Future dental medicine - Nanodentistry

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DEFINITION: 'Nanodentistry' is defined as the science and technology of diagnosing, treating and preventing oral and dental disease, relieving pain, and of preserving and improving dental health, using nanoscale-structured materials [1]. The nanotechnology generally considers entities between 1 and 100 nm leading to properties and functionalities of materials that fundamentally differ from what is known from larger scales. The surface of the nanoparticles dominates the materials properties, which are usually given by the bulk.

MATERIALS & METHODS: The common biomaterials are ceramics, metals, and polymers or any kind of combination. Nanoscale patterns on the surfaces and within the volume of the materials accomplish the dedicated functionalities. The fundamental knowledge of the human tissues on the nanometer scale is required to take advantage of these innovative technologies for patients in an efficient manner. Imaging techniques to characterize nanomaterials include micro-tomography, electron microscopy, scanning probe microscopy, X-ray scattering and diffraction methods.

RESULTS: Filling materials for reconstructions, dental root implants, bone augmentation and dentin re-mineralization already take advantage of nanotechnology today, but have increasing growth potential (Fig. 1). Today's dental materials will be replaced by nature-analogue, anisotropic tooth restorations. The nanostructures in dentin are orthogonally oriented to the ones of the same size in the enamel [2]. The calcium phosphate phases for bone augmentation gain more and more importance along with the increase in age of the population. The absorbable calcium phosphate phases or bio-glasses support the growth of the natural bone being applied to larger and larger defects. The materials have to be optimized on the micro- and nanometer scales to tweak the biocompability, the bioactivity and the osseoconductivity promoting tissue regeneration and resisting the mechanical loads. The micro- and nanostructured surfaces of tooth implants guarantee the osseointegration. Nanoparticles are already used in 'sensitive' toothpastes and will enable the re-mineralization of damaged teeth [3].

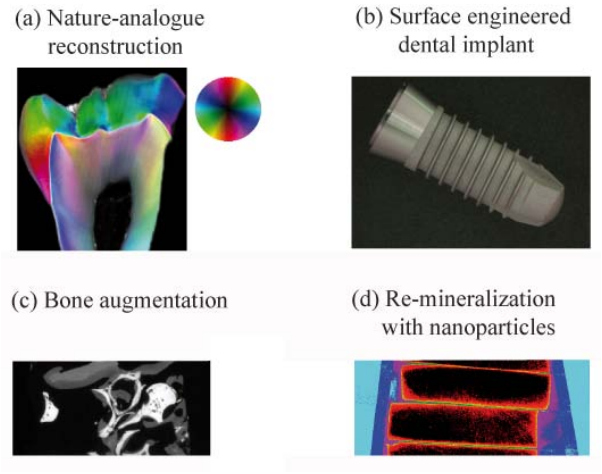

Fig. 1: Present applications of nanotechnology in dentistry with growing turnover.

DISCUSSION: Nanotechnology has started to a new era of dental medicine that will change the current methods in diagnosis, treatment and prevention of the different patients. As medicine advances and people live longer, nanodentistry will play an increasing role in enabling people to keep their natural teeth and oral tissues healthy and functioning. The scientists will understand in detail how the teeth grow, develop and heal. The medical experts will understand the assembly of nanostructures in dentin and enamel to enable the development of biomimetic tooth repair and regeneration. Dentists will be able to reconstruct hard and soft periodontal tissues as well as to treat caries including biomimetic re-mineralization and repair of diseased teeth.

REFERENCES: [1]H. Dosch, M. van de Voorde (Eds.) (2009) *Gennesys White Paper: A new European partnership between nanomaterials science and nanotechnology and synchrotron radiation and neutron facilities.* Max-Planck-Institut für Metallforschung, Stuttgart [2]H. Deyhle et al. (2009). *Bio-inspired dental fillings* Proc. SPIE **7401**:74010E [3]F. Kernen et al. (2008). *Synchrotron radiation-based micro computed tomography in the assessment of dentin de- and re-mineralization* Proc. SPIE **7078**:70780M

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