Design and Construction of Thermally Combined Microcurrent Electrical Therapy Device as Preliminary Study for Rheumatoid Arthritis Treatment

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ABSTRACT

Rheumatoid Arthritis (RA) is a chronic inflammatory disease that destroys the cartilage within joints. Even though RA cannot be cured, its progress can be slowed and its symptoms can be managed by applying microcurrent and thermal therapy to enhance the healing process of the joints. This research aims to combine two different therapeutic modalities: Microcurrent Electrical Therapy (MET) and thermal therapy, which will be called as Thermally combined Microcurrent Electrical Therapy (T-MET) device. For MET, the resulted output was square wave with fix 50% duty cycle, adjustable frequency (0.31 – 100 Hz), and adjustable current amplitude (36 - 466 µA). For thermal therapy, two different modes were provided: heating mode (up to 40°C) and cooling mode (up to 15°C). The test was done three times. It took 30 minutes and 105.8 minutes to reach the upper and lower limit temperature respectively. T-MET device had been designed and constructed. However, clinical trials to RA patient needs to be further investigated.

Keywords: Electrodes, Microcurrent Electrical Therapy (MET), Peltier, Rheumatoid Arthritis (RA), Thermal Pad, Thermal Therapy, Thermally Combined Microcurrent Electrical Therapy (T-MET)

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1. INTRODUCTION

Rheumatoid Arthritis (RA) is a chronic inflammatory polyarthritis, which mostly affects hands and feet, although may also affect other joints such as the wrist, shoulder, knee, and hip. This condition can lead to swelling, tenderness, and warmth of the joints. In addition to causing a great deal of pain, RA also causes significant disability, or even worse, shortens life expectancy by about 10 years (Weaver, 2004). RA is also considered as one of the most common forms of autoimmune diseases, affecting about two to four times as many women as men (Lee & Weinblatt, 2001). Only 30% of the causes of RA can be attributed to genetic factors, the rest remains unknown even though the cases are far reaching and date back thousands of years (Alarcon, 1995).

RA affects about 0.5% - 1% of the adult population worldwide (Silman & Pearson, 2002). However, it is much more common in Native Americans (affecting over 5%) and less common in African and Asian people (The Patient Experience, 2012). In 2010, there were approximately 4.6 million people with RA in the seven major markets (US, Japan, France, Germany, Italy, Spain, and UK). More than half (2.6 million) of the case were in the US alone (The Patient Experience, 2012). In Indonesia (1992), there were 0.2% of RA cases in rural areas and 0.3% in urban areas (Darmawan, Muirden, Valkenburg & Wigley, 1993). The number of cases were relatively the same as in some other Asian countries such as the Philippines - 0.17% in 1997 (Dans, Tankeh-Torres, Amante & Penserga, 1997), Thailand - 0.12% in 1998 (Chaiannuay, Darmawan, Muirden & Assawatanabodee, 1998), India - 0.5% in 2001 (Chopra, Patil, Billemelly, Relwani & Tandle, 2001), Vietnam - 0.28% in 2003 (Minh Hoa, Darmawan, Chen, Van Hung, Thi Nhi & Ngoc An, 2003), and China - 0.2%-0.37% in 2008 (Zeng, Chen, Darmawan, Xiao, Chen, Wigley, Chen & Zhang, 2008). RA is also considered as one of the most common forms of autoimmune diseases which affects about two to four times as many women as men (Lee & Weinblatt, 2001).

Nowadays, there are many different options for treating RA. Two non-invasive therapeutic procedures which are widely available in the markets include stimulation by Microcurrent Electrical Therapy (MET) device and thermal therapy (either hot or cold pack). Combining those two non-invasive therapies, called as Thermally combined Microcurrent Electrical Therapy (T-MET) device, is the aim of this research. However, T-MET device is not yet tested in RA patients due to lack of permit in testing the medical equipment. This research focuses on designing, constructing, and testing the outputs of T-MET device.

2. STUDY OF MET AND THERMAL THERAPY

Therapy with MET has been considered to be able to give healing response in the damaged articular cartilage (Campbell, 1969). This research was further investigated by Cheng et al. (1987) by observing the ATP regeneration and protein synthesis in rat skin with microcurrent stimulation. As a result, there was an increase in ATP regeneration up to 500% and the rate of protein synthesis and waste product removal by 70% (Cheng, Vanhoof, Bockx & Hoogmartens, 1987). This research was then continued by Kirsch (1996) that suggests the use of square wave microcurrent stimulation with 50% duty cycle. Furthermore, observation by Zizic et al. (1999) showed that there was a significant improvement in the physician’s global evaluation, the patient’s evaluation of pain/symptoms and the patient’s evaluation function, all of the treated hand compared to the placebo device group. Looking at the pathogenesis of RA, the serum of RA patients is always accompanied with an increased level of inflammatory cytokines IL-1, TNF-alpha (Kay & Calabrese, 2004), IL-6 (Park & Pillinger, 2007), substance P (Garrett, Mapp, Cruwys, Kidd & Blake,
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