Corrosion resistance measurements of dental alloys

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INTRODUCTION: Metals and metallic alloys still belong to the vital materials in dentistry, as they provide the necessary mechanical stability and elasticity to fabricate designated delicate constructs. Several patients, however, complain of incompatibility owing to corrosion of the applied metals. Consequently, the metallic parts are *in vitro* tested electrochemically to determine their resistance to corrosion. The better approach, however, are *in vivo* measurements. *In vivo* studies require the specific set-up accounting for the limited space, accessibility and restricted treatment period. Hence, the ec-pen[1] has recently been developed.

METHODS: The field study is based on the ec-pen that consists of two electrodes located in the electrolyte reservoir. Pushing the tip towards the metal part of interest, electrolyte is released to wet the surface. This rather simple and fast procedure allows for electrochemical measurements, as in the present study performed with six dental alloys. The selected alloys are the Ni-based alloy Remanium CS (Dentaurium, Germany), the Co-based alloys Remanium 2000 (Dentaurum, Germany) and Bärlight (Ahlden GmbH, Germany), the Pd-Ag alloy Est. Actual as well as the Au alloys with higher and reduced concentration Est. Royal and Est. Plus (Cendres&Métaux SA, Switzerland).

RESULTS: The ec-pen permits impedance measurements to determine the corrosion potential and the polarization resistances. Table 1 summarizes the results. As expected, Co- and Ni-based alloys exhibit low corrosion resistance, while the noble metals show much better values both in buffered saline and natural saliva. Corrosion and polarization resistance data correlates well with the results of crevice corrosion (cp. Table 1).

DISCUSSION & CONCLUSIONS: The electro-chemical measurements using the ec-pen are reproducible and allow differentiating between different dental alloys with respect to their corrosion resistance. The obtained data correspond to the ASTM standard test methods for pitting and crevice corrosion resistance.[2] Consequently, the relatively simple and small ec-pen is a promising tool for patient-relevant impedance measurements to reveal the metal compatibility in vivo.

Fig. 1: Gingival reaction of tooth 12 caused by metal ions.

Table 1. Corrosion resistance measurements of selected dental alloys.

Dental alloy	Crevice corrosion [µg]	Impedance resistance [Ωcm^{-2} 10^4]
Au high	0.21 ± 0.10	10.5 ± 3.5
Au reduced	1.20 ± 0.08	9.9 ± 2.2
Pd-Ag	1.8 ± 0.3	3.9 ± 1.2
Co-based (1)	4.4 ± 2.0	3.5 ± 2.5
Ni-based	24 ± 16	2.1 ± 2.2
Co-based (2)	791 ± 30	0.15 ± 0.30

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