STUDY ON THE EFFECTS OF TRANSCUTANEOUS ELECTRICAL MUSCLE STIMULATION ON EXPERIMENTAL FATTY LIVER

Thesis

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TO MY

FAMILY

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List of Abbreviations

ACC	Acetyl-coenzyme A carboxylase
ALT	Alanine amino transferase
AST	Aspartate amino transferase
CREBP	Carbohydrate regulatory element binding protein
DM	Diabetes mellitus
FAS	Fatty acid synthase
FFA	Free fatty acid
GI	Glycemic index
GLUT	Glucose transporter
GPx	Glutathione peroxidase
GR	Glutathione reductase
GSH	Glutathione
GSSG	Oxidized glutathione
HDL	High density lipoproteins
HFCS	High Fructose Corn Syrup
HOMA	Homeostasis Model Assessment

IGF-1	Insulin-like growth factor -1
IL	Interleukin
JNK	Jun N-terminal kinase
LCFA	Long-chain fatty acids
LDL	Low density lipoproteins
MDA	Malondialdehyde
NAFLD	Non-alcoholic fatty liver Disease
NASH	Non-alcoholic steatohepatitis
PKC	Protein kinase – C
ROS	Reactive oxygen species
SREBP	Sterol regulatory element – binding protein
TBA	Thiobarbituric acid
TC	Total cholesterol
TEMS	Transcutaneous electrical muscle stimulation
TG	Triglyceride
TNF	Tumor necrosis factor
VLDL	Very low density lipoprotein

Introduction

Fatty liver is one of the commonest findings in Egyptian people , where about 20 - 25 % are affected . It may be attributed to their pattern in feeding and hence high prevalence of obesity **(*the 13th conference of the Egyptian society of studying fatty liver , Egypt May 2013*) .** Fatty liver disease is the most common cause of chronic liver diseases ***(Duvnjak et al ., 2009) .*** It is a component of metabolic syndrome where obesity , type 2 diabetes mellitus , and hyperlipidemia are co-existing conditions ***(Chitturi et al ., 2004; Botezelli et al ., 2010) .***

Lack of adequate exercise , combined with dietary indiscretion and genetic predisposition all have contributed to the worldwide epidemic of obesity and non-alcoholic fatty liver disease (NAFLD) together with increase in the prevalence of insulin resistance ***(Harrison and Day , 2007) .***

Common protocols of exercise in experimental animals such as swimming , exhibited valuable results in reducing fatty liver in addition to improving insulin sensitivity ***(Ropelle et al ., 2009; Botezelli et al 2010) .*** Also , voluntary wheel running attenuated weight gain and reduced serum glucose , insulin, free fatty acids , triglycerides and increased hepatic fatty acid oxidation and prevented steatosis in exercised rats ***(Rector et al ., 2008).***

In human , active exercise in the form of physical training, consisting of cycling , running or swimming showed to improve NAFLD **(*Gauthier et al ., 2003 ; Harrison and Day , 2007*) .** In addition, aerobic exercise programs showed to reduce hepatic fat accumulation and insulin resistance in obese adolescent girls ***(Van der Heijden et al ., 2010) .***

On the other hand , fatigue in patients with non-alcoholic fatty liver disease is significant and associates with inactivity and excessive daytime sleepiness which appears to be unrelated to either severity of underlying liver disease or insulin resistance **(*Newton et al ., 2008*)** . Thus , this easy fatigability together with overweight may offer a great restriction in front of the continuation of active exercise .

Recently , in the sedentary society, with the emergence of mass produced portable battery operated systems and the simple operating instructions which are designed for individual home use, a variety of systems with various applications for toning , strengthening , body shaping and general fitness became available . In addition , because of the exhausting physical activity and crash dieting , the benefits of electrical stimulation became apparent , as it provides a safe , fast and effective method for exercise **(*Vrbova et al ., 2008*) .**

Moreover , electrical muscle stimulation can attain much higher levels of activity over time than any exercise regimen because the central nervous , cardiovascular , and other systems will not interfere with and limit the amount of activity , as is the case in active exercise **(*Pette and Vrbova , 1999 ; Banerjee et al ., 2005*) .**

Very little studies were performed using passive exercise , as in transcutaneous electrical muscle stimulation (TEMS) , to evaluate its effect on fatty liver . In a recent study , TEMS was applied to the lower abdominal muscles in an experimental model of fatty liver in male rats . The study showed partial improvement of the associated insulin resistance but it manifested increased hepatic steatosis. The results were attributed to locality of stimulation and explained by possible increased visceral fat lipolysis with increased fatty acid influx through the porto-hepatic circulation and /or rate of fatty acid oxidation due to muscle exercise did not match the rate of lipolysis **(*El-kafoury et al ., 2011*) .**

In this study , the effect of TEMS on different locality, applied to the lower limb muscles , on fatty liver in male rats were evaluated together with relatively prolonged total duration of exercise .