmill has been used successfully to increase maximal oxygen uptake in stroke patients. Twenty-five people (12) who had suffered a stroke at least 6 months earlier and who still had a hemiparetic gait took part in 40-minute sessions on the treadmill, 3 times a week for 6 months. The results showed an increase in maximal oxygen uptake (peak VO_2) and a decrease in energy expenditure at the same exertion level compared to a control group of 20 people with only low-intensity training. Readers are also referred to a Cochrane Review showing the need for additional studies in order to determine which type of training yields the greatest fitness results. However, improved aerobic fitness does appear to lead to improved walking ability (13).

Physical endurance was improved and heart rate lower at constant load, after 12 weeks of cycle training (14). In addition, the study subjects reported an improved self-perception and general well-being. The increased self-confidence and endurance also seemed to give individuals more confidence and energy to improve other activities as well.

A combined strength and aerobic fitness training programme involving 35 study subjects, all of whom had suffered a stroke at least 6 months earlier and had multiple comorbidities (concurrent illnesses) led to significant improvement in maximal oxygen uptake, increased muscle strength, and weight loss (15).

The studies described below exemplify the effects of physical activity in stroke patients. However, the number of subjects in several of these studies was relatively small. More studies are therefore needed. For further information about the background and effects of fitness training, please refer to subject review articles (17, 18).

Table 1. The effect of fitness and strength training in stroke patients.

Form of training	Intensity	Frequency (times/week)	Duration	Measured pulse (n)	Result	Design	Ref.
Fitness							
Bicycle training (ergometer) Control group: relaxation	60–80% of max HR*	3	30 min. 12 weeks	142	↑ Work load → Functionally independent	RCT**	
Bicycle training	Progressing to → 70% max HR	3	30 min. 12 weeks	42	↑ 13% of VO_2 max ↓ Blood pressure ↑ Muscular strength → Spasticity	RCT	11
Walking on treadmill	60–70% of max HR	3	40 min. 12 weeks	21	↑ Peak VO_2 ↓ Energy consumption (20%)	***	12
Circuit training	Functional strength and mobility	3	60 min. 4 weeks	12	↑ Walking endurance ↑ Walking velocity ↑ No. of step tests	RCT	16
Strength							
Weight lifting machines	Reciprocal knee extension/flexion	3	40 min. 6 weeks	15	↑ Muscle strength ↑ Walking capacity ↑ Physical activity → Spasticity	***	7
Isokinetic training Control group: Concentric training	Eccentric training	2	40 min. 6 weeks	20	↑ Except muscle strength ↑ Paretic leg load ↑ Walking velocity → Spasticity	RCT	
Combined fitness and strength							
Circuit training	Aerobics Strength training, lower extremities	3	60–80 min. 12 weeks	13	↑ Muscle strength ↑ Walking velocity ↑ Physical activity ↑ Life quality → Spasticity	RCT	9
Circuit training	30 min. fitness 30 min. strength 20 min. flexing	3	60–80 min. 12 weeks	35	↑ Peak VO_2 ↑ Muscle strength ↑ Hamstring/ low back flexibility	RCT	15

* Max HR = Maximal Heart Rate (220 – age ± 12).
** RCT = Randomised Controlled Trial, i.e. a trial with a randomly selected study and control group.
*** = Not controlled study.
**** = Peak VO_2 (maximal oxygen uptake).

Since many stroke patients have comorbidities, i.e. concurrent illnesses, such as diabetes, hypertension or cardiovascular disease, the possibility of physical activity and the effects of such activity are also dependent on these other conditions. The effect of muscular training depends ultimately on how well the patient regains motor control. The degree of paralysis, sensory disturbances, balance, etc., in addition to comorbidity, determine the type of activity possible. For further information about the background and effects of strength training, please refer to subject review articles (19, 20).

Indications

Physical activity has a documented *primary preventive* effect against cardiovascular diseases. This primary prevention of stroke is described in a study on 11,000 American men with an average age of 58. Those who walked 20 km a week were at significantly lower risk of suffering a stroke at follow-up 11 years later (21). Four independent cohort studies show a reverse and dose-dependent relationship between physical activity and the risk of stroke, i.e. a little is better than none at all, and a lot is better than a little. Two other studies revealed a reverse but not dose-dependent relationship between physical activity and the risk of stroke (22).

Although the degree of paralysis and sensory disturbances may vary from near normal function to severe disability and significantly reduced mobility, the same principal indications apply to stroke patients as to healthy individuals, i.e. that any physical activity not restricted by disability will improve muscle function and general fitness. Since vascular disease is common in stroke patients, the indications for secondary prevention in these people are generally consistent with the indications for these diseases, as well as for diabetes and hypertension. However, scientific evidence showing that physical activity itself has a *secondary preventive* effect on stroke recurrence is lacking.

Prescription

At present, there are limited possibilities for continued training once stroke patients have been discharged from a hospital or rehabilitation clinic. Many stroke patients have residual symptoms and find it difficult to keep up with a normal exercise class or other desired physical activity. The risk of feeling dejected and experiencing a lower quality of life due to reduced fitness and strength can easily be avoided by creating opportunities for stroke patients with residual symptoms to continue training.

Normal activities that the individual enjoys are recommended, such as walking, climbing stairs, dancing, circuit training, gardening, arm and leg pedaling, training on the exercise bike, walking on the treadmill, wheelchair exercising, group exercise classes and water aerobics. Exercise that can be done with others is both socially and psychologically stimulating. However, the intensity of the training should be adapted to the individual and relevant symptoms. It is important to remember that, along with more organised physical activity/training, everyday physical activities are also very valuable. Such activities may consist of gardening, household chores, going for a walk or playing with one's grandchildren. If the intensity of the activity is such that the patient is slightly out of breath but can still carry on a conversation, it is quite sufficient for attaining the desired effect and maintain endurance.

The relative heart rate (percentage of max HR), level of exertion, or degree of breathlessness experienced by the patient can be used as a guide when deciding on an appropriate training intensity. Using relative heart rate in patients treated with beta blockers may be difficult, however, since beta blockers reduce both maximal heart rate and heart rate during submaximal exercise.

According to Åstrand, calculations of maximal oxygen uptake ("aerobic fitness value") based on submaximal exercise testing are also misleading. The same applies to people with atrial flutter. Consequently, the best guide is the subjective perceived level of exertion (Rating of Perceived Exertion, RPE). (Please refer to the chapter on Assessing and controlling physical activity). Measuring the maximal oxygen uptake is usually not possible as motor functions and cardiac limitations, if present, do not allow for maximal exercise testing.

Table 2. Guidelines for prescribing physical activity to stroke patients.

Form of training	Activity	Intensity	Frequency (times/week)	Duration
Fitness training	Walking Nordic pole walking: Circuit training Ergometer bicycle training Arm/leg cycling Walking on treadmill Step training Water exercises: Dancing Wheelchair driving	60–80% max HR* 12–15 RPE** Slightly to moderately out of breath	2–5	10–60 min./ session 4–6 months – throughout life
Strength training	Weight lifting machines, e.g. leg press Eccentric/concentric training Isokinetic training Functional training	Start with 50%, increase to 70–80% of RM*** 12–13 RPE**	1–3 Increase: increase load, not number of repetitions	1–3 sets of 7–10 reps 10–12 weeks
Muscular endurance training	Circuit training Sequence training Walking/moving	30–50% of 1 RM*** 9–11 RPE**	1–5	3 sets of 25–50 reps (dose-response)
Functional training	Balance and coordination training	Increase level of intensity	1–3	
Flexibility	Warm up Cool down Stretch Flex		With every type of training	

* Max HR = Maximal Heart Rate (220 – age ± 12).
** RPE = Rating of Perceived Exertion = subjective perceived level of exertion according to the Borg scale 6–20.
*** RM = Repetition Maximum. 1 RM is the maximum amount of weight one can lift in a single repetition for a given exercise.

Functional mechanisms

Oxygen uptake and cardiac function

The functional mechanisms may vary and be dependent on the possible presence of other disease. A concurrent cardiovascular disease may dominate the functional mechanisms of physical activity and training. If no other diseases are present, as in the case of residual lesion following a subarachnoid hemorrhage in younger stroke patients, the functional mechanisms should be identical to those found in untrained healthy individuals of the same age.

Skeletal muscle function

Strength training facilitates motor unit recruitment and increases discharge rate (23). In order to achieve power, timing and coordination of the muscles stroke patients must be given the opportunity to train at an adequate intensity, frequency and duration. To begin with (6–8 weeks), the increased muscle strength obtained through physical training is the result of neural adaptation (increased recruitment of motor units, less inhibition, improved coordination, reduced coactivation, etc.). Muscle hypertrophy, whereupon muscles cells increase in size, occurs at a later stage. The muscle strength of paralysed stroke patients can be improved by combining eccentric and concentric training methods (6). Using the Stretch-Shortening Cycle (SSC, eccentric/concentric muscle contractions) (24) in a closed muscle chain when training the weight-bearing muscles of the lower extremities (e.g. sit-to-stand position, walking up and down stairs) may have a positive effect on motor functions.

Peripheral muscle endurance

Muscular endurance training leads to increased levels of mitochondria, oxidative enzymes, myoglobin and capillarisation (25).

Aerobic fitness

With an improved aerobic fitness level comes an increased ability to manage everyday activities at a lower percentage of maximal oxygen uptake (lower relative load). Physical activities can then be carried out at a lower heart rate and lower systolic blood pressure. An ineffective movement pattern resulting in increased energy expenditure during activity may be improved by training, also reducing the level of exertion. Aerobic fitness training has a positive effect on the risk factors for cardio- and cerebrovascular diseases.

Functional tests and health controls

An assessment of motor functions should be carried out before any advice is given on physical activity. This is best performed by a physiotherapist using one or more of the assessment tools currently available such as those by Fugl-Meyer and Lindmark, the Rivermead Mobility Index, or the 10-meter Walk Test. If prescribed a certain strength training, the muscle strength of the patient should be measured with a dynamometer. The degree of muscle tone and balance should also be assessed. Mobility and presence of contractures should also be noted. If a patient with concurrent heart disease (angina pectoris, status post heart attack, heart failure and arrhythmia tendencies) is following a specific fitness training programme, the patient's cardiovascular function should be assessed by the physician in charge and include ECG at rest and during exercise.

Table 3 shows clinical test methods used for the assessment of physical ability.

Table 3. Clinical tests for the assessment of physical ability in stroke patients.

Fitness	Standardised ergometer cycling test during which the load (watt), time (minutes), velocity (revolutions/minute), pulse and blood pressure are registered by the test monitor. Perceived exertion (Borg RPE scale), leg tiredness and pain, if any (Borg CR10 scale), are evaluated by the test subject. Pulse and blood pressure are measured while resting before the test and then again 15 minutes after the test. NB! Åstrand's sub-maximal test cannot be carried out on persons taking beta blockers or suffering with atrial fluttter.
Muscle strength	1 RM for different muscle groups. Hand held dynamometer. Isometric or isokinetic measuring.
Muscular endurance	Functional endurance test (for example, the number of symmetrical rising/sitting down, heel raising, step tests).
Functional walking capacity	6-minute walking test. The walking distance is measured and perceived leg tiredness and breathlessness assessed according to the Borg CR10 scale. Perceived exertion is also assessed according to the Borg RPE scale. Pulse (HF) and blood pressure should be taken before and after the walking test.

Interaction with drug therapy

Most stroke survivors are prescribed a number of medications. Prophylactic treatments with blood thinners (anticoagulants) to prevent new thromboses or embolisms are commonly used and do not affect one's ability to exercise or recommendations regarding physical activity. In the case of hypertension and heart disease, different medications, such as beta blockers, which reduce the submaximal and maximal heart rate, may have an effect on the person's physiological reaction to physical activity. See also recommendations for physical activity in patients with hypertension and heart disease. Some stroke sufferers also have diabetes which must naturally be given specific consideration. Antidepressant treatment, such as SSRIs, need not be limiting, but rather may have a synergistic effect on physical activity.

Contraindications and risks

Contraindications to physical activity and exercise are primarily associated with other diseases. (See above.)

With the exception of inappropriate dose-intensity in patients with a cardiovascular disease and the potential triggering of severe angina or arrhythmia, the risks involved with physical activity relate mainly to the increased risk of falling due to impaired motor function and balance. Stroke patients are 2–4 times more likely to fall or suffer hip fractures (26). They are also at greater risk of getting fractures due to osteoporosis as a result of immobilisation and other osteoporosis risk factors. Closer supervision of at-risk patients during physical activity is therefore important, as well as considering the use of hip protectors.

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