

Investigation of thermal effect and chondroprotective effect by next-generation thermal stimulation technology

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INTRODUCTION: We have shown that moderate thermal stimulation at around 40°C can enhance chondrocyte metabolism and inhibit apoptosis via heat shock protein (HSP) 70. However, it is difficult to deliver thermal energy deep into the human body with conventional thermotherapy, and new thermo-stimulation techniques are needed clinically. Photosensitising substances are substances that emit heat when irradiated with specific light rays. We hypothesised that this substance could be administered directly into joints to provide uniform thermal stimulation within the joints. The purpose of this study was to investigate the thermal effect of thermal stimulation techniques using photosensitising substances and their effect on cartilage cells.

METHODS: Chondrocytes isolated from cartilage tissue of Wistar rats were cultured and photosensitising substances were added to the medium. The cells were divided into three groups: those with photosensitiser added and irradiated with light (Addition+Irradiated group), those with photosensitiser added only (Addition group), those with light only (Irradiated group) and those without either (control group), and the temperature of the medium was measured. The gene expression of chondrocytes in each group was analysed. Next, photosensitisers were intra-articularly administered to the left knee of 6-week-old Wistar rats, and the intra-articular temperature was measured by light irradiation.

RESULTS SECTION: The medium temperature before the start of irradiation was 34°C. The temperature of the medium in the Addition + Irradiated group increased with time, and at the end of irradiation, the temperature of the medium increased to 39°C. No significant temperature increase was observed in the other groups. The expression of HSP70 and aggrecan was significantly increased in the Addition + Irradiated group. Type II collagen expression was unchanged. The temperature in the knee joint of rats increased to 40°C.

DISCUSSION: Thermal stimulation with photosensitising substances in this study increased the temperature in the medium and in the joints of rats and had anabolic effects on chondrocytes. The use of photosensitising substances with exothermic properties in the joints makes it possible to warm the entire articular cartilage uniformly and efficiently.

SIGNIFICANCE/CLINICAL RELEVANCE: Thermal stimulation technology using photosensitising substances may lead to the development of new thermal therapies.

Changes in rat knee joint temperatures using next-generation thermal stimulation technology.

