Synchrotron researchers develop novel ibuprofen delivery methods for bones

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An excruciatingly painful broken bone. Surgery. Recovery. Healing. You could take an anti-inflammatory drug, like ibuprofen for the pain, but it works more or less throughout the body, resulting in less pain-relief than you'd like.

Researchers from Western University are developing a drug carrier that would ensure the drugs needed to treat the pain are taken directly to the bones, providing better targeted treatment.

The group, led by Dr. Tsun-Kong Sham and PhD student Xiaoxuan Guo, in collaboration with Dr. Ying-Jie Zhu of the Shanghai Institute of Ceramics of the Chinese Academy of Sciences used the Canadian Light Source synchrotron to study how Calcium Silicate Hydrate (CSH) nanostructures interacted with ibuprofen. CSH is a relatively new chemical in medical research, valuable to bone disease treatment as a non-toxic bone component. Coupled with ibuprofen, it could also help relieve pain from fractures and bone surgery.

One of the team's researchers, Dr. T.K. Sham explains that "CSH is similar to a delivery truck while the ibuprofen is like the cargo."

This kind of drug-delivery is an attractive route for medical innovation, with applications in cancer research, pain relief, and a variety of other pharmaceuticals. The ibuprofen-CSH research "provides some important hints about future design of drug carriers," said Sham.

The team needed to see just how well CSH could carry its cargo. Because of the porous structure of CSH, it could be loaded up with lots of ibuprofen—they just had to understand "the chemical interactions between IBU and CSH on the molecular level," Sham explained.

Using synchrotron X-ray Absorption Spectroscopy, Dr. Sham's team were able to study the interactions between the ibuprofen and its carrier on an atom-by-atom basis. The interactions show up as changes in the electronic structures, which the researchers could extrapolate to find out how fast the ibuprofen could be loaded and unloaded, and how that process happens. It's the drug-treatment equivalent of understanding the efficiency of a U-Haul.

The synchrotron research provided Guo a comprehensive and promising look at how ibuprofen gets loaded into CSH. The success of the procedure showed high ibuprofen carrying ability and "excellent sustained drug release behaviours" could lead to a world of new biomedical applications.

What's more, the group is among the first to explore how XAS synchrotron techniques could be used in drug delivery research. They plan to explore loading and unloading in a variety of other drug-carrier combinations in the future.

"We hope we have provided new opportunities to advance the knowledge of drug delivery, drug targeting and drug release using the powerful synchrotron radiation techniques at the Canadian Light Source," Sham said.

More information: "Drug–nanocarrier interaction—tracking the local structure of calcium silicate upon ibuprofen loading with X-ray absorption near edge structure (XANES)." Xiaoxuan Guo, Jin Wu, Yun-Mui Yiu, Yongfeng Hu, Ying-Jie Zhu, Tsun-Kong Sham. *Phys. Chem.*

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