Characterization of degenerated human cartilage with differential scanning calorimetry

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Osteoarthritis is a heterogeneous disease with numerous factors (mechanical and molecular) leading to its pathologic hallmark of cartilage loss within a joint.

The change of energy in thermal processes can be measured by Differential scanning calorimetry (DSC). A limited number of papers have been published before on the subject of thermal analysis of normal and degenerative human hyaline cartilage. One research group has concluded that structural manifestation of osteoarthritis appears as a remarkable change of thermal stability of hyaline cartilage samples. The data on the calorimetric enthalpy changes proved to be inconsistent.

The purpose of this study was to further characterize the altered metabolism in human degenerated cartilage that promotes disease progression. A new protocol had to be established before the investigation. Degenerative human hyaline cartilage was obtained from 28 hip and normal cartilages from 7 knees during arthroplasty procedures performed at the University of Szeged. Preoperatively the diagnosis of the patient was established.

The thermal properties of samples were determined by differential scanning calorimetry (Mettler-Toledo DSC 821e apparatus). From the DSC curves the decomposition temperature, the transition temperature range and the total calorymetric enthalpy change were calculated.

With the rise of temperature an endothermic reaction was observed in all of the cases. The enthalpy change of the process initiated by the temperature change showed marked difference between the normal and pathological groups. Greatest change in the enthalpy was observed in normal cartilage: -811.496 J/g. Therefore, denaturation caused by heating was largest in the normal human hyaline cartilage. Consequently these samples required the largest amount of energy for decomposition. Statistical tests proved these calculations to be significant ($p<0.05$). All samples showed a clear denaturation peak on the calorimetric curve.

This study clarifies the previously reported thermoanalytical results, with acquiring normal cartilage from live surgery, thus providing similar sample environment. The use of thermal analysis could be a simple and effective method for controlling the relationship between biomarkers and disease progression. Characterization of the altered metabolism in cartilage that promotes disease progression should lead to future fundamental treatment options that can prevent structural damage.