DOSE-DEPENDENT ENHANCING EFFECT OF LOW INTENSITY PULSED ULTRASOUND ON BONE FORMATION IN FAST LENGTHENING OF DISTRACTION OSTEOGENESIS

Introduction

Distraction Osteogenesis is a process of bone regeneration under tensile stress with axial rhythmic lengthening after osteotomy. The distraction rate of rabbit tibia model for distraction osteogenesis was optimized from 0.7 to 1.3mm per day (1). Fast distraction rate (greater than optimal range) could shorten distraction period but resulted in more fibrous tissue and bone cysts in distraction gap. Low intensity pulsed ultrasound (LIPUS) has been tested to enhance bone maturation during consolidation stage. Thus we hypothesize that LIPUS may facilitate the bone formation of distraction osteogenesis with fast distraction.

Materials and methods

Open osteotomy was performed in the mid-diaphyseal region of tibia on 20 New Zealand female rabbit (18-22weeks old), which was stabilized by an external lengthening device. The osteotomised tibia was distracted with 2mm/day as fast lengthening for one week after 7-day latency. LIPUS treatment was applied on the anterior side of tibia during distraction for 20 min or 40 min. The non-LIPUS treated tibia served as sham group. The sample size of each group was five.

Tibiae were harvested after distraction. Plain X-ray of the specimens was taken and peripheral quantitative computational tomography (qQCT) assessed bone mineral content (BMC) and volume of mineralized tissue in the distraction callus. The specimens were then performed for decalcified histology. The sections which were stained by safranin O/fast green dye, showed proteoglycan rich cartilage in red color. The sections were divided into three regions: endocortical, intercortical and periosteal region (Fig. 1). The cartilage area fraction was evaluated for the cell-matrix relationship. All data was expressed as mean and standard error of the mean (SEM). The results of BMC, volume of mineralized tissue and cartilage area fraction were compared between treatment and sham groups using Kruskal-Wallis H test.

Result

In the plain X-ray, more osseous tissue was formed in LIPUS-20min and LIPUS-40 min group. The newly formed bone located near proximal region (Fig. 2). In the pQCT result, the BMC of distraction callus was increased 68.2% by 20min LIPUS treatment and 104.3% by 40-min treatment significantly (Table 1). LIPUS also increased volume of mineralized tissue by 77% for 20 min and 44% for 40 min treatment significantly (as compared with 20-min treatment) (Table 1). The result implied that LIPUS enhanced mineralization and increased the size of mineralized tissue in distraction callus. Longer duration of LIPUS treatment resulted in more bone formation.

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