Reconstructing mandibular defects with bioengineered tooth and bone

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Current strategies for jaw reconstruction require multiple procedures, first to repair the bone defect to offer sufficient support, and then to place the tooth implant. The entire procedure can be painful and time-consuming, and the desired esthetic and functional repair can be achieved only when both steps are successful.

Although the patient's quality of life can be improved significantly, the prognosis is often unpredictable, especially in young patients, whose jaws continue to grow, while the implant remains fixed. The ability to bioengineer combined tooth and bone constructs, which would grow in a coordinated fashion with the surrounding tissues, could potentially improve the clinical outcomes, and also reduce patient suffering.

Under the guidance of Dr. Pamela C. Yelick, a research team at Tufts University (Boston, MA) has examined the feasibility of simultaneously reconstructing both teeth and bone. In 2002, the group first reported the regeneration of tooth crowns, from cultured tooth bud cells seeded onto biodegradable scaffolds and implanted into rat hosts.

The morphology of the developing tissue-engineered tooth crowns closely resembled that of naturally formed teeth. Next, they generated a hybrid tooth-bone construct, by combining a bone-marrow-derived stem-cell-seeded scaffold with the previously used tooth model, implanted and grown in the omenta (tissues connecting abdominal structures) of rat hosts.

In this case, the formation of not only the tooth crowns but also tooth root and surrounding alveolar bone was observed. However, since the omentum offers an environment quite distinct from that of the natural tooth site, the jawbone, the team examined hybrid tooth-bone construct development using third molar tooth bud cells and bone marrow derived from, and implanted back into, the same minipig.

Their results showed the formation of organized bioengineered dental tissues closely resembling those of naturally formed teeth, including dentin, enamel, pulp, and periodontal ligament, after 12 weeks of implantation. Further analyses confirmed the expression of tooth- and bone-specific markers on the bioengineered tissues. In addition, they observed novel mineralized tissue interface formation, including enamel/bone and dentin/bone interfaces.

These results demonstrate the feasibility and therapeutic potential for regenerating tooth and bone from autologous stem cells, for craniofacial reconstructions in humans. This model is currently being modified to improve alveolar bone formation, regenerated dental tissue orientation, tooth root development, and tooth eruption.

Source: International & American Association for Dental Research

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