# CHAPTER I

# INTRODUCTION

## 1. Rationale

Cerebral palsy (CP) has a high incidence among children with physical disability in developing countries. The worldwide prevalence and incidence of this disorder are not clearly known. In the USA, the estimated incidence of CP was approximately 2-4 per 1,000 live births and the spastic form of CP was the most prevalent (1). In Thailand, the first official incidence was done in 2001 but CP has not been classified yet until 2007. Therefore, the incidence of CP for the whole Thailand kingdom in 2007 was 29,841 (2). However, the report of Rajanukul Institute revealed that the number of children with CP increased from 1,742 children in 2005 to 2,550 in 2008 (46% increased) (3).

Since CP is attributed to non-progressive disturbances that occurs in the developing fetal or infant's brain, it is a group of permanent disorders of the development of movement and posture, and causes activity limitations. The activity limitation is resulted from motor impairments which are multifactorial problems such as abnormal muscle tone, muscle weakness, muscle shortening, musculoskeletal deformities, coordination problems and loss of selective motor control (4).

The decreasing in muscle strength causes the greatest limitation in gross motor function, especially walking (5). In children with spastic diplegia, it was found that a common walking abnormality is crouch gait which is characterized by increased knee flexion throughout the stance phase in combination with excessive flexion at the hip and excessive dorsiflexion at the ankle (6). Generally, crouch is treated by hamstrings lengthening and also strengthening of quadriceps muscle (7-8). Some previous studies demonstrated that children who participated in resistance training target on quadriceps muscle could improve the degree of crouch and gait variables. However, most participants in previous studies were mild in severity (8-9). In addition, quadriceps weakness, especially at inner range, was shown to be a factor in crouch (9). In children with CP, poor selective motor control may prevent the child from fully participate in resistance training program and children may not be able to fully activate their voluntary muscles because they are unable to isolate specific muscles. Thus, specific strengthening program was required and electrical stimulation (ES) has been shown to solve this issue (10-11). At present, ES has been used successfully to increase muscle strength in individual with both typical and atypical development especially when voluntary muscle contraction is not effective (12). In the study of children with CP, neuromuscular electrical stimulation (NMES) is the most common form of ES that commonly used to increase muscle strength and improve motor function (11). Specifically, it may be an additional strength training technique for children who may not have an adequate isolation muscle control to increase strength in the targeted muscle and to move the limb through the available range of motion against gravity (10). Although there were studies reported that NMES have a potential to increase muscle strength and improve motor function in CP population, so far, most studies have poor methodology and lack of statistical power to provide conclusive evidences for this modality (11). Among the variability of muscle that was used to determine the effect of NMES on muscle strength and motor function in children with CP in previous evidences, two studies focused on quadriceps muscle weakness. Daichman and co-workers (10) reported that quadriceps strength, gait spatiotemporal parameters and pediatric evaluation of disability inventory (PEDI) score improved and hamstrings spasticity decreased after NMES applied on quadriceps muscle for 6 weeks in a child with spastic diplegia, however, there was only one subject in this study which leaded to limited generalization. Although Kerr and co-workers (13) recruited large participants in randomized controlled study, no significant difference was found between NMES and placebo group for quadriceps strength after 16 weeks of NMES program and the authors highlighted that a shortfall in their experimental design and an exceedingly high inter-participant variability contributed to masking the effect of the stimulation. As a result, this approach remains controversial and its clinical utility remains a topic for debating. A review study of Kerr and co-workers (11) concluded that more evidence was required to show the efficacy of NMES in strengthening muscle and improving motor function in children with CP. They also suggested that more rigorous study designs, follow up and homogeneous subjects are required to determine the efficacy of this treatment technique. More specifically, the contribution of quadriceps muscle weakness by NMES to the degree of crouch has not been well documented. Therefore, the purpose of this study was to determine the effects of NMES on knee extensors muscle in individual with spastic diplegia who ambulate with crouch gait in a trial with control design for seven weeks of training and two weeks of follow-up. It was hypothesized that NMES had potential to increase quadriceps strength, improve quadriceps lag, reduce quadriceps and hamstrings muscle spasticity and enhance the extension of the hip, knee and ankle joints angles during standing. This study provides the knowledge that may be used as an adjunct therapy for individuals with spastic diplegia who have a difficulty in resistive strengthening program.

## 2. Research Question and Hypotheses

Research question

How does the NMES applying on knee extensor muscle affect on individuals with spastic diplegia?

Hypothesis

After applying the NMES on knee extensor muscle in individuals with spastic diplegia, quadriceps strength, and angles of hip, knee and ankle joints during standing will increase whereas quadriceps lag and quadriceps and hamstrings spasticity will decrease as compared to before applying the NMES on knee extensor muscle.

Dependent variables

1. Quadriceps strength
    - Quadriceps maximum voluntary isometric contraction (QMVIC)
    - Percent changes in QMVIC
2. Quadriceps lag
3. Angles of hip, knee and ankle joints during standing.
4. Quadriceps modified Ashworth Scale (QMAS)
5. Hamstrings modified Ashworth Scale (HMAS)

**3. Purposes of the study**

The purposes of this study were to determine the effects of the knee extensor NMES on quadriceps strength, quadriceps lag, angles of hip, knee and ankle joints during standing, QMAS and HMAS in individuals with spastic diplegia.

**4. Advantages of the study**

The results from this study would be used as a treatment option or as an alternatively adjunct therapy in rehabilitation program for individuals with spastic diplegia who walk with crouch gait and have a difficulty in volitional resistance training program.