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# EFFECT OF STAIR-WALKING IN PARKINSON PATIENTS

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ปัญหาการเดินเป็นอาการสำคัญในผู้ป่วยพาร์กินสัน และส่งผลทำให้ผู้ป่วยสูญเสียความสามารถในการทำงานและการพึ่งพาตนเอง การฝึกเดินในผู้ป่วยพาร์กินสันเป็นส่วนสำคัญในการพัฒนาความสามารถในการเดิน การศึกษาครั้งนี้มีวัตถุประสงค์ เพื่อศึกษาผลการฝึกเดินขึ้นลงบันไดในผู้ป่วยพาร์กินสัน อาสาสมัครเป็นผู้ป่วยพาร์กินสันที่ระดับความรุนแรงน้อยถึงปานกลางจำนวน 16 คน แบ่งออกเป็นกลุ่มควบคุมซึ่งจะได้รับการฝึกเดินพื้นราบที่บ้าน โดยมีการให้คำแนะนำและติดตามอย่างใกล้ชิด จำนวน 7 คน (อายุ 71.29±12.16 ปี) กลุ่มทดลองซึ่งจะได้รับการฝึกเดินขึ้นลงบันได จำนวน 9 คน (อายุ 64.67±13.52 ปี) อาสาสมัครทั้ง 2 กลุ่มได้รับการฝึกเดิน 30 นาที 3 ครั้ง/สัปดาห์ เป็นเวลา 4 สัปดาห์ และทดสอบความสามารถในการเดิน ได้แก่ ระยะเวลาในการก้าวเดินก้าวแรก ความเร็วในการเดิน ความยาวก้าว และความถี่ก้าวก่อนและภายหลังการฝึกเดิน ผลที่ได้จะถูกนำมาทดสอบทางสถิติที่ระดับนัยสำคัญที่ 0.05 ผลการศึกษา เมื่อนำผลการทดสอบความสามารถในการเดินก่อนและหลังการฝึกเดินขึ้นลงบันได มาทดสอบทางสถิติพบว่ากลุ่มควบคุมและกลุ่มทดลองนั้น มีค่าความสามารถในการเดินเปลี่ยนแปลงอย่างมีนัยสำคัญทางสถิติที่ 0.05 เมื่อเปรียบเทียบกับก่อนการฝึก และเมื่อทำการทดสอบเปรียบเทียบค่าความสามารถในการเดินภายหลังการฝึกเดินขึ้นลงบันได ระหว่างกลุ่มควบคุมและกลุ่มทดลอง พบว่ากลุ่มทดลองเกือบทั้งหมดมีค่าการเปลี่ยนแปลงความสามารถในการเดินดีขึ้นมากกว่ากลุ่มควบคุม ยกเว้นระยะเวลาในการก้าวเดินก้าวแรกและความถี่ก้าวไม่พบความแตกต่างอย่างมีนัยสำคัญที่ 0.05 โดยในกลุ่มทดลองมีการเปลี่ยนแปลงที่ดีขึ้นมากกว่ากลุ่มควบคุม จากการศึกษานี้สรุปได้ว่าการฝึกเดินขึ้นลงบันได สามารถนำไปใช้ในการพัฒนาความสามารถในการเดินสำหรับผู้ป่วยพาร์กินสันที่ระดับความรุนแรงน้อยถึงปานกลางได้ การฝึกเดินขึ้นลงบันไดเป็นการกระตุ้นผ่านสิ่งเร้าทางสายตาและการเรียนรู้ของสมองผ่านทางจังหวะการเดิน

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UNCHALEE CHAROENSANTIURAI : EFFECT OF STAIR-WALKING IN PARKINSON PATIENTS. THESIS ADVISOR : PROF. AREERAT SUPUTTITADA, M.D., THESIS CO-ADVISOR : ASSOC.PROF. ROONGROJ BHIDAYASIRI, M.D., 62 pp.

Gait problem are among the primary symptoms of Parkinson's disease (PD) and lead significantly to a patient's loss of function and independence. Gait training in Parkinson patients as an important component among the treatment to improve gait ability. The purpose of this study was to investigate the effect of stair-walking in Parkinson patients. Sixteen Thai Parkinson patients within stage 2-3 of the Modified Hoehn and Yahr disability scales volunteered to participate in this study. Seven subjects in control group (age 71.29±12.16 years) received ground walking training at home with supervision and closed monitor. Nine subjects in experimental group (age 64.67±13.52 years) received stair-walking training program. Two groups received training program 30 minutes 3 times/week for 4 weeks. All received gait ability measurement (step initiation time, gait speed, step length and step frequency) before and after training. An alpha level of 0.05 was used to determine statistical significant. **Result**: Post training, the experimental and the control groups showed significant decrease in the error of gait ability ($p<0.05$) in all parameters. Post training, the experimental group showed a significant improve in mean difference of gait speed and step length ($p<0.05$) when compare with the control group. Even mean difference of step initiation time and step frequency showed not significant, but there were more improvement than control group. **Conclusion**: The stair-walking training program can be recommended for improvement of gait ability in Parkinson patients with mild to moderate severity. It may stimulate as visual cue and gradual implicit motor learning of rhythmic walking.

Field of Study :.....Sports Medicine.....Student's Signature.....

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Co-advisor's Signature.....

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# CHAPTER I

# INTRODUCTION

## Background and Rationales

Parkinson's disease (PD) is one of the most common neurodegenerative disease, with a prevalence of 1% of people over 60 years of age. The risk of developing PD increases with age. Ten percent of patients become symptomatic before the age of 40, 30% before 50, and 40% between 50 and 60 years (Reuter and Engelhardt, 2003).

PD is a slowly progressive disease of later life. It results from degeneration of dopaminergic cells in the substantia nigra, a region in the basal ganglia. Progressive loss of dopaminergic cells is associated with normal aging but seems to be accelerated in patients with PD. The reason for the degeneration of dopaminergic cells is still unknown. The function of the basal ganglia is involved the movement control, motor learning, planning and motivation. The primary clinical features of PD are motor symptoms such as bradykinesia, rigidity, postural instability and tremor (Reuter and Engelhardt, 2003).

In the early stages, many of the symptoms of PD can be controlled by medication, levodopa and other forms of anti-Parkinson medication can be very effective for treating hypokinesia, tremor and rigidity. When coupled with interventions promoting physical activity and continued participation in societal roles, the person with newly diagnosed PD can experience very little disturbance to movement and function (Morris et al., 2000, 2005).

In the later stages of disease progression, postural instability compounds the stiffness, slowness and falls are common. Parkinsonian medications typically have little impact on postural instability and physiotherapists play a major role in teaching the person how to prevent loss of balance and falls at this stage (Morris et al., 2005). Although pharmacological interventions can slow the progression of this disease,

medications tend to become ineffective over a period of time, and appropriate physical therapy intervention may be necessary throughout the stages of this disease (Cutson et al., 1995).

Gait disturbances are among the primary symptoms of PD, gait pattern characterized by hesitant, shuffling steps that are short and quick, that can lead to falls. The resulting fear of falls can lead to decreased activity and further loss of independence (Cutson et al., 1995). When people with PD walked a short distance, they typically show reduced velocity of walking associated with reduced stride length and a compensatory increase in cadence. These abnormalities are thought to be because of hypokinesia, that is, reduced speed and amplitude of movement, which is a major motor impairment observed in PD (Hayashi et al., 1997, Canning et al., 2006).

The effects of physical training on motor performance in PD has been studied by several researchers in recent years: most of them reported positive results on some motor tasks, such as gait, bradykinesia, rigidity and transfer, so that the effectiveness of motor training on these aspects is generally accepted. Gait training delays the development of postural instability and subsequently improves gait ability in the long-term. Therefore, most researchers supported the specific training of gait in patients as an important component among the treatment to improve gait ability.

Task-specific gait and step training resulted in a reduction in falls and improvement in gait speed and dynamic balance in individuals with postural instability gait difficulty pre-dominant Parkinson disease and moderate disease symptoms (Protas et al., 2005). Stepping is a commonly executed protective strategy for maintain balance in the everyday environment. Step may be initiated voluntarily to guard against a fall, or induced reactively in response to external challenges to balance (Reuter and Engelhardt, 2003).

Therefore, most researchers supported the specific training of exercise with external cue in patients as an important component among the treatment modalities to improve gait ability. Transverse line visual cues are associated with longer steps, greater push-off force and higher velocity in gait initiation in people with Parkinson disease. And it improved gait initiation time, the length of steps and the magnitude of push-off force and overall velocity in people with Parkinson disease. (Jiang and Norman, 2006)

Previous studies have found ascending and descending steps relatively easy because the stair act as visual cue that drive motor performance (Morris, 2006).

From the literature review, there is no literature study of effectiveness of stair-walking training in Parkinson's patients. The main aim of the present study is to investigate the effect of step initiation time, walking speed, step length and step frequency post stair-walking training in Parkinson's patients. The outcome of this study is expected to be useful for gait ability improvement in Parkinson's patients.

## Objectives

To investigate the effect of stair-walking training on the changes of gait ability in Parkinson patients

## Research Question

1. Does the stair-walking training has the changes of gait ability in Parkinson patients?

2. Dose the gait ability in stair-walking training differ from overground walking training?

## Scope of research

The study is an experimental research design which Parkinson patients within stage 2-3 of the Modified Hoehn and Yahr disability scales participated as subjects.

The study approval was obtained form the University Ethics Committee. Written inform consent was obtained from each subject before the experiment started. On attendance, subjects were given a briefing on the experimental procedure and risk involved, and reminded of their right to withdraw at any time.

## Limitation

The number of subjects is small since time limitation of master of science curriculum.

**Operational Definition**

1. Parkinson's disease is defined as idiopathic Parkinson's patient, which refers to the symptom of tremor, rigidity, bradykinesia and postural instability.

2. Modified Hoehn and Yahr is defined as a commonly used system for describing how the symptoms of Parkinson's disease progress. The scale allocates stages from 1 to 5 to indicate the relative level of disability. In this study focused on Parkinson's patient among the stage 2-3 of the modified Hoehn and Yahr.

3. Stair-walking training is defined as walking training up – down on Corner exercise staircase. Stair arrangement: three 15 cm. higher steps on a side, eight 10 cm. higher steps on other side. Steps are 60 cm. wide and 22 cm. deep. Fitted with two sides of handrails.

4. Gait ability is defined as measurement of ability of gait. In this study used step initiation time, walking speed, step length and step frequency in walking at self-adapted walking speed on 10-meters walkway.

**Expected Benefits and Application**

1. Providing the beneficial information of stair-walking training in patients with PD, which may be recommended as can be used to improve gait ability in Parkinson rehabilitation program.

2. Providing the preliminary data for further research.

# CHAPTER II

# REVIEW OF THE LITERATURES

## Historical Background of PD

Parkinson's disease (PD) was named after James Parkinson originally describing the disease in classic article untitled "Essay on the Shaking Palsy". The cardinal manifestations of PD based on the examination and observation of six patients including tremor, stooped position, propulsive gait and difficulty in initiating movement (Parkinson, 1817). To date, the cardinal features of PD include resting tremor, bradykinesia, rigidity and postural instability.

PD is a progressively neurodegenerative brain disease. Its onset progresses insidiously, relentlessly and affects multiple neuronal systems of the central nervous system. The causes are often unknown, but anatomical evidence indicates deficiency of the neurotransmitter dopamine in the basal ganglia (Schenkman and Bulter, 1989).

## Functional Anatomy and Connection of Basal Ganglia

Basal ganglia are another accessory motor system. Anatomically, they are located mainly lateral to the thalamus, occupying a large portion of the deep regions of both cerebral hemisphere. Basal ganglia consist of caudate nucleus, putamen, globus pallidus, subthalamic nucleus and substantia nigra. The caudate nucleus and putamen are considered the striatum. The globus pallidus or pallidum is divided into two segments including the external (GPe) and internal segment (GPi). Substanis nigra, a pigmented dopamine rich nucleus, is also divided into segments comprising substania nigra par compacta and par reticulate.

Basal ganglia form extensive interconnections with the cortex and the thalamus referred as basal ganglia-thalamocortical circuits. Therefore, the primary function of basal ganglia is believed to indirectly aid the motor cortex in planning and generating motor commands via the sensorimotor cortex. The basal ganglia also play a role in cognitive and affective behavior (Horak et al., 1996, Gentilucci and Negrotti, 2002).

There are at least five basal ganglia-thalamocortical circuits, which link cerebral cortex, basal ganglia and thalamus as motor loop. Motor loop or subcortical feedback loop controls locomotor function. The motor circuit forms motor and somatosensory areas of the cortex. This circuit connects the restricted portion of the basal ganglia, thalamus and the output back to the premotor cortex, supplementary motor cortex of the frontal lobe (Dawson, 2000). The motor circuit is not only focused on the precentral motor fields but also oculomotor circuit and limbic circuit. According to this function, basal ganglia are capable of concurrent participation in separate functions including skeletomotor, oculomotor, cognitive and limbic process as a parallel structure of the individual basal ganglia thalamocortical circuitry (Alexander and Crutcher, 1990).

Theoretically in primary feedback loop, input from all areas of the cortex project to the striatum by glutamate mediated pathway. The striatum send GABAergic or substance P inhibitory projections to internal segment of the globus pallidus (GPi) and substantia nigra par reticulate (SNr), which two outputs project to cortex via thalamus. Activity in the striatal neurons subserving this pathway is enhanced by dopaminergic input from the substantia nigra par compacta (SNc). This pathway is believed to serve for facilitating motor programs (Anne et al., 2002). Additional two pathway, the putamen first receives dopaminergic projection from the SNc forming the nigrostriatal tract. The major inhibitory output of the putamen projects to GPe by both GABA and enkephalin. The excitatory subthalamic nucleus (STN) then drives the SNr and GPi to inhibit the thalamus. Second, the STN can also be activated directly by the cortex to SNr and GPi, It is hypothesized that it is used to suppress inappropriate motor behaviors.

Moreover, the association loop is one of the dopaminergic nigrostriate pathways. The association loop is responsible for cognition, memory, behavior, oculomotor and limbic processes by involving caudate nucleus. The caudate nucleus receives dopaminergic fibers from SNc via thalamus indirectly connects to the association cortex such as the frontal, parietal and occipital lobe (Kato et al., 2002).

Interestingly, the role of the dopamine in basal ganglia appears to be complex. There is a recent evidence that dopamine modulated cortical networks subserving two distinct mechanisms. The nigrostriatal projections facilitate motor function indirectly via thalamic projection to motor cortices, whereas the mesocortical dopaminergic system facilitates working memory function via direct inputs to prefrontal cortex (Mattay et al., 2002).

In summary, the basal ganglia play an important role in planning and controlling in correct execution. The major input from the cerebral cortex to striatum is mediated by the neurotransmitter glutamate (Glu). The neurotransmitter dopamine has an important role in controlling direct and indirect pathway of motor circuits of basal ganglia. There are two pathways associated with this dopamine transmitter. One is a direct pathway from putamen to GPi/SNr using GABAergic and substance P. The other one is an indirect pathway from putamen to GPi/SNr via GPe and STN mediated by GABA or enkephalinergic neurons. The activation of direct pathway is associated with facilitating movement while activation of indirect pathway suppresses movement (Figure 2.1, (Alexander and Crutcher, 1990)).

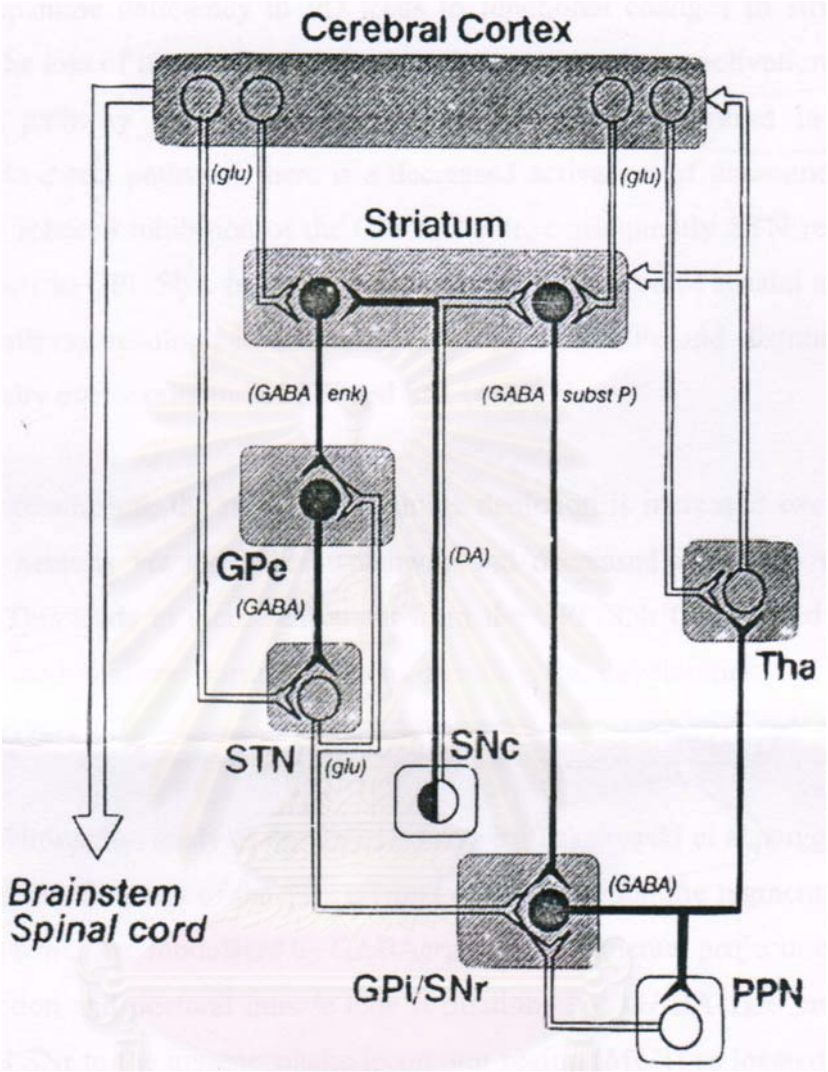


**Figure 2.1** Schemic diagram of the circuitry and neurotransmitters of the basal ganglia-thalamocortical circuitry, indicating the parallel 'direct' and 'indirect' pathways from the striatum to the basal ganglia output nuclei. Inhibitory neurons are shown as filled symbols, excitatory neurons as open symbols.

Abbreviations: DA, dopamine; enk, enkephalin; GABA, γ-aminobutyric acid; GPe, external segment of globus pallidus; GPi, internal segment of globus pallidus; glu, glutamate; PPN, pedunculopontine nucleus; SNc, substantia nigra pars compacta; SNr, substantia nigra pars reticula; subst P, substance P; STN, subthalamic nucleus; Tha, thalamus (Alexander and Crutcher, 1990)

**The Connection of Basal Ganglia in PD**

Dopamine deficiency in PD leads to functional changes in striato-pallidus circuits. The loss of nigrostriatal dopaminergic activity reduces activation of neuron in the direct pathway and reduces the normal inhibition of neuron in the indirect pathway. In direct pathway, there is a decreased activation of dopaminergic neurons leading to reduced inhibition of the GPi and SNr, consequently STN reinforcing the hyperactivity in GPi/SNr. In contrast, there is a disinhibition of striatal neurons in the indirect pathway resulting in decreased activity in the GPe and disinhibition of the STN, thereby over-excitation of GPi and SNr (Obeso et al., 2000).

In conclusion, the result of dopamine is increased excitation of the GPi/SNr neurons via the indirect pathway and decreased inhibition via the direct pathway. This leads to increased output from the GPi/SNr that exceed inhibition of brainstem and thalamo-cortical neurons resulting in development of parkinsonian features. (Figure 2.2)

Additionally, study of decerebrated cats by Takakusaki et al (2003). suggested that the lateral and medial parts of the SNr afferent to the mesopontine tegmental area of the brainstem which are modulated by GABAergic nigrotegmental projections contributed to locomotion and postural muscle tone regulation. The GABAergic projection from the medial SNr to the mesopontine tegmentum controls the locomotor pattern and that lateral SNr to the pedunculopontine tegmental nucleus (PPN) as the muscle-tone inhibition region determines the level of muscle tone. It seems that locomotion and muscle tone can be independently controlled by the separated nigrotegmentral projections. This hypothesis may assist in understanding of the mechanisms of motor disturbances in PD. An increased in SNr inhibition, together with a decreased in cortical excitation of the PPN may increase the level of muscle tone. Similarly, an excessive inhibition of the MLR and a decreased in cortical excitation of the brainstem may elicit gait failure (Takakusaki et al., 2003).

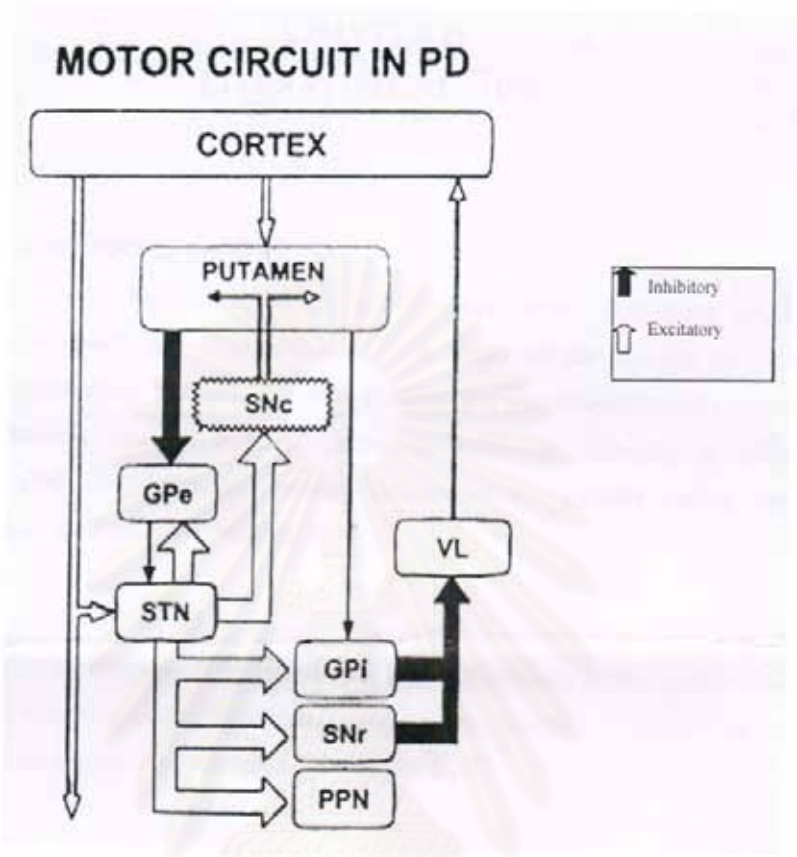


**Figure 2.2** The model of basal ganglia circuitry in the parkinsonian state.

Black arrows represent inhibitory projections and white arrows represent excitatory projections. The thickness of the arrow represents the degree of functional activity of the projection (Obeso et al., 2000).

## Clinical Manifestations of Parkinson and Parkinsonism

The four main motor symptoms of PD are resting tremor, bradykinesia, rigidity and postural instability. Gait difficulty also is discussed as a separate major motor symptom of PD, although the origin of gait difficulty lies in the other cardinal features (Dewey RB, 2000). Generally, the presence of resting tremor in addition to one of the other symptoms or the presence of the other three symptoms in the absence of resting tremor, will indicate the clinical diagnosis of PD.

### Resting tremor

Resting tremor is an alternately rhythmic activity in antagonist muscles presented 79% to 90% in clinical series (Gelb et al., 1999). A frequency of the resting tremor is approximately 3-7 cycles/sec (Hz), which causes a typical action of the thumb and fingers know as pill rolling. Typically, the resting tremor is more prominent at rest, and may present during action but disappears during deep sleep. The tremor tends to begin in one finger and hand and spreading over time to involve the whole arm, the contralateral side or the ipsilateral leg. However, the side with the initial symptoms is usually more severely affected and the tremor remains asymmetric throughout the course of the disease. Amplitude will vary, and will become more pronounced when the patient is under stress (Gabriel Hou and Lai, 2008). In addition, tremor can also affect the chin, lip, tongue and neck (Gelb et al., 1999, Dawson, 2000). It has been suggested that tremor is due to an altered firing rate of ventral intermediate nucleus (VIM) of the thalamus (Morris, 2000, Lozano and Carella, 2002).

### Rigidity

Rigidity or muscle stiffness can be detected by slow passive movement throughout the entire range of motion of the affected joint that can be felt degree of resistance of both extensor and flexor muscles. The resistance is either cogwheel or lead pipe. The cogwheel phenomenon is felt as a fluctuating resistance with tremor bursts. Lead pipe rigidity is defined as continuous resistance throughout the range

of movement and is felt when passively stretching muscles around a joint in a relaxed subject. As with tremor, rigidity usually begins unilaterally and may ultimately spread to involve the contralateral side (Dawson, 2000, Guttman et al., 2003). Rigidity may result from abnormal activation of long-latency stretch reflexes coupled with an increase in central reflex gain (Burke et al., 1977) and peripheral mechanical proportion of muscle (Dietz, 1997).

Rigidity also causes stooped posture and forward shift of the center of gravity (propulsion), resulting in postural instability. Patients also manifest flexed limbs and decreased arm swing when walking (Stanley and Protas, 2008).

**Bradykinesia**

Bradykinesia is used to described the overall slowness of voluntary movement, if often used interchangeably with hypokinesia (poverty of movement) and akinesia (absense of movement) (Jankovid J, 2003). Characteristic is an inability to initiate and intently perform movement and also affect all types of movement especially complex movements (Kutukcu et al., 1998, Kutukcu et al., 1999). These may contribute to develop a stooped posture, slow voluntary movement, decrease arm swing associated with shuffling gait, decrease facial movement (hypominia) resulting in drooling, change in speech (hypophonia). Moreover, these symptoms result in difficulty performing everyday functions, such as getting dressed, doing household chores and rising from chairs or bed. Writing may become micrographic, with a progressively smaller character size as the person continues to write (Koller, 1992).

There is hypothesis that bradykinesia results from disruption of the neurotransmitters used in the neural projections from the internal globus pallidus to the supplementary motor area, the premotor and motor area (Brotchie et al., 1991,Cunnington et al., 1995). This consequence may result in hypoactivity in thalamo-cortical execution (Valls-Sole J and Valldeoriola, 2002).

**Postural instability and gait disorder**

Impairment of postural stability or balance is a major functional problem for persons with Parkinson's disease especially advanced stage according to the defining feature of stage 3-4 disease on the Hoehn and Yahr scale.

Postural instability is likely to be the combined effect of rigidity and bradykinesia and generally occurs in patients with more advanced PD. It is mainly due to the loss of postural reflexes, which causes difficulties in positional adjustment. The patient's trunk is flexed to the stooped posture, and he or she presents with shuffling gait. The patient with PD tends to walk more quickly due to involuntary propulsion, and he or she may take smaller and faster steps (festination) and fall forward as a result. In addition, PD patients frequently have freezing gait, or sudden inability and hesitancy in moving their legs. Freezing is most often seen in gait initiation and on turns. Once gait is initiated, the patient can walk more naturally, as if thewed. Patients with freezing gait have particular difficulty walking through narrow passages or reaching a destination (such as a chair) before sitting down. Falls can easily occur during these freezing episodes. Due to PD patients frequently fail to extend their arms to protect themselves; clinicians depend upon clinical test to estimate falling risks. The clinical may examine a patient's ability to balance by performing the pull test from behind. This test examines the patient's response to a sudden, strong posterior displacement produced by a pull on the shoulder while the patient is erect with eyes open and feet slightly apart. The patient is prepared and can practice prior to the test; however, patients with more severe PD may fall if not caught by the examiner (Stanley and Protas, 2008).

These symptoms resulting from postural instability are unfortunately relatively resistant to pharmacological treatment. Patients may require physical therapy or rely on walking aids (Stanley and Protas, 2008).

Atpical parkinsonism disorders or parkinsonian syndromes occur from a known cause. Clinical signs of many parkinsonism syndromes consist of resting tremor, akinesia, rigidity, postural instability and gait abnormalities, as well as other neurologic abnormalities, e.g. supranuclear gaze palsy, cerebellar ataxia, autonomic dysfunction, dementia or hallucination. These parkinsonian diorders poorly response to levodopa (Stacy and Jankovic, 1992, Litvan, 1998). Secondary parkinsonism is one form of parkinsonism resulting from injury, infections, tumor or stroke, metabolic derangement, drug and toxins. Furthermore, parkinsonism include hereditary neurodegenerative disease and multiple system degenerations (Stacy and Jankovic, 1992).

The diagnosis of PD continues to be based on presenting signs and symptoms. To date, the cardinal signs of PD are rigidity, bradykinesia, tremor and postural instability. Other less common features include sensory phenomena, loss of smell, depression, dementia, sleep disturbance and autonomic nervous system dysfunction (Koller, 1992).

**The Modified Hoehn and Yahr Disability Scales**

The Hoehn and Yahr staging scale based on the level of clinical disability. It consists of seven stages from mildly to severely disable. Stage 1 is unilateral involvement only, usually with minimal or no functional impairment. Stage 1.5 is unilateral involvement plus axial involvement. Stage 2 is bilateral or midline involvement without impairment of balance. Stage 2.5 is mild bilateral involvement, impairment of balance without recovery on pull test. Stage 3 is mild to moderate bilateral involvement and impairment of postural instability, first signs of impaired righting reflexes. Functionally the patient is somewhat restricted in activities but many have some work potential, depending on the type of employment. Patients are physically capable of leading independent lives. Stage 4 is fully developed, severely disabling disease: the patients is still able to walk and stand unassisted but is markedly incapacitated. Finally, stage 5 is confinement to bed or wheelchair unless aided (Hoehn and Yahr, 1967).

## Treatment of PD

Treatment of PD is symptomatic and individualized. Available therapeutic approaches include pharmacological, non-pharmacological and surgical procedures. No know medication is able cure PD, although the effect to arrest its progression has always been a major focus of its treatment.

### Pharmacological

Development of pharmaceuticals for symptomatic relief is the main goal of PD therapies. Various classes of drugs are available for the treatment of PD include levodopa (carbidopa/levodopa), dopamine agonist, amantadine, catechol C methyltransferase (COMT) inhibitors, selegiline and anticholinergics (Jellinger, 1987). Levodopa remains the most potent drug for treatment of PD and usually patients who are unresponsive to high doses of levodopa are unlikely to respond to other dopaminergic agents. Levodopa lessens rigidity, tremor and bradykinesia but its efficacy is limited by motor fluctuations, dyskinesia and neuropsychiatric complications (McRae et al., 2002).

Dopamine agonists (bromocriptine, pergolide, pramipexole and ropinirole) are helpful in treatment of PD. Adverse effects of dopamine agonist consist of nausea and vomiting, orthostatic hypotension, sedation, headache, cardiac arrhythmia and psychosis. COMT inhibitors (entacapone and tolcapone) are used as adjunctive therapy to levodopa in treatment of PD. Administration of COMT inhibitors can decrease “off” time and increase “on” time in PD (Jellinger, 1987, Pellecchia et al., 2004).

Anticholinergics (benzatropine, biperiden, trihexyphenidyl and procyclidine) are used for symptomatic treatment of tremor in patients with PD. It is thought that anticholinergics exert their effect by partially correcting the cholinergic excess that occurs in the relative dopamine deficiency of PD patients. Adverse effects include blurred vision, memory impairment, confusion, delirium, urinary retention and constipation (Schenkman et al, 1997).

The main medical treatment of PD aims at firstly, improvement of the dopaminergic motor symptoms or delay as long as possible the motor complications, secondary, amelioration of neuropsychiatric, cognitive and autonomic complaints and lastly, establishing therapies to slow or prevent disease progression (Djaldtti and Melamed, 2002).

**Non-pharmacological**

Non-pharmacological treatment included physical, occupational and speech therapies. The patients with PD improve their physical performance and activities of daily living through exercise (Crizzle and Newhouse, 2006). Exercise is an activity that patients can perform together with pharmaceutical treatment to reduce complications from the pathology of the disease, thus enabling the patients to continue carting out their daily living activities and to reduce their dependence on others to maintain quality of life (Chen et al., 2005, Gabriel Hou and Lai, 2008).

The goals of a training program must be attainable for the patients. The first aim of physical treatment is to keep the patient as functional as possible. Exercise treatment will not stop progress of PD, but it should prevent secondary complications such as loss of muscle strength, decrease of movement range with subsequent contractures, orthostatic hypotension, inactivity osteoporosis, and pneumonia.

In the current, exercise program should emphasize safe and functional movements and ideally include strengthening, flexibility, endurance and balance activities. Numerous research studies have shown that physical therapy/exercise interventions positively impact movement problems experienced by PD patients (Stanley and Protas, 2008). Especially, gait training in Parkinson patients as an important component among the treatment to improve gait ability.

Many researcher studied exercises with visual cued to stimulate walking. After they have taken the first step, they tend to continue walking in short, quick steps, especially during the first steps. Thus, they should practice normal walking with straight back and longer steps.

Although antiparkinsonian medications improve gait, their effectiveness decreases progresses. Other forms of interventions have limited impact on gait and balance over time. Therefore, there is a need to explore alternative, rehabilitation interventions to improve gait and balance impairments (Protas et al., 2005).

**Gait pattern in Parkinson**

As a result of PD progressive disease, a number of clinical motor signs become apparent, including a gait that can be primarily characterized by hopokinesia and akinesia (Brunt et al., 2008).

Hypokinesia refers to a slowness of gait characterized by loss of arm swing on one or both sides, slowing, especially after walking for a long time, shortened stride length and intermittent shuffle, tripping over objects (Pal et al., 2002) and decreased ground clearance. The term shuffling gait is often used to describe how patients with PD walk. The fear of falling may also contribute to the hypokinetic characteristics of PD gait.

Akinesia is manifested in the inability of PD patients to initiate gait or in freezing during gait. Freezing, or sudden cessation of walking, usually occurs while turning or when confronted with environmental constraints such as a doorway or an approaching target (Brunt et al., 2008). Difficulties in gait initiation and changes in postural control are also problematic. Turning is difficult because it requires a series of gait initiations. Freezing and motor blocks, balance deficits, and frequent fells occur during latter stages of PD (Giladi N, 2002).

When people with PD walk a short distance, they typically show reduced velocity of walking associated with reduced stride length and a compensatory increase in cadence. Patients with last stage, the effected individual demonstrates diminishing arm swing and an overall attitude of flexion when walking, with the head projecting abnormally anteriorly and the thoracic spine becoming kyphotic. The arms and legs

assume a flexed and adducted posture and the patient takes increasingly shorter steps. PD who have problems with balance tend to have problems with their first step, but after that they can have a series of quick, short steps and unable to suddenly stop walking; otherwise, they will easily fall down (Hayashi et al., 1997, Canning et al., 2006).

Elderly persons with PD are characterized by poverty of movement, loss of muscular strength and endurance, and diminished functional capacity. The weakness may arise from various factors associated with the disease including inactivity arising from the basic disability as well as electrophysiologic changes in muscle activation involving alterations of the discharge patterns of muscle units during activation and coactivation of opposing muscle groups (Scandalis et al., 2001).

Typically, when these patients become less confident in their coordination, many patients prefer to restrict their activity because of potential injury. This restricted activity results in muscular atrophy, similar to the condition of sedentary elderly individuals. The encouragement of such patients to perform various exercises and avoid the complication of muscle atrophy in addition to the underlying neurologic deficit is the rationale for physical rehabilitation methods in patients with PD (Scandalis et al., 2001). Even when people with PD are capable of walking at velocities comparable to healthy controls, they do not sustain this velocity over longer distances. Training that targets high velocities warrants investigations as a remediation technique (Canning et al., 2006).

These abnormalities are thought to be because of hypokinesia, that is, reduced speed and amplitude of movement, which is a major motor impairment observed in PD (Hayashi et al., 1997, Canning et al., 2006). Therefore, improvements in walking speed and stride length are the primary goals of gait in therapy in patients with PD (Poel et al., 2003).

## Gait training in Parkinson

Several researchers supported the gait training in Parkinson patients as an important component among the treatment to improve gait ability. Several authors reported increased gait ability; gait speeds, step length, step frequency after treadmill training or repetitive training of compensatory stepping in individuals with PD (Protas et al., 2005).

### Gait training with treadmill

Treadmill training is widely used to enhance the gait performance of PD patient. Many studies have examined the effects of ambulation training on treadmill with no body weight support or with body weight support on gait and motor performance in PD.

Miyai et al. (2002) investigated the effect of body-weight supported treadmill training (BWSTT) on gait and parkinsonian symptoms of PD in 24 patients with mild to moderate stage. In this 4-week crossover study, BWSTT produced greater improvement in motor performance compared with conventional physical therapy (PT), increasing stride length and gait speed, reducing step frequency and parkinsonian symptoms. A follow-up randomized controlled trail showed a long term effect of BWSTT on gait, beyond that of conventional PT which lasted for about 4 months.

Pohl et al. (2003) examined the immediate effects of a single treadmill session in a crossover, 4 – consecutive - day trial in 17 patients with early PD. Their results suggest that gait speed and stride length can be improved through a single intervention treadmill training (even speed-dependent treadmill training or limited progression treadmill without body-weight support), but not through conventional gait training or a no-intervention waiting period.

Frenkel-Toledo et al. (2005) assessed the influence of treadmill training on stride to stride variability in 36 patients with early PD compared with 30 healthy matched age. Their results showed that when walking on a treadmill, patients with PD improve their gait and walk with reduced gait variability, even when walking at the same speed as on overground walking.

Herman et al. (2007) evaluated the effects of 6 weeks of intensive treadmill training on gait rhythmicity in 9 patients with mild to moderate PD. They adjusted speed of treadmill every week and assessed short effect, post completed training and long effect, 4-weeks post completed training. This results showed the potential to enhance gait speed and stride length in short term effect and long term effect.

Fisher et al. (2008) studied the effects of treadmill training in improving motor performance in 30 patients with early Parkinson. They compared with conventional physical therapy program. This found that improved motor performance in gait speed, step length and step frequency during self-selected and fast walking speed post 8 weeks of training in experimental group.

The mechanism whereby treadmill training works in PD remains to be fully determined. One possibility is that the treadmill acts as an external rhythm by setting the walking pattern, reinforcing neuronal circuits that contribute to gait pacing. This explanation is supported by earlier findings which showed that treadmill provides an external rhythm that compensates for the defective internal rhythm of the basal ganglia in the same way that rhythmic auditory stimulation or visual cues work in PD (Herman et al., 2007).

Another possibility is that treadmill training works as a form of motor relearning. The treadmill training used here was repetitive and involved on going feedback. The patient learns to adapt to progressively increasing demands a process that may enhance the automating of motor control (Herman et al., 2007).

**Gait training with step**

Few studies reports suggest that ambulation training using repetitive training of compensatory stepping in individuals with PD results in improvements in gait performance.

Rogers et al. (2003) studied the influence of step training on the speed of voluntary step initiation in aging. They found 8 older adults improved step initiation time and longer step length. The subjects underwent step training consisted of pull pertubations and somatosensory reaction stimulus cued for 3 week regimen of either twice weekly.

Jobges et al. (2004) studied the effect of repetitive training of compensatory step. That found 14 patients with mild to moderate PD underwent training consisted of pull pertubations for 14 days. The results showed an increase of gait speed from 0.64 m/s to 0.77 m/s. This increase was accompanied by and increase in cadence (0.80 steps/s to 0.87 steps/s) and step length (0.80 m. to 0.87 m.), but there was no control group comparison.

Using a paradigm that focused on stepping rather than routine walking, Protas et al. (2005) assessed the benefits of gait and step perturbation training in 18 patients with mild to moderate PD. They found that walking on a treadmill at a speed greater than overground walking speed while walking in 4 directions (back and forth and sideways) and step training (practicing starting and stopping) resulted in a reduction in falls and improvement in gait speed, cadence, stride length and dynamic balance in a small group of patients.

Researcher suggests that repetitive motor activity forms an important prerequisite of motor learning, that like as repetitive step in walking on treadmill. And repetitive step is conceivable the central nervous system processes that mediate protective stepping resemble those involved in the control of gait Rogers et al. (2003).

**Gait training with cue**

Many researches have recommended the use exercise with external cued to stimulate walking. Visual and auditory sensory cues as well as the anti-parkinsonian medication levodopa can modify gait movements and muscle activation in some patients with PD (Morris et al., 2000, Suteerawattananon et al., 2004).

Morris et al. (1996) studies the effect of visual cueing training in 16 Parkinson patients. Subjects were performed gait training at 2-min intervals for 20 minutes for 3 weeks. The results showed improved gait speed, step frequency and step length post training.

Suteerawattananon et al. (2004) determined the effect of a single combined visual and auditory cues session on gait pattern in 24 Parkinson patients with mild to moderate stage. That found improved gait speed, step frequency and stride length. Auditory cueing significantly improved cadence, but visual cueing improved stride length.

Jiang and Norman (2006) evaluated the effects of auditory and visual cues on gait initiation in 14 Parkinson patients with mild to moderate stage. The results showed the longer of firsts and second step lengths and higher gait velocity were significantly greater in the visual cue than baseline, but no significant effect of auditory cue. And there were no significant effects of cue on step initiation time, but decreased step initiation time in both cues.

Nieuwboer et al. (2007) investigated the effects of a home physiotherapy programme based on rhythmical cueing on gait parameters in 153 Parkinson patients with mild to moderate stage. All subjects received a 3-week home cueing programme using prototype cueing device. They found significant improved in gait speed and step length, but no significant effect of step frequency.

A common mechanism of external cue training may be the shunt of the Basal Ganglia-Supplementary Motor area interaction either by a more important implication of the motor cortex by attention or by the activation of a specific visuomotor pathway for external stimuli and so, to by-pass the deficit of internal cueing (Morris et al., 1996, Azulay et al., 2006).

**The effect of stair-walking exercise**

Stair can be used anywhere and low cost. Stairs are frequently encountered obstacles in daily living and stair climbing requires much more effort and energy than ground walking. Stair climbing like walking, it requires no equipment and is freely available, at least in the developing world. Stair climbing was readily accessible, free and easily accumulated into an individual's life (Olander et al., 2008).

In healthy people, stair-walking is a readily accessible form of exercise which is associated with a reduced mortality in populations (Boreham et al., 2000). Loy et al. (1994) indicated stair climbing is an appropriate exercise for middle-aged females improving both aerobic capacity and strength following 12 weeks of training. And the data supported the use of stair-climbing exercise as an alternative mode to running with similar treadmill and running performance results subsequent to 9 weeks of training (Loy et al,. 1993). Following 12 weeks of stair-climbing the only statistically significant change was a decrease in Ratings of Perceived Exertion (RPE) during the stair-climbing lest in the exercise group (Ilmarinen et al., 1979).

In Parkinson patients, stair-walking combined repetitive step and visual cued. Repetitive step, that like as walking on treadmill. Treadmill training, the effect induced gradual implicit motor learning of rhythmic walking. It used repetitive and involved on going feedback (Miyai et al., 2002). Staircase could provide some visual cueing during walking. The visual cues are commonly transverse lines or rods on the floor. These types of visual cues have been associated with increases in stride length and velocity in Parkinson patients (Jiang and Norman, 2006).

From the literature review, the patients with PD show improved gait ability post gait training program. We found no information was presently available on the impact of improvement in gait ability through stair-walking training in PD.

We are interested in applying stair-walking training for rehabilitation program in Parkinson patients. So the aim of this study was to evaluate the effect of stair-walking training program on gait ability in patients with PD. The stair was used in this study because it can be utilized effectively without expensive equipment and easy to use.

We would like to study the effect of stair-walking training on gait ability in Parkinson patients with compare to conventional physical therapy training program.

# CHAPTER III

# RESEARCH METHODOLOGY

## Research design

This study is an experimental research which aims to examine the effect of stair-walking training in Parkinson patients. The subjects were allocated to two groups. Both groups were similar in severity of PD. Training group completed a 4-week stair-walking program and control group completed a 4-week ground walking program.

## Research methodology

### Population and Sample

In this study, the target population was both male and female volunteers with PD. The samples were patients with PD who recruited from Chulalongkorn Comprehensive Movement Disorder Center within King Chulalongkorn Memorial Hospital. Approval of this study was provided by Chulalongkorn University Ethic Committee. They were divided into two groups; experimental group and control group. The patients were interviewed about their disease, medical history. The characteristic data including weight and height were recorded. The inclusion and exclusion criteria were as follows.

### Inclusion criteria

1. Diagnosis of idiopathic PD by neurologists
2. PD within stage 2-3 of the Modified Hoehn and Yahr disability scales
3. Ability to stand independently and walk with or without an assistive device
4. Receiving antiparkinsonian medication and medically stable

**Exclusion criteria**

1. Have a problem of musculoskeletal system especially lower extremity.
2. Have a stooped posture.
3. Have a problem of movement from other movement disorder.
4. Have a problem of cardiovascular disease.
5. Have difficulty in understanding instructions.

**Sample size**

Volunteers were chosen from Chulalongkorn Comprehensive Movement Disorder Center within King Chulalongkorn Memorial Hospital. The volunteers had to pass the inclusion and exclusion criteria.

**Sample size calculation**

Sample sizes were calculated from the study of Miyai et al. (2002). They investigated the effects of treadmill training with body weight support in 20 Parkinson patients within stage 2-3 of the Modified Hehn and Yahr. Control group 9 patients and experimental group 11 patients. In this study, the mean error of gait speed after training of control group was 10.8 ± 1.8 seconds/10m. and experimental group was 8.5 ± 0.7 seconds/10m. And the sample size was calculated below.

$$n = \frac{2\,(Z_\alpha + Z_\beta)^2\ S_p^2}{D^2}$$

$\alpha$ = 0.05 (two-sided), $Z_\alpha$ = 1.96

$\beta$ = 0.20 (two-sided), $Z_\beta$ = 1.28

D = differences of mean needed to be test

$$S_p^2 = \frac{(n_1 - 1) S_1^2 + (n_2 - 1) S_2^2}{n_1 + n_2 - 2} = \frac{(9-1)(1.8)^2 + (11-1)(0.7)^2}{9 + 11 - 2}$$

$$S_p^2 = 1.712$$

Substistute to $$n = \frac{2 (1.96 + 1.28)^2 (1.712)}{(10.8-8.5)^2}$$

$$n = 6.794$$

n for each group will be 7 persons. To prevent drop out rate during the experimental and detect more reliability, subjects will add for more 15%. So, total subjects are 10 persons for each group.

**Instruments**

1. Case record form
2. Information form
3. Corner exercise staircase
4. Timer- counter with sensor infrared
5. Measuring tape
6. Stop watch (JS-306, Junso® , China)

**Assessment of the gait ability**

The assessment of the gait ability is a test that quantitatively examines the ability of walking in Parkinson patients. Gait ability assessments were recorded with timer-counter with sensor infrared. The following measurements were performed before-after walking training program. The patients was asked to walk at self-adapted walking speed on 10-meters walkway with timer-counter with sensor infrared, while the subject was guarded by a physical therapist to prevent falls. The patients completed 3 trials on 10-meters walkway, and the average of the results from these 3 trials was used as data.

Walking speed (m/s) was calculated from the time to walk at self-adapted walking speed on 10-meters walkway.

Step initiation time (sec) was calculated from the time between the sign of start and the foot over the ground.

Step length (meter) was calculated by dividing the 10 meters by step frequency (steps).

Step frequency (steps/10 m) was calculated from the number of step. There were counted by the observer.

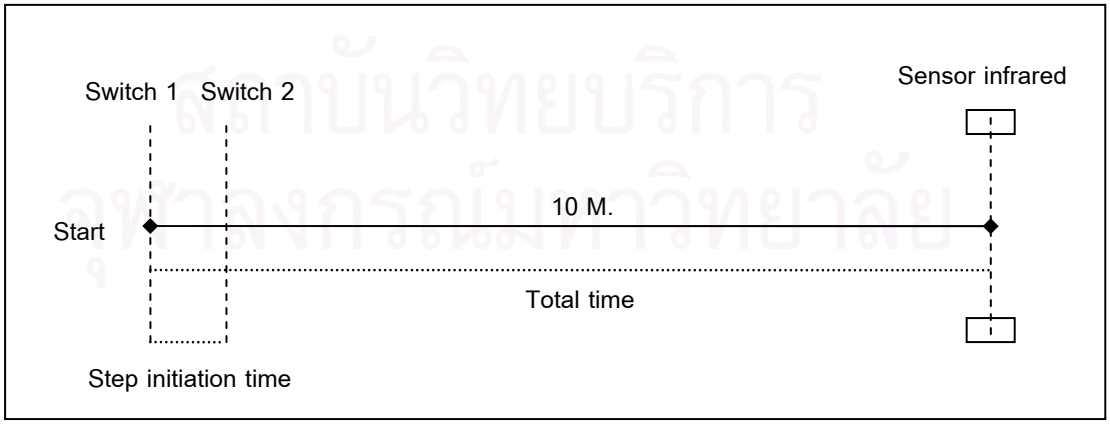


**Figure 3.1** Diagram for gait ability assessment

**Data collected from timer-counter with sensor infrared**

Timer-counter with sensor infrared was the instrument for measure the ability of walking. Timing began after the examiner said “Start”, while the examiner pressed the first switch off. Press the second switch off for step initiation time while the foot’s subject over the ground. When subjects passed 10 meters, the timing stopped by sensor infrared. Data were showed on the monitor after each switch off. Time was recorded to the nearest .01 second, and the average of 3 trials was taken. Test-retest reliability for this measure within our clinical lab is excellent (R=.99).


**Figure 3.2** Computer for timer-counter program

**Figure 3.3** Sensor infrared

### Walking training program

Before and after training, both groups received general exercise and static stretching. Static stretching which involved slowly stretching muscles to the fullest and keeping tension for at least 10 seconds. The subjects received walking training time 30 minutes per session, 3 sessions per week for 4-weeks.

**Figure 3.4** General exercise

### Stair-walking training program

The experimental group was then asked to walk at self-adapted walking speed on the corner exercise staircase. The subjects were asked to walk up the 10-cm-high step in the first week. And then in the third week, the subjects were asked to walk up the 15-cm-high step. The subject was allowed to rest if fatigue occurred during stair-walking training, but the training time was stop and counted again when the subjects start walking training. They were further instructed that they could use the handrail if they thought it was necessary for safety purpose. The subject was also guarded by a physical therapist during the training.



aining program

**Ground walking training program**

The control group was then asked to walk at self-adapted walking speed on the ground at home. The subjects were allowed to rest if fatigue occurred during walking.

**Procedure**

Sixteen Thai Parkinson patients within stage 2-3 of the Modified Hoehn and Yahr disability scales were recruited the subject from inclusion/exclusion criteria. After the subject gave informed consent, the subject was asked to provide demographic information and history of PD. The subjects are divided into two groups. They was randomly assigned to either the stair-walking training experimental group or a control group who received the home program; seven subjects' control and nine subjects' experimental group. All received walking training program for 4-weeks, which experimental group underwent the stair-walking training and control group underwent the conventional walking training. Furthermore, all received step initiation time, gait speed, step length and step frequency measurement occurred before and after training.

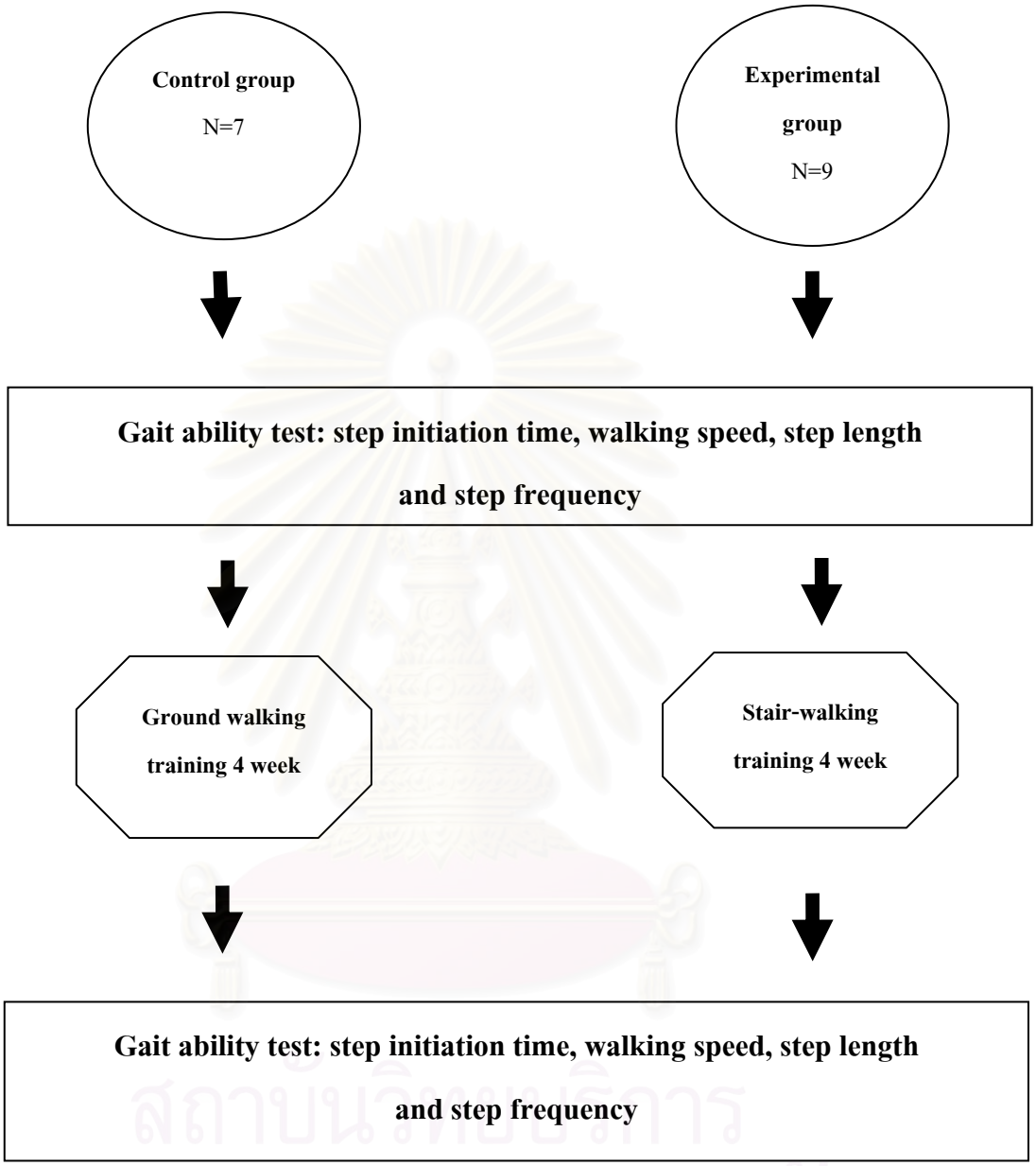


Figure 3.6 The research procedure

**Data analysis**

All results were expressed as the mean ± SD. All of the data was normal distribution. The paired t-test was to detect the differences of the error in step initiation time, gait speed, step length and step frequency between before and after training. The unpaired t-test was to detect the differences of the error in step initiation time, gait speed, step length and step frequency between control and experimental group.

An alpha level of 0.05 was used to determine statistical significant. All analyses were performed on the Statistical Package for the Social Sciences version 14.0 (SPSS, Chicago, IL, USA).

# CHAPTER IV

# RESULT

A total of 50 Parkinson patients within stage 2-3 of the Modified Hoehn and Yahr disability were recruited through directly explanation of the details of the study by researcher at the Chulalongkorn Comprehensive Movement Disorder Center within King Chulalongkorn Memorial Hospital. The final subject number was 16, who completed the entire study.

## Characteristics of the subjects

Baseline characteristics of the subjects both in control and experimental group were summarized in **Table 4.1**. Age of the experimental subjects were 64.67 ± 13.52 years, and control subjects were 71.29 ± 12.16 years. Duration of PD was more in the experimental group (4.89 ± 2.76) than the control group (4.43 ± 1.13).

**Table 4.1** Baseline characteristics of the subjects.

| Characteristics | Group | |
|---|---|---|
| | Experimental Group | Control Group |
| Patients (n) | 9 | 7 |
| Sex (male/female) | 7/2 | 3/4 |
| Age (years) | 64.67 ± 13.52 | 71.29 ± 12.16 |
| Hoehn and Yahr stage 2/2.5/3 | 5/3/1 | 3/2/2 |
| Duration of PD (years) | 4.89 ± 2.76 | 4.43 ± 1.13 |

**Gait ability**

Baseline gait ability pre-trained was tested in both groups. There was no statistical difference of pre-trained between the two groups (Table 4.2). There was no statistical difference in step initiation time, gait speed, step length and step frequency.

**Table 4.2** The mean error gait ability of pre-trained between control and experimental group.

| Gait ability | Pre-trained | | P-value |
|---|---|---|---|
| | Experimental n=9 | Control n=7 | |
| Step initiation time (sec) | 1.18 ± 0.29 | 1.44 ± 0.49 | 0.210 |
| Gait speed (m/sec) | 0.82 ± 0.23 | 0.63 ± 0.13 | 0.068 |
| Step length (m.) | 0.51 ± 0.12 | 0.39 ± 0.09 | 0.053 |
| Step frequency (step/10 m) | 20.81 ± 6.26 | 26.43 ± 6.01 | 0.092 |

Compared between experimental and control group using Unpaired t- test Statistics.

* Significant difference between both group, P<0.05

Baseline gait ability post-trained was tested in both groups. There was statistical difference of post-trained between the two groups (Table 4.3). When compared post-trained between experimental and control group p-value was less than 0.05 in gait speed, while p-value was less than 0.01 in step length and step frequency. But there was no statistical difference in step initiation time.

**Table 4.3** The mean error gait ability of post-trained between control and experimental group.

| Gait ability | Post-trained | | P-value |
|---|---|---|---|
| | Experimental n=9 | Control n=7 | |
| Step initiation time (sec) | 0.84 ± 0.29 | 1.11 ± 0.35 | 0.392 |
| Gait speed (m/sec) | 1.03 ± 0.30 | 0.69 ± 0.12 | 0.026* |
| Step length (m.) | 0.60 ± 0.13 | 0.42 ± 0.10 | 0.009† |
| Step frequency (step/10 m) | 16.85 ± 3.40 | 24.81 ± 5.98 | 0.006† |

Compared between experimental and control group using Unpaired t- test Statistics.

* Significant difference between both group, P<0.05

† Significant difference between both group, P<0.01

In post-trained, gait ability was statistical difference between experimental and control group in gait speed, step length and step frequency, especially in step length and step frequency was less than 0.01. In step initiation time was no significant, but the value in experimental group improved more than control group.

Baseline gait ability was tested in pre-post trained. There was statistical difference of experimental group between pre-post trained (Table 4.4). When compared experimental group between pre-post trained p-value was less than 0.01 in gait speed. P-value was less than 0.005 in step length and step frequency. P-value was less than 0.001 in gait speed.

**Table 4.4** The mean error gait ability of experimental group between pre-trained and post-trained.

| Gait ability | Experimental group (n=9) | | Mean differences | P-value |
|---|---|---|---|---|
| | Pre-trained | Post-trained | | |
| Step initiation time (sec) | 1.18 ± 0.29 | 0.84 ± 0.29 | 0.34 ± 0.29 | 0.009† |
| Gait speed (m/sec) | 0.82 ± 0.23 | 1.03 ± 0.30 | 0.21 ± 0.10 | 0.000# |
| Step length (m.) | 0.51 ± 0.12 | 0.60 ± 0.13 | 0.09 ± 0.05 | 0.001‡ |
| Step frequency (step/10 m) | 20.81 ± 6.26 | 16.85 ± 3.40 | 3.96 ± 2.65 | 0.002‡ |

Compared between pre and post trained using Paired t- test Statistics.

† Significant difference between both phase, P<0.01

‡ Significant difference between both phase, P<0.005

# Significant difference between both phase, P<0.001

Baseline gait ability was tested in pre-post trained. There was statistical difference of control group between pre-post trained (Table 4.5). P-value was less than 0.05 when compared control group between pre-post trained in step initiation time, gait speed, step length and step frequency.

**Table 4.5** The mean error gait ability of control group between pre-trained and post-trained.

| Gait ability | Control group (n=7) | | Mean differences | P-value |
|---|---|---|---|---|
| | Pre-trained | Post-trained | | |
| Step initiation time (sec) | 1.44 ± 0.49 | 1.11 ± 0.35 | 0.33 ± 0.26 | 0.015* |
| Gait speed (m/sec) | 0.63 ± 0.13 | 0.69 ± 0.12 | 0.06 ± 0.07 | 0.041* |
| Step length (m.) | 0.39 ± 0.09 | 0.42 ± 0.10 | 0.02 ± 0.02 | 0.018* |
| Step frequency (step/10 m) | 26.43 ± 6.01 | 24.81 ± 5.98 | 1.62 ± 1.70 | 0.046* |

Compared between pre and post trained using Paired t- test Statistics.

* Significant difference between both group, P<0.05

In the post-trained, both groups improved gait ability after 4 week of training. Gait ability of experimental group more improved than control group, especially in gait speed was less than 0.001. Step length and step frequency was less than 0.005, step initiation time was less than 0.01.

Baseline mean difference of gait ability was tested in both groups. There was statistical difference of mean difference of gait ability between the two groups (Table 4.6). P-value was less than 0.05 when compared control group between pre-post trained in gait speed, while p-value was less than 0.001 in step length. But there was no statistical difference in step initiation time and step frequency.

**Table 4.6** The mean difference of gait ability between control and experimental group.

| Gait ability | Mean differences | | P-value |
|---|---|---|---|
| | Experimental (n=9) | Control (n=7) | |
| Step initiation time (sec) | 0.34 ± 0.29 | 0.33 ± 0.26 | 0.760 |
| Gait speed (m/sec) | 0.21 ± 0.10 | 0.06 ± 0.07 | 0.006* |
| Step length (m.) | 0.09 ± 0.05 | 0.02 ± 0.02 | 0.000# |
| Step frequency (step/10 m) | 3.96 ± 2.65 | 1.62 ± 1.70 | 0.065 |

Compared between experimental and control group using Unpaired t- test Statistics.

* Significant difference between both group, P<0.05

# Significant difference between both phase, P<0.001

In post-trained, mean difference of gait ability was statistical difference between experimental and control group in gait speed and step length, especially in step length was less than 0.001. In step initiation time and step frequency was no significant, but the value in experimental group improved more than control group.

# CHAPTER V

# DISCUSSION AND CONCLUSION

The aim of this study is that whether the current study was to investigate the effect of stair-walking training in Parkinson patients, we expected that this program would lead to an improvement of gait ability in the experimental group.

## Gait ability

In the current investigation, post-trained of experimental and control group was the improvement for the errors of gait ability. For the experimental group, gait ability had a great significant improvement as compared with pre-trained. Especially, gait speed had a greater significant improvement than other parameters. As well as gait ability of the control group had a great significant improvement as compared with pre-trained.

From the data of gait ability, the error of the gait ability between experimental and control group was examined. The researcher found an improvement of gait ability in experimental and control group. The experimental group was more improvement than control group. For step length and step frequency of the experimental group had a great significant improvement as compared with the control group. Expect step initiation time of the experimental group was not significant improvement as compared with the control group, but it was more improvement than control group.

Stair-walking, that like as walking on treadmill. This investigation was same as the other studies which used treadmill training. For instance, Miyai et al. (2002) studied the treadmill training with body-weight supported which compared with conventional physical therapy program on gait parameters in Parkinson patients. The results increased stride length and gait speed, reduced step frequency in experimental group.

The results of Fisher et al. (2008) studied were that they compared treadmill training and physical therapy program on motor performance. They found improved motor performance in gait speed, step length and step frequency during self-selected and fast walking speed in experimental group.

Stair-walking exercise may stimulate as visual cue too. This investigation was same as the other studies which used visual cue. For instance, Morris et al. (1996) studies the effect of visual cueing training in Parkinson patients. The results showed improved gait speed, step frequency and step length post training. The results of Nieuwboer et al. (2007) showed significant improved in gait speed and step length, but no significant effect of step frequency in home physiotherapy programme based on rhythmical cueing. Jiang and Norman (2006) applied auditory and visual cues on gait initiation in Parkinson patients. The results showed the longer of firsts and second step lengths and higher gait velocity were significantly greater in the visual cue. And there were no significant effects of cue on step initiation time, but decreased step initiation time in visual cues.

This investigation was differed from the other studies which used step training. For instance, Rogers et al. (2003) studied the speed of voluntary step initiation which used step training in aging. They reported that it was significantly reduced in step initiation time. But this studied in normal aging group.

In this study, the result showed up that there were differences in statistics both groups. Because of all groups were exercise group which the experimental group was obtained stair-walking training program. The control group was obtained conservative training program.

The result showed up that step initiation time was no difference in statistics between the experimental and control group. Nevertheless, it had no difference in statistics; the experimental group had more decreased error of step initiation time than the control group.

Stair-walking was different from treadmill as following aspects; treadmill was stimulate the step walking by machine that acts as an external rhythm by setting the walking pattern only. But stair-walking may stimulate as visual cue from the staircase too, that not found in treadmill. In stair-walking exercise, the subjects have to raise their legs themselves and higher step walking than walking on treadmill. Stair-walking exercise may gain more strength of lower extremities than treadmill. So that subjects who did stair-walking exercise can improve their gait pattern, especially can improve ground clearance that help to prevent of fall.

## Conclusion

The current results indicate that gait ability improved in all stair-walking training and ground walking training at home. It showed necessary training or exercise for gait ability improvement.

Gait training program in this study: stair-walking training in the experimental group and ground walking training in the control group, can improve gait ability in Parkinson patients.

Stair-walking exercise can improve gait ability in Parkinson patients more than ground walking exercise. Stair-walking exercise may stimulate as visual cue and gradual implicit motor learning of rhythmic walking.

Thus, it is suggest that stair-walking training program can be used to improve gait ability in Parkinson rehabilitation program.

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# APPENDICES

# APPENDIX A

## เอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมโครงการ
(Patient Information Sheet)

**ชื่อโครงการ** ผลของการฝึกเดินขึ้น-ลงบันได ในผู้ป่วยพาร์กินสัน

**ผู้ทำการวิจัย** นางสาวอัญชลี เจริญสันติอุไร
นิสิตหลักสูตรวิทยาศาสตร์มหาบัณฑิต สาขาเวชศาสตร์การกีฬา

**อาจารย์ที่ปรึกษาโครงการ** ศ. พญ. อารีรัตน์ สุพุทธิธาดา

**อาจารย์ที่ปรึกษาร่วม** รศ. นพ. รุ่งโรจน์ พิทยศิริ

**ผู้ดูแลที่ติดต่อได้**

1. ศ.พญ. อารีรัตน์ สุพุทธิธาดา ภาควิชาเวชศาสตร์ฟื้นฟู คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย โทรศัพท์ 02-256-4433
2. รศ.นพ. รุ่งโรจน์ พิทยศิริ ภาควิชาอายุรศาสตร์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย โทรศัพท์ 02-256-4630
3. นางสาวอัญชลี เจริญสันติอุไร ภาควิชาสรีรวิทยา คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย โทรศัพท์ 02-256-4267 , มือถือ 084-211-3453

**สถานที่วิจัย**

1. ภาคสรีรวิทยา คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
2. ภาควิชาเวชศาสตร์ฟื้นฟู คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

**ความเป็นมาของโครงการ**

โรคพาร์กินสัน เป็นโรคการเสื่อมของระบบประสาท พบประมาณ 1 ใน 100 คนที่มีอายุมากกว่า 65 ปีขึ้นไป สาเหตุของการเกิดโรคยังไม่ทราบแน่ชัด ผู้ป่วยจะมีอาการเคลื่อนไหวช้า การแข็งเกร็ง เดินลำบาก และมีการสั่น การรักษาคือการรับประทานยาและการผ่าตัดซึ่งสามารถลดอาการแข็งเกร็งและการสั่นได้ดี

แต่ปัญหาสำคัญในผู้ป่วยพาร์กินสัน คือ การเดิน ซึ่งมีอาการเดินติดขัดในช่วงของการเริ่มเดินและการซอยเท้าถี่ ซึ่งการรักษาด้วยยา หรือการผ่าตัดไม่เห็นผลที่ชัดเจนนัก ซึ่งปัญหาดังกล่าวทำให้ผู้ป่วยเสี่ยงต่อการล้ม การทำกิจวัตรประจำวันลดลงและอาจเกิดภาวะทุพพลภาพได้ ทำให้การพัฒนาความสามารถในการเดินจึงเป็นจุดประสงค์หลักในการฟื้นฟูผู้ป่วยพาร์กินสันทากายภาพบำบัด

วิธีการฟื้นฟูสมรรถภาพทางการเดินในผู้ป่วยพาร์กินสันมีหลากหลายวิธี วิธีการหนึ่งที่ได้รับการสนใจมากคือ การฝึกเดิน และการฝึกก้าวขา การฝึกก้าวข้ามสิ่งกีดขวาง การฝึกก้าวขึ้น-ลงพื้นต่างระดับ โดยการฝึกทุกวิธีจะมีการให้สัญญาณ เพื่อช่วยกระตุ้นให้ผู้ป่วยพาร์กินสันสามารถเริ่มทำกิจกรรมนั้นๆ ได้อย่างมีประสิทธิภาพ และมีการประยุกต์การออกกำลังกายแบบมีแรงต้านและแบบแอโรบิค มาใช้ในการรักษาผู้ป่วยพาร์กินสันร่วมด้วย

ดังนั้นผู้ทำการวิจัยจึงมีความสนใจว่าการฝึกเดินโดยการขึ้น-ลงบันได สามารถเพิ่มความสามารถในการเดินในผู้ป่วยพาร์กินสันได้จริงหรือไม่ การฝึกเดินขึ้น-ลงบันไดเป็นรูปแบบการฝึกที่หากได้ผลดี ผู้ป่วยสามารถฝึกเองที่บ้านได้โดยไม่ต้องใช้เครื่องมือพิเศษใดๆ และเพื่อที่จะนำความรู้นี้ไปประยุกต์ใช้ในการรักษาผู้ป่วยพาร์กินสันรายอื่นต่อไป

**วัตถุประสงค์**

เพื่อศึกษาผลของการฝึกเดินขึ้น-ลงบันได ต่อการเปลี่ยนแปลงความสามารถในการเดินในผู้ป่วยพาร์กินสัน

**รายละเอียดที่จะปฏิบัติต่อผู้เข้าร่วมโครงการ**

1. ผู้เข้าร่วมวิจัยจะได้รับการชี้แจงรายละเอียดเกี่ยวกับงานวิจัยโดยย่อ และได้รับการแจ้งให้ทราบว่าการเข้าร่วมโครงการศึกษาวิจัยในครั้งนี้ ผู้เข้าร่วมวิจัยไม่ต้องเสียค่าใช้จ่ายใดๆ ทั้งสิ้น ได้รับการสัมภาษณ์และคัดกรองความเสี่ยงเบื้องต้นโดยผู้วิจัยตามเกณฑ์คัดเลือกเข้ามาศึกษา เมื่อผู้เข้า ร่วมวิจัยตัดสินใจเข้าร่วมงานวิจัย ผู้เข้าร่วมวิจัยจะต้องลงนามยินยอมเข้าร่วมในการวิจัย

2. ผู้เข้าร่วมการวิจัยจะถูกแบ่งโดยวิธีการสุ่ม ออกเป็น 2 กลุ่ม คือ กลุ่มทดลองและกลุ่มควบคุม ทั้ง 2 กลุ่มจะได้รับการขอร้องให้มาทำการทดสอบ และประเมินผลทั้งหมด 2 ครั้ง คือ ครั้งแรกเป็นการทดสอบก่อนการฝึก ครั้งที่ 2 เป็นการทดสอบและประเมินผลหลังการฝึกเป็นระยะเวลา 4 สัปดาห์ ซึ่งการทดสอบและการประเมินผลประกอบไปด้วย ระยะเวลาที่ใช้ในการก้าวขาครั้งแรก ความเร็วในการเดิน ความยาวก้าว และความถี่ก้าว

3. ขั้นตอนการวิจัย เมื่อผู้เข้าร่วมวิจัยมาถึงสถานที่ทำการวิจัย ให้ผู้เข้าร่วมวิจัยนั่งพัก 10 นาที ทำการวัดอัตราการเต้นของหัวใจขณะพัก ความดันเลือด หลังจากนั้นผู้ทำการวิจัยจะอธิบายถึงรายละเอียดในการทดสอบ โดยผู้เข้าร่วมการวิจัยจะทดสอบการเดินเป็นระยะทาง 10 เมตร โดยจะทำการทดสอบทั้งหมด 3 ครั้ง ในการทดสอบผู้วิจัยผู้ที่ทดสอบจะไม่ใช่คนคนเดียวกันกับผู้ที่ฝึกเดินขึ้น-ลงบันได และไม่ทราบว่าผู้เข้าร่วมการวิจัยอยู่ในกลุ่มทดลอง หรือกลุ่มควบคุม เพื่อเป็นการป้องกันอคติ (bias) ที่อาจจะเกิดขึ้นได้ในการทดสอบ

4. ผู้เข้าร่วมวิจัยที่อยู่ในกลุ่มทดลองจะได้รับการอธิบายถึงรายละเอียด ในการฝึกเดินขึ้น-ลงบันได โดยก่อนและหลังการฝึกจะทำการยืดเหยียดกล้ามเนื้อ และต่อด้วยการเดินขึ้น-ลงบันได เป็นเวลา 30 นาที โดยเดินด้วยความเร็วที่ผู้เข้าร่วมวิจัยทำได้ สามารถลดความเร็วหรือหยุดพักได้ถ้าผู้เข้าร่วมงานวิจัยต้องการ และจะต้องทำการฝึกเป็นเวลา 3 ครั้ง/สัปดาห์ นาน 4 สัปดาห์ ในระหว่างการฝึกดังกล่าวผู้เข้าร่วมการวิจัยจะอยู่ภายใต้การดูแลของผู้ทำการวิจัย และจะไม่ก่อให้เกิดอันตรายใดๆ แก่ท่าน ผู้เข้าร่วมวิจัยควรสวมเสื้อผ้าและรองเท้าที่สะดวกต่อการเดินทดสอบ

5. ผู้เข้าร่วมการวิจัยที่อยู่ในกลุ่มควบคุมจะได้รับการอธิบายถึงรายละเอียด ในการฝึกเดินบนพื้นราบที่บ้านเป็นเวลา 30 นาที ทำการฝึกเป็นเวลา 3 ครั้ง/สัปดาห์ นาน 4 สัปดาห์

**ประโยชน์และผลข้างเคียงที่จะเกิดขึ้นแก่ผู้เข้าร่วมโครงการ**

1. ผู้เข้าร่วมการวิจัยที่อยู่ในกลุ่มทดลองจะได้รับการฟื้นฟูสมรรถภาพ ในการเดินของท่าน

2. ผู้เข้าร่วมการวิจัยที่อยู่ในกลุ่มควบคุม ท่านจะไม่ได้รับผลโดยตรง แต่ท่านจะได้รับคำแนะนำเพื่อนำมาฟื้นฟูสมรรถภาพในการเดินของท่านต่อไป หลังสิ้นสุดโครงการ

3. เป็นข้อมูลในการฟื้นฟูสมรรถภาพทางการเดิน ในผู้ป่วยพาร์กินสันได้อย่างเหมาะสม

4. ข้อมูลที่ได้จากงานวิจัยของท่านจะเป็นข้อมูลในการพัฒนางานวิจัย ในอนาคตต่อไป

**ค่าตอบแทนอาสาสมัครผู้เข้าร่วมโครงการวิจัย**

ท่านจะได้รับค่าชดเชยการเดินทางสำหรับการเข้าร่วมโครงการวิจัยท่านละ 200 บาท

**ผลข้างเคียงที่อาจเกิดขึ้นแก่ผู้เข้าร่วมโครงการ**

ท่านจะไม่ได้รับความเสี่ยงใดๆ เนื่องจากมีนักกายภาพบำบัดคอยดูแล และมีการสวมเครื่องวัดอัตราการเต้นของหัวใจตลอดการทำวิจัย หากท่านมีอาการรู้สึกเจ็บแน่นหน้าอก หายใจลำบาก ชีพจรเต้นเร็วมาก เหนื่อยหอบมาก หรือมีอาการปวดล้าบริเวณขามากจนทนไม่ได้ สามารถแจ้งผู้วิจัยได้ทันที หรือเมื่อนักกายภาพบำบัดเห็นว่าท่านมีอาการดังที่กล่าวมาจะหยุดการทดสอบพร้อมกับการปฐมพยาบาล และส่งพบแพทย์ในทันที

**การเก็บข้อมูลเป็นความลับ**

ผู้ทำการวิจัยขอยืนยันว่า ข้อมูลเกี่ยวกับตัวผู้เข้าร่วมงานวิจัยจะถูกเก็บไว้เป็นความลับ และจะใช้สำหรับงานวิจัยนี้เท่านั้น และชื่อของผู้เข้าร่วมงานวิจัยจะไม่ปรากฏในแบบฟอร์มการเก็บข้อมูล และในฐานข้อมูลทั่วไป โดยมีผู้ทำวิจัยเพียงคนเดียวเท่านั้นที่ทราบรายละเอียดของข้อมูลนี้ ผู้ทำวิจัยขอขอบพระคุณผู้เข้าร่วมงานวิจัยที่ให้ความร่วมมือในการทำวิจัยครั้งนี้

ท่านสามารถขอถอนตัวออกจากโครงการวิจัยได้ทุกเวลา

หากท่านมีข้อสงสัยใดๆ สามารถสอบถามได้ที่ น.ส.อัญชลี เจริญสันติอุไร โทรศัพท์ 084-211-3453 ซึ่งยินดีตอบคำถามทุกเวลา

ทั้งนี้ หากท่านมีปัญหาทางด้านจริยธรรมการวิจัย ท่านสามารถร้องเรียนได้ต่อคณะกรรมการจริยธรรมการวิจัยที่เบอร์ (02) 256-4455 ต่อ 14, 15

# APPENDIX B

## **ใบยินยอมเข้าร่วมการวิจัย** (Consent form)

**การวิจัยเรื่อง** ผลของการฝึกเดินขึ้น-ลงบันได ในผู้ป่วยพาร์กินสัน

วันให้คำยินยอม วันที่..... เดือน ..... พ.ศ. .....

ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยครั้งนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย วิธีการวิจัย อันตราย หรืออาการที่อาจเกิดขึ้นจากการวิจัย รวมทั้งประโยชน์ที่เกิดขึ้นจากการวิจัยอย่างละเอียด และมีความเข้าใจดีแล้ว

ผู้วิจัยรับรองว่าจะตอบคำถามต่างๆ ที่ข้าพเจ้าสงสัยด้วยความเต็มใจ ไม่ปิดบังซ่อนเร้น จนข้าพเจ้าพอใจ

ข้าพเจ้ามีสิทธิที่จะบอกเลิกการเข้าร่วมในโครงการวิจัยนี้เมื่อใดก็ได้ และเข้าร่วมโครง การวิจัยนี้โดยสมัครใจ และการบอกเลิกการเข้าร่วมการวิจัยนี้ จะไม่มีผลต่อการรักษาโรคที่ข้าพเจ้าจะพึงได้รับต่อไป

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆ ที่เกี่ยวข้อง กระทำได้เฉพาะกรณีจำเป็น ด้วยเหตุผลทางวิชาการเท่านั้น

ผู้วิจัยรับรองว่าหากเกิดการบาดเจ็บใดๆ อันเนื่องมาจาการเข้าร่วมการวิจัย ดังกล่าว ข้าพเจ้าจะได้รับการรักษาพยาบาลโดยไม่คิดมูลค่า และจะได้รับการชดเชยรายได้ที่สูญเสียไประหว่างการรักษาพยาบาลดังกล่าว ตลอดจนเงินทดแทนความพิการที่อาจเกิดขึ้นตามความเหมาะสม

ข้าพเจ้าได้อ่านข้อความข้างต้นแล้ว และมีความเข้าใจดีทุกประการ และได้ลงนามในใบยินยอมนี้ด้วยความเต็มใจ

ลงนาม..... ผู้ยินยอม

(.....)

ลงนาม .....พยาน

(.....)

ลงนาม ..... ผู้ทำวิจัย

(.....)

# APPENDIX C

## แบบบันทึกข้อมูลส่วนบุคคล

**การวิจัยเรื่อง** ผลของการฝึกเดินขึ้น-ลงบันได ในผู้ป่วยพาร์กินสัน

**ส่วนที่ 1 ข้อมูลพื้นฐาน** **เลขที่**.....

1. อายุ.....ปี เพศ.....
2. น้ำหนัก.....กิโลกรัม ส่วนสูง.....เซนติเมตร BMI……
3. The Hoehn and Yahr Stage.....
4. เริ่มเป็นโรคพาร์กินสันตั้งแต่อายุ.....ปี
5. ระยะเวลาในการเป็นโรคพาร์กินสัน.....ปี
6. ในปัจจุบันได้รับการรักษาด้วยวิธี……
7. ท่านมีปัญหาในการเดินหรือไม่

   O ใช่ O ไม่
8. ท่านใช้เครื่องช่วยเดิน หรือไม่

   O ใช่ O ไม่
9. ท่านเคยล้มหรือไม่

   O ใช่ O ไม่
10. ท่านมีประวัติเป็นโรคหัวใจ หรือไม่ (angina, MI, CHF, stroke, TIA, PVD, AAI)

    O เป็น O ไม่เป็น
11. ท่านมีประวัติเป็นโรคเบาหวานหรือไม่

    O เป็น O ไม่เป็น
12. ท่านมีประวัติเป็นโรคความดันโลหิตสูงหรือไม่

    O เป็น O ไม่เป็น
13. ท่านมีไขมันในเลือดสูงหรือไม่

    O เป็น O ไม่เป็น
14. ท่านมีประวัติเป็นโรคหอบหืด โรคถุงลมโป่งพอง หรือโรคปอดเรื้อรังหรือไม่ (asthma, cystic fibrosis, interstitial lung disease)

    O เป็น O ไม่เป็น
15. ท่านมีปัญหาการบาดเจ็บหรือผิดปกติเกี่ยวกับระบบกระดูก กล้ามเนื้อ และข้อต่อหรือไม่

    O มี เจ็บหรือผิดปกติที่..... O ไม่มี

**ส่วนที่ 2 แบบบันทึกผลการทดสอบ**

**ทดสอบเดินระยะทาง 10 เมตร**

| | ก่อนการฝึก | หลังการฝึก |
|---|---|---|
| ระยะเวลาในการก้าวขาครั้งแรก (นาที) | | |
| ความเร็วในการเดิน (เมตร/นาที) | | |
| ความยาวก้าว (ซม.) | | |
| ความถี่ก้าว (ก้าว/นาที) | | |

***หมายเหตุ.....

## การฝึกเดินขึ้น-ลงบันได

- การหยุดพัก

| | **ครั้งที่** 1 | **ครั้งที่** 2 | **ครั้งที่** 3 |
|---|---|---|---|
| **สัปดาห์ที่** 1 | | | |
| **สัปดาห์ที่** 2 | | | |
| **สัปดาห์ที่** 3 | | | |
| **สัปดาห์ที่** 4 | | | |

***หมายเหตุ.....

**วันที่ทำการฝึกเดินขึ้น-ลงบันได**

| | **ครั้งที่** 1 | **ครั้งที่** 2 | **ครั้งที่** 3 |
|---|---|---|---|
| **สัปดาห์ที่** 1 | | | |
| **สัปดาห์ที่** 2 | | | |
| **สัปดาห์ที่** 3 | | | |
| **สัปดาห์ที่** 4 | | | |

***หมายเหตุ.....

# แบบบันทึกผลการฝึกเดินที่บ้าน

- ผู้เข้าร่วมการวิจัยทำการฝึกเดินบนพื้นราบ ด้วยความเร็วที่ท่านสามารถทำได้ โดยท่านสามารถลดความเร็วหรือหยุดพักได้เมื่อท่านต้องการ เป็นเวลา 30 นาที 3 ครั้ง/สัปดาห์ เป็นระยะเวลา 4 สัปดาห์
- หากท่านมีอาการรู้สึกเจ็บแน่นหน้าอก หายใจลำบาก ชีพจรเต้นเร็วมาก เหนื่อยหอบ หรือมีอาการปวดล้าบริเวณขามากจนทนไม่ได้ ให้ท่านหยุดพักในทันที
- หากท่านมีปัญหาอันใดโปรดแจ้งได้ที่ น.ส.อัญชลี เจริญสันติอุไร โทรศัพท์ 084-211-3453

**วันที่ทำการฝึกเดิน**

| | **ครั้งที่** 1 | **ครั้งที่** 2 | **ครั้งที่** 3 |
|---|---|---|---|
| **สัปดาห์ที่** 1 | | | |
| **สัปดาห์ที่** 2 | | | |
| **สัปดาห์ที่** 3 | | | |
| **สัปดาห์ที่** 4 | | | |

***หมายเหตุ.....

.....

# APPENDIX D

**Table I** The mean error gait ability of experimental and control group between pre- and post-trained

| | Experimental group | | P-value | Control group | | P-value |
|---|---|---|---|---|---|---|
| | Pre-trained | Post-trained | | Pre-trained | Post-trained | |
| Step initiation time (sec) | 1.18 ± 0.29 | 0.84 ± 0.29 | 0.009† | 1.44 ± 0.49 | 1.11 ± 0.35 | 0.015* |
| Gait speed (m/sec) | 0.82 ± 0.23 | 1.03 ± 0.30 | 0.000# | 0.63 ± 0.13 | 0.69 ± 0.12 | 0.041* |
| Step length (m.) | 0.51 ± 0.12 | 0.60 ± 0.13 | 0.001‡ | 0.39 ± 0.09 | 0.42 ± 0.10 | 0.018* |
| Step frequency (step/10m) | 20.81 ± 6.26 | 16.85 ± 3.40 | 0.002‡ | 26.43 ± 6.01 | 24.81 ± 5.98 | 0.046* |

Compared between pre and post trained using Paired t- test Statistics.

* Significant difference between both group, P<0.05.

† Significant difference between both phase, P<0.01.

‡ Significant difference between both phase, P<0.005.

# Significant difference between both phase, P<0.001.

**Table II** The mean error gait ability of pre-trained and post-trained between experimental and control group

| | Pre-trained | | P-value | Post-trained | | P-value |
|---|---|---|---|---|---|---|
| | experimental | control | | experimental | control | |
| Step initiation time (sec) | 1.18 ± 0.29 | 1.44 ± 0.49 | 0.210 | 0.84 ± 0.43 | 1.11 ± 0.35 | 0.392 |
| Gait speed (m/sec) | 0.82 ± 0.23 | 0.63 ± 0.13 | 0.068 | 1.03 ± 0.30 | 0.69 ± 0.12 | 0.026* |
| Step length (m.) | 0.51 ± 0.12 | 0.39 ± 0.09 | 0.053 | 0.60 ± 0.13 | 0.42 ± 0.10 | 0.009† |
| Step frequency (step/10m) | 20.81 ± 6.26 | 26.43 ± 6.01 | 0.092 | 16.85 ± 3.40 | 24.81 ± 5.98 | 0.006† |

Compared between experimental and control group using Unpaired t- test Statistics.

* Significant difference between both group, P<0.05.

† Significant difference between both group, P<0.01.

# BIOGRAPHY

| | |
|---|---|
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