Animal Study on Lysing Adipose Tissues by Shock Waves

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Abstract

Extracorporeal shock wave lipotripsy is proposed to be a new non-invasive technology for rupturing fat cells, since ruptured fat cells can be metabolized via the circulatory system of human beings. In this study, a polystyrene fluoride (PVDF) needle-type pressure sensor was used to detect the focused shock wave profile and to measure its pressure in water and in adipose tissue at different operational voltages of 6-10 kV. The corresponding energy flux density was also calculated. Six-month-old male of New Zealand rabbits and two-month-old of LanYu pigs were used for the experiments. After shock wave administration, the tested adipose tissues were inspected by eye for physiological changes and side effects. After the visual examination, the tested animal was euthanized, and the tested adipose tissues were microscopically examined for pathological changes. Through these animal experiments, it was concluded that at least 600 trials of shock waves were required for rupturing fat cells under the condition of an energy flux density of 0.112 ml/mm² in a focal area. A minor side effect of the administration of shock waves of this magnitude is slight hemorrhaging in the skin layer, which can be healed within one week.

Keywords: Extracorporeal shock wave therapy, Lipolysis, Pathological examination

1. Introduction

Extracorporeal shock wave lithotripsy (ESWL) has been a well established technique for the treatment of urinary stones [1]. The basic idea of ESWL is the use of underwater shock wave focusing in a truncated ellipsoidal reflector in which there are two foci. Inside the reflector, shock waves are generated by a spark that emanates from two electrodes with their tips located at the first focal point close to the reflector. At the second focus, a nidus is located and generated shock waves are focused there after reflection from the reflector. This kind of shock wave generation is referred as an electromagnetic- and piezoelectric-type shock wave generator. Later, electromagnetic- and piezoelectric-type shock wave generators were invented in addition to the electrohydraulic type [2]. The mechanism of ESWL is generally attributed to the compression effect of localized high-pressure generated by underwater shock-wave focusing; the impact effect of micro-jets due to caviation [3]; and a spalling effect due to expansion waves reflected from the stone surface when focused shock waves exit from the stone [4].

Subsequently, focused shock waves were used to treat musculoskeletal disorders which included treatments of tennis elbow, plantar fascitis, heel spurs, etc [5-9]. Recently, ESWT has become a peer-accepted treatment for musculoskeletal disorders in orthopedics. The beneficial affects of ESWT might be attributed to be the mechanism of neovascularization on treated tissues [10]. The application of shock waves to bacteria fertilization have also been reported [11]. Very recently, ESWT was applied to the treatment of ischemic heart disease [12] and dermatology [13,14]. Following the use of ultrasound such as the Ultrasound device for rupturing adipose tissues [15,16], we attempted to destroy the cohesive gels used in breast augmentation procedures through the application of shock waves. In our previous study, an in-vitro study on a pig’s adipose tissues was conducted and the test results were reported in [17] which confirmed the feasibility of lipolysis by shock waves. This study was followed by additional tests conducted on animals. Because the present injured fat area is quite small compared to that removed by a liposuction technique, the noninvasive method of ESWT might replace invasive liposuction for removal of excessive fat cells through the metabolic system [18]. To compare different methods of lipolysis, our experiments were designed to determine a set of parameters for lipolysis by ESWT as a baseline for further clinical tests. These parameters included the minimum energy

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