Investigation of biominerals in the human knee of advanced osteoarthritis

L. LAMMERS[1], M. FUERST[2, 3] AND H.P. WIESMANN[1]

[1]Department of Cranio-Maxillofacial Surgery, University Hospital, Muenster, Germany (Lydia.Lammers@ukmuenster.de; Hanspeter.Wiesmann@ukmuenster.de)
[2]Department of Orthopaedics, University Medical Center, 22143 Hamburg-Eppendorf (mfuerst@uke.uni-hamburg.de)

Motivation

Osteoarthritis (OA) is a painful joint degeneration disease and in most cases leading to a complete surgical knee replacement. There is evidence that pathologic mineralisation contributes to OA (Swan *et al*., Pritzer *et al*.), but an actual distribution and composition of involved minerals, as well as the mechanisms of their generation still remain poorly understood.

Our intention was to find an effective and implementable way to analyse methodically the presence, nature and compositon of minerals in the knee, to find out more about the physiological processes which lead to this special mineralisation.

Methods

Our studies were carried out on pieces of cartilage of medial femur condyle gained from over 30 different patients undergoing total knee replacement surgery. Additionally, chondrocytes obtained from these cartilage-specimens were cultured and investigated. We used several analytical methods in conjunction, including radiography, optical polarised light microscopy (LM), SEM, TEM, X-ray microdiffraction and Raman spectroscopy.

Results

Mineralisation was discovered in all specimens and analysed with the mentioned methods. Almost amorphous or polycrystalline hydroxyl-apatite was detected in huge amounts. In some cases idiomorphic calcium pyrophosphate was detected, but mostly associated with hydoxyl-apatite.

Discussion

Our data imply that mineralisation of articular cartilage seems to be a common event in end-stage OA. However, calcium pyrophosphate appears not to be the initiator of this disease. Instead, the mineralisation of apatite is a more likely cause, considering it was identified in all specimens. The production of pyrophosphate inside the cells perhaps functions as an inhibitor to reduce further mineralisation of apatite in cartilage.

References

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SHRIMP age of detrital zircon from the rock of Taiwan

CHING-YING LAN[1], TADASHI USUKI[1], KAZUAKI OKAMOTO[1], TZEN-FU YUI[1] AND CHIEN-YUAN TSENG[2]

[1]Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan (kyanite@earth.sinica.edu.tw)
[2]Department of Earth Sciences, National Cheng Kung University, Tainan, Taiwan (yuan1515@yahoo.com.tw)

The pre-crustal history of Taiwan recognized through Nd model ages and upper intercept discordia of TIMS U-Pb zircon ages for crustal rocks was reported to start at Paleoproterozoic (~2.3 Ga) time. However, the oldest SHRIMP U-Pb age of relict zircons for the Paleogene metasandstones gave Late Neoarchean to Early Paleoproterozoic (2.55–2.3 Ga) ages. Besides, the relict zircon age for the Paleogene metasandstones showed the large predominance of late Paleoproterozoic (2.0–1.6 Ga) and lesser amounts of Neoproterozoic (0.9–0.8 Ga) zircons. In contrast, the late Neoarchean, late Paleoproterozoic and Neoproterozoic relict zircon ages are not observed for the meta-granites of the basement rocks. One river sediment presented minor late Archean to Early Paleoproterozoic (2.7–2.3 Ga) and dominant late Paleoproterozoic (2.0–1.9 Ga) relict zircon ages. The ages of relict zircon in the Paleogene metasandstones do not show a close match with those in the basement rocks. The unmatched age pattern implies that the basement rocks may not be the source rock of the Paleogene metasandstones.

It is generally believed that Taiwan is a part of Cathaysia of South China block. The basement of the Cathaysia exhibits Paleo- to Meso-proterozoic ages and up to Eoarchean (3.7–3.6, 2.9–2.5 Ga) SHRIMP U-Pb detrital zircon ages. It is interesting to note that the Mesoproterozoic age (1.4 Ga) commonly found in the Cathaysia has rare occurrence in the Paleogene metasandstone and is lacking in the basement rocks and the river sediment of Taiwan. Furthermore, the detrital zircon ages for Cathaysia are older than those for Taiwan. Much work remains to be done in searching for the provenance for rocks of Taiwan, the paleogeography of Taiwan and the relationship of Taiwan with Cathaysia.