Summary

Measuring methods and procedures in medicine

Biodegradable materials and shape memory alloys (SMA) have great potential in medicine, but for their use it is necessary to know their properties thoroughly. This work focused on investigating the mechanical properties of nickel-titanium (NiTi) rotary instruments, NiTi orthodontic coil springs and biodegradable esophageal stents.

For NiTi rotary instruments, the aim was to optimize the methodology for testing their cyclic fatigue resistance and shaping ability. For this purpose, 20 copies of resin endoblocks were produced using the 3D JetPrinting method. These copies were then compared with commercially available originals. A statistically significantly lower dimensional variability of printed blocks was found compared to commercial endoblocks, confirming the high reproducibility of their production process.

For NiTi orthodontic coil springs, the deactivation plateau is the most important from a clinical point of view. It is the part of the load curve in which the acting force of the spring is independent of its extension and is used to move the treated tooth into the correct position. Therefore, the aim of this work was first to establish a methodology for the unambiguous determination of the deactivation plateau. With the developed methodology, it was possible to test the elastic properties of NiTi orthodontic springs using mechanical cycling and then compare the deactivation plateau of different types of springs. Further attention was paid to the constancy of the applied force over time during orthodontic treatment. The influence of the viscous component on forced relaxation was tested using a relaxation test of force over time, and the effect of temperature changes on the behavior of the NiTi orthodontic spring was tested using thermo-mechanical cycling, during which environmental temperatures were purposely changed simulating possible temperature changes in the patient's mouth. It has been found that only springs with low hysteresis, low temperature dependence of force enable the achievement of optimal speed of tooth movement and reproducible clinical results.

Biodegradable stents are becoming a promising method for the treatment of esophageal strictures. For the proper functioning of the esophageal biodegradable stent, it is necessary that it exerts sufficient force on the walls of the esophagus throughout the treatment period so that it does not prematurely narrow or collapse. For this reason, it is essential to know the viscoelastic properties of the stent. An in vitro force relaxation test over time was used to test them. A clinically significant decrease in stent strength was found within the first 48 hours after application. A further decrease in strength due to the viscoelastic properties of the material was found to be clinically insignificant.