Scientists use a sweetener to make materials for bone reconstruction

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A team of researchers from the Indian Institute of Science, Bangalore, has developed a novel polymer that can accelerate healing of bone fractures. Dr. Kaushik Chatterjee, Assistant Professor in the Department of Materials Engineering and Professor Giridhar Madras from Department of Chemical Engineering at IISc (Indian Institute of Science, Bangalore) are working on developing polymers that can serve as templates to facilitate bone growth. The team is working on developing maltitol-based biodegradable polyesters for accelerated bone healing.

Bones are one of the most important structures in our body providing the much needed support and protecting our organs. They undergo wear and tear and can break as a result of an injury or diseases like osteoporosis, leading to a fracture. Our body can heal fractured bones on its own, but this needs support if the damage is severe. Often, healing can be very slow owing to old age. Moreover, some fractures like hip fractures, take an enormous time to heal making the patient bed-ridden for several months.

According to a report from the World Health Organization, around 9 million hip fractures occurred during the year 2000 worldwide and this number is expected to increase steadily. Currently, treatment involve using grafts, either from the patientôs own body (autograft) or from a cadaver (allograft). However, the success rates of these transplants are not high, prompting the development of newer strategies to heal bone fractures Tissue engineering has immense potential to solve this issue and has become a hot area of research. Scientists are looking for the perfect material that is biodegradable and provides a biocompatible scaffold with mechanical properties that mimic the hierarchical structure of bone. ñAs the bone tissue starts to regenerate, the plastic must be resorbed and excreted by the body in a safe manner. Thus, we worked with maltitol, a sugar substitute/sweetener to prepare such plastics with other compounds that are used to prepare tablets/drugs. After melting these materials, they are allowed to react and the resulting prepolymers were converted to high molecular weight plastics by crosslinking. The advantage is that as the plastic degrades over time, maltitol and the other constituents that are released are not toxic and can be safely removed from the body. They will work much like the new generation sutures used for stitching in surgery where a second visit to cut them is not essential since they are slowly and safely degraded in the body. In a similar manner we hope that these new plastics would be able support the

initiation of bone formation after implantation and eventually get degraded to allow full healing,ò says Prof. Chatterjee.

In a recent study reported in a journal RSC Advances, the researchers have shown that the properties of the new polymers synthesized using maltitol can be tuned to match clinical needs. Synthetic biodegradable polymers are preferred over natural polymers, metals and ceramics, because of their flexibility in tailoring the physical properties, tissue response, biodegradability and biocompatibility. The choice of the precursors used to prepare the polymers of different stiffness can be made to tailor the needs of the different bone tissues in the human body, which can vary significantly from limbs to skull says Janeni Natarajan, the PhD student who worked on this project . She adds, ñBecause my husband is a doctor, he shares the sufferings undergone by patients with me. He also tells about the satisfaction attained after treating people suffering from excruciating pain. This inspired me to work in the areas related to medicine and developing new biomaterials that can address these issues.ò

Sugar-based alcohols have been widely used in biodegradable polyesters and are endogenous to human metabolism. So is it toxic? As a part of the study, the researchers have tested if the use of maltitol-based polymers were toxic to cells of the human body and found that these polymers were cytocompatible with no signs of cell death. In addition to this, these materials showed better mechanical properties compared to the current FDA approved materials which is an important criteria in designing materials for bone healing.

This is a great step in the field of materials engineering and biomedicine. Prof. Giridhar believes that that there have been significant breakthroughs in engineering such materials in recent years and with the rapid advancements in this field many new treatment options will become available to surgeons in future.