In-vitro examination (thermomechanical variation loading and break test) of four-tooth full anatomical bridges manufactured from Bio HPP in milling and moulding procedures

**Topic: Basic research**

**Materials and methods**

In order to create a defined test situation, a human molar was added to a circular crown anchor preparation with rounded level. Exact plastic duplicates of these abutments were manufactured and these were socketed in pairs (distance = 17 mm) with simulated parodontal mobility (Fig. 1). The bridges were manufactured from Bio HPP using the following design parameters:

- Full anatomical design without veneers. Average dimensions of the connector areas (Fig. 2) from the palatine to buccal region 4.97 mm (1), 4.44 mm (2) and 4.95 mm (3). Average diameter from the occlusal to basal region 3.64 mm, (1), 3.91 mm, (2) and 3.73 mm (3). The connector surface was therefore 13.55 mm² (1), 13.59mm² (2) and 13.55mm² (3) on average. The longest bracing stretch was located in the region of the pontic centred in the region of the central fissure to the basal layer (Fig. 3).

The series (n=8 in each case) were manufactured either using a moulding procedure (Fig. 4) or using a milling procedure (Fig. 5). After preparation of the plastic abutments (Al₂O₃ at 110µm/2bar + Heliobond: Ivoclar-Vivadent) and the internal side of the bridge anchor (Al₂O₃ at 110µm/2bar + VisioLink: Bredent + Heliobond), adhesive cementing of the bridges was carried out (VariolinkII: Ivoclar-Vivadent).

The cementsed bridges were subject to thermomechanical variation loading in the Regensburg chewing simulator (1.2 x 10⁶ x 50 N mechanical and 2 x 3000 x 55/5°C thermal variation loads corresponding to a clinical duration of wearing of 5 years). Break loading was subsequently carried out (UTM Zwick: v=1 mm/min; break cut-off threshold 10% of the maximum strength).

**Aim**

The aim of the study was to investigate four-tooth bridges made from Bio HPP with regard to break behaviour and breaking stress according to variation in thermomechanical loading. The bridges were manufactured without veneer material in a full anatomical design from Bio HPP either using a milling or moulding procedure.

**Results**

**Moulded bridges**

Acoustic indications of failure at 871-1158N, no discernible damage to the constructions, continued to increase the force applied. There was visible crack formation in the centre at 1325-1585N on the pontic underside (Fig. 8) with extreme deflection of the constructions. No break in the bridges, "closure" of the basal crack due to the elastic resilience of the material upon termination of the loading.

**Milled bridges**

Basal crack formation in the middle on the pontic at 1338-1855N, no previous fracture sounds with low values. 6 of the 8 constructions could be stressed until they broke (Fig. 9).

**Discussion**

Each break strength should be defined as bridge failure if there was basal crack formation in the constructions (Tab. 1 and 2).

- **Moulded bridges**
  - Basal crack formation occurred prior to crack formation (Tab. 1) probably indicate internal tensions in the system, which were revealed by the behaviour of the elastic material upon application of force. The resulting deflection would probably cause composite veneers to fracture/chip at these stress values (871-1158N).

- **Milled bridges**
  - Basal crack formation occurred in the milled bridges, on average, at an application of force approx. 100 N higher (Tab. 2) than in the pressed bridges. It is possible that the milled constructions behaved in a less elastic manner, as additional build-up of force was possible after crack formation until fracture. The absence of premature fracture sounds leads us to suspect lower elasticity or less internal tension.

**Conclusion**

With regard to the break values following chewing simulation, the full anatomical construction of four-tooth bridges from Bio HPP can be considered as a possible metal-free treatment alternative. Additional investigations into abrasion resistance/antagonist behaviour, plaque/bacteria adhesion or mucosal compatibility would be useful.

According to the results of this in-vitro study, material preparation should preferably be carried out using a milling procedure, when using non-veneered Bio HPP bridges.

**References**

Dr. C. Kolbeck, PD Dr. M. Rosentritt: In-vitro investigation of a four-tooth bridge made from plastic stumps (TCML and break test): Full anatomical design milled or pressed from PIEK. Rapport #141 dated 21.12.2011. carola.kolbeck@ukr.de