Epileptic Seizure-induced Intra-bone Structural Changes in Spines of Genetically Epileptic rats: A Synchrotron-Fourier Transform Infrared Imaging Study

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Disease- and drug-related bone disorders are rapidly increasing in the population. It is previously reported that anti-epileptic drugs (AEDs) may cause osteopenia, osteoporosis, and fractures in epilepsy patients [1]. However, it cannot be determined whether the bone disorders in epileptic patients are due to AED therapy and/or to epilepsy and epileptic seizures. The current study provides the first report on determination of the possible effects of epilepsy and epileptic seizures on bone tissues including intra-bone variatons. The experiments performed on genetically epileptic and healthy rats, give the advantage of studying the effects of epileptic seizures alone without interfering with anti-epileptic drugs. Spine tissues were investigated by synchrotron-Fourier Transform Infrared microspectroscopy (SR-FTIRM) to get information about the site-specific effects of seizures on cortical part of spines. An advantage of SR-FTIRM for bone research is enabling the collection of data in also between 700-400 cm^{-1} infrared range. In this range, the $\nu_4\ PO_4^{3-}$ band (500-650 cm^{-1}) gives more accurate data for mineral properties including crystallinity, since this band is affected from other absorptions less than the $\nu_1, \nu_3 PO_4^{3-}$ band (1200-900 cm^{-1}) [2]. High spatial resolution of SR-FTIRM provides to study intra-bone variations by enabling investigation of the changes in the small and/or heterogeneous parts of bone tissues more accurately. Intra-bone variations can give valuable results about the cause of the disorder on bone [3]. According to SR-FTIRM studies, mineral content was found to be decreased in epileptic group compared to the healthy control. Although total carbonate content was found to be decreased, B-type carbonate content which substitutes for phosphate groups in the mineral part of bone, was shown to be increased in epileptic group compared to the control in all parts of cortical bones. In addition, relative amount of nonreducible (mature) to reducible (immature) types of cross-links, was found to be changed critically in epileptic group, indicating an increase in immature crosslinks in the bones of that group. Furthermore, crystallinity value indicating crystal size was found to be increased in epileptic group compared to the healthy control which was due to the effect of epilepsy and epileptic seizures on bones. In conclusion; epilepsy and epileptic seizures caused a decrease in the strength of bone without any anti-epileptic treatment. The most affected cortical parts in spines, were mid-cortical and endosteum (inner cortical membrane) according to SR-FTIR studies. This result may point to an alteration in the osteoclastic endosteal bone resorption [3] due to epilepsy and drug treatment.

References:
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