Swiss researchers create artificial tooth that mimics natural microstructure

By DTI

ZURICH, Switzerland: Materials researchers from ETH Zurich (the Swiss federal institute of technology) have developed a procedure that allows them to mimic the structure of biological composite materials, such as teeth and seashells.

Using the new technique, they produced an artificial tooth whose surface is as hard and structurally complex as a real tooth, while the layer beneath is softer, just like natural dentine.

"Our technique is similar to 3-D printing, but ten times faster and much more cost-effective," said Dr Florian Bouville, a postdoctoral researcher from the ETH study group. The new method, called magnetically assisted slip casting (MASC), allows for the creation of complex composite materials that are almost perfect imitations of their natural models.

In order to demonstrate the technique’s potential for future applications in dentistry, the researchers produced an artificial tooth. "The profile of hardness and toughness obtained from the artificial tooth corresponds exactly with that of a natural tooth," said lead researcher Dr André Studart, Professor of Complex Materials at ETH, pleased with the results.

In the MASC process, a plaster cast is filled with a suspension containing magnetised ceramic platelets. In order to achieve the unique structure of the natural models, in which numerous microplatelets are joined together in different layers, a magnetic field is applied during the hardening process and its orientation changed at regular intervals. The ceramic platelets align to the magnetic field, resulting in layers with differing material properties in a single object.

Although the MASC results are promising, the appearance of the material has to be significantly improved before the technique can be used for dental prostheses, Studart remarked. For the time being, the results offer proof that the natural fine structure of a tooth can be reproduced in the laboratory. Although other methods exist to imitate nacre or tooth enamel, up to now it was a challenge to create a material that mimics the complex structure of the entire seashell or tooth.

As reported on the ETH website, the magnetisation and orientation of the ceramic platelets in the MASC process has already been patented. The study, titled "Magnetically assisted slip casting of bioinspired heterogeneous composites", was published online on 21 September in the Nature Materials journal.
State of health and risk factors differ distinctly among individuals, especially the elderly. In an interview with Dental Tribune, Prof. Martin Schimmel, Head of the Division of Gerodontontology at the University of Bern, spoke about ethical and financial challenges regarding implant treatment of the elderly and the importance of offering this vulnerable population the benefits of implant therapy.

Dental Tribune implant manufacturers seem to be exclusively targeting younger age groups nowadays. Do you think the silver generation is being overlooked when it comes to implant therapy and, if so, what could be the reasons for this?

Prof. Martin Schimmel: I do not think that statement is true. Tooth loss is increasingly associated with elderly people. In my opinion, most manufacturers of dental implants are aware of the fact that people in the Western world are retaining their own teeth for longer owing to the successful implementation of preventive measures.

The treatment of trauma cases in younger people is rather limited. At the same time, the clientele for implant treatment is becoming increasingly older. Data from the Department of Oral Surgery and Stomatology at the University of Bern’s dental clinic clearly demonstrates this. Narrow-diameter implants are also explicitly marketed as “Gero” implants nowadays.

Why do older patients benefit from implant therapy in particular?

Prof. Martin Schimmel: Particularly fully edentulous patients and those with an edentulous mandible benefit the most. Stabilizing mandibular complete dentures with the help of endosteal implants is one of the greatest achievements in dentistry. Scientific studies have found many positive effects, including improved quality of life, satisfaction with dentures, masticatory functionality and reduced bone atrophy.

Partially edentulous patients can benefit from fixed implant prosthesis functionally, as well as structurally. Conventional removable dentures have proven to be inferior, especially in free-end situations.

During a panel discussion at the EAO congress last year in Rome, it was found unanimously that there is no age limit for implant therapy. What is the maximum age at which dental implants could reasonably be used?

Age per se is not a contra-indication. Even in palliative care, implants may still play a valid role. Excluding people from the benefits of this therapy owing to their statistically lower remaining lifespan is unethical. However, one must consider exactly the point at which implants in the mouth do more harm than good—primum non nocere [above all, do no harm]—particularly in situations where cleaning is no longer possible and implants become merely a surface to which biofilms adhere. Furthermore, the possibility of medical contra-indications does increase with old age.

What factors play a crucial role in the implant treatment of elderly patients, and what factors do clinicians need to consider compared with treatment of other age groups?

Of course, the interindividual variability between patients increases with age, meaning that the older the patient, the more personalized treatment strategies have to be. The planning and implementation need to be constantly adjusted to medical, psychological and social individualities. Minimally invasive surgical approaches and prosthetic treatment methods that take the reduced adaptability and other physiological changes due to age into account have proven successful in this respect.

In Western countries, the gap between rich and poor is ever widening. Elderly people are increasingly falling into the latter group. What measures can help to ensure their access to dental implant treatment?

The only path to broad access to these therapies for financially less well-off patients lies in private or public insurance systems. These are political issues. However, dentists, dental technicians and the industry are constantly working on industrial production structures and thereby reducing costs. Digital developments in dentistry will surely help to provide patients with otherwise expensive treatments for a much more reasonable price. Nevertheless, over-simplified production methods are often not suitable for the complex treatment needs of the elderly.

You have pointed out the benefits of digital production methods. What other measures could also facilitate access to dental implants for the elderly?

Nowadays, the bulk of the costs incurred is due to the hours of work performed by the dental team and technicians. Digital processes can help to shorten treatment times through innovative workflows. Moreover, quasi-industrial production methods can be used in less complex cases, thus reducing costs further. It is important to note that implant manufacturers have maintained or even lowered their price levels for quite some time. However, it remains important to evaluate the economic value of using low cost implants, because they can have a much higher failure rate, as demonstrated by a recent Swedish study (Editorial note: Derks et al. 2015).

From a health policy standpoint, do you see any deficits in the subsidization of dental implants for the elderly?

This might differ from country to country. In Switzerland, for example, the subsidization of patients with low income is evaluated individually by local authorities. The treatment of persons who receive social security benefits or needs-based minimum benefits is subsidised if implant therapy can be performed in a simple, economical and appropriate way. Two inter-foraminal implants, for example, will be reimbursed if conventional prosthetic treatment is not able to restore a patient’s chewing ability.

In the statutory health insurance system, there is an obligation to perform the therapy if the loss of teeth was due to the occurrence or treatment of a severe disease, or to an accident or birth defect. There is certainly room for other indications, but one also has to consider the burden for the social security systems. In my opinion, Switzerland has established a good system and can serve as a model.

Thank you very much for the interview.