Short Communication

Fracture Strength of Resin-Bonded Dental Prostheses with a Rigid Versus Nonrigid Joint. An In Vitro Study

Katrien M. L. Cleuren, DDS[a]/Katleen Vandamme, DDS, PhD[b]/Ignace Naert, DDS, PhD[c]

This in vitro study investigated whether a resin-bonded dental prosthesis (RBDP) with a hyperstatic, rigid joint was preferable to an isostatic, nonrigid construction in terms of debonding and fracture strength. RBDPs replacing a missing molar with a rigid (design I) or a resilient model (design II) were compared to a commercially available system (Crownless Bridge Work) (design III, control). All groups were subjected to thermocycling (TC) and dynamic mechanical loading (ML) in a dual-axis chewing simulator (TC: 6,000 × 5°C/55°C; ML: 1,200,000 × 49 N × 1.4 Hz). None of the RBDPs of design III showed movement or fracture during the test period. Significant differences between designs I and III ($P = .0049$) and between designs II and III ($P = .0007$) were noted. Despite a tendency for lower fracture values of design I, no significant differences could be established between the test designs with a rigid or nonrigid construction. The commercially available dental prosthesis with a nonrigid joint was confirmed to resist a 5-year survival simulation. *Int J Prosthodont 2009;22:140–142*

Fixed prosthetic solutions with minimal tooth reduction, such as a resin-bonded dental prosthesis (RBDP), constantly gain interest in modern restorative dentistry. Although initially considered as interim restorations in contrast to the more permanent conventional fixed prostheses, recent data suggest comparable clinical complication incidences and longevity for RBDPs.[1] Debonding, however, remains its most common complication due to wringing forces.[1] Nonrigid connectors, allowing independent movement between the retainers during loading, seem to be beneficial in this respect.[2] The aim of the present study was to evaluate the fracture strength of RBDPs with a rigid versus nonrigid joint in vitro. A higher fracture strength for an RBDP with a nonrigid joint was hypothesized according to an earlier conducted numerical study.

[a]*Clinical Assistant, Department of Prosthetic Dentistry, School of Dentistry, Oral Pathology, and Maxillofacial Surgery, Faculty of Medicine, Leuven, Belgium.*

[b]*Post-Doctoral Research Fellow, Department of Prosthetic Dentistry/BIOMAT Research Cluster, School of Dentistry, Oral Pathology, and Maxillofacial Surgery, Faculty of Medicine, Leuven, Belgium.*

[c]*Professor and Chairman, Department of Prosthetic Dentistry/BIOMAT Research Cluster, School of Dentistry, Oral Pathology, and Maxillofacial Surgery, Faculty of Medicine, Leuven, Belgium.*

Correspondence to: *Prof I. Naert, Department of Prosthetic Dentistry/BIOMAT Research Cluster, School of Dentistry, Oral Pathology, and Maxillofacial Surgery, Faculty of Medicine, K.U. Leuven, Kapucijnenvoer 7 – blok a – bus 07001, B-3000 Leuven, Belgium. Fax: +32 16 33 23 09. Email: gnace.Naert@med.kuleuven.ac.be*

Materials and Methods

Twenty-seven RBDPs replacing a missing molar were fabricated and divided into three groups: a rigid model (design I), a nonrigid model (design II), and a commercially available system (Crownless Bridge Works, TC Torsion Dental) (design III, control) (Figs 1 and 2). Ceramic blocks were used as abutments. The anchor plates of designs I and II consisted of a pin, wing, and an anchor. For design III, ready-made universal anchors without wings were used (Fig 3). The pontic of design I was bilaterally rigidly cemented to the anchor plates.

Fig 1 Nonrigid or so-called torsion attachment. The outer (secondary) part becomes part of the pontic after casting; the inner (primary) part will be luted to the anchor and can slide and rotate into the outer part (2 degrees of freedom).

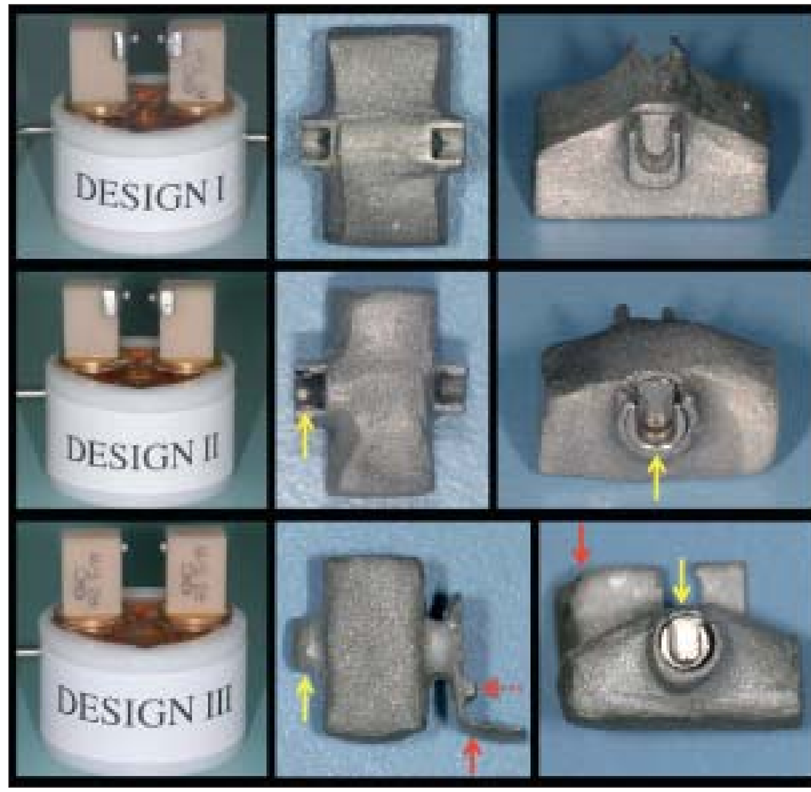

Fig 2 *(right)* Anchor and pontic design of types I, II, and III. A torsion attachment is inserted in design types II and III at one side *(yellow arrow)*. The pontic carries a wing *(plain red arrow)* with groove *(dotted red arrow)* in design III.

The pontic of design II was cemented at only one side and a torsion abutment was inserted at the other. The pontic of design III incorporated a wing at one side and a torsion attachment on the other. Standardized preparation of the abutments consisted of an anchor channel for all groups and an additional groove preparation at one side for design III. All groups were subjected to thermocycling (6,000 × 5°C/55°C) before exposure to dynamic loading (1,200,000 × 49 N × 1.4 Hz) (Willytec). Failures were scored as no (score 0), ≤ 0.5 mm (score 1), or > 0.5 mm (score 2) movement, or cement fracture and loss of retention at one (score 3) or at both sides (score 4). Statistical analysis was performed using a Kruskal-Wallis test ($\alpha = 5\%$).

Results

None of the RBDPs of design III displayed movement or fracture during the entire test period, neither at the matrix nor the patrix site. Significant differences were noted between designs I and III ($P = .0049$) and II and III ($P = .0007$) (Fig 4). Despite a tendency to lower fracture values for design I, no significant differences could be established between designs I and II. No fracture or loss of retention was observed on the patrix part for any of the design types.

Discussion

Absence of any significant difference in fracture incidence between designs I and II might in part be attributed to the selected loading parameters. The eccentric loading force of 50 N that resulted in a bending moment of 250 Ncm might have led to excessive stress for the single rigid connection of design II. The nonrigid anchor only counteracts the vertical vector of the applied load, and the contralateral rigid anchor had to therefore resist all bending forces. This may have contributed to the dislodgement of the rigid connection of design II. Indeed, the rigid connection of design II always failed first. A lower loading force (eg, 25 N) could possibly have altered the results.[3]

Absence of a loss of retention or failure for design III might be explained by the large bond surface created through a cast wing as part of the pontic and the groove preparation. Preparation of grooves in abutment teeth for posterior RBDPs appears to be beneficial in improving the survival rates of RBDPs.[4]

Although the protocol of the study was based on published recommendations for the simulation of clinical load parameters, care must be taken when extrapolating the data to clinical reality. Is the resulting load the nominal load as suggested? What about the

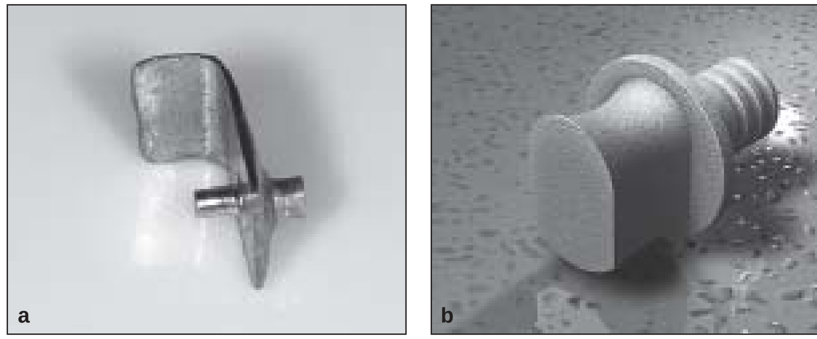

Fig 3 Anchor designs of a (**a**) cast anchor plate (CrCo) and (**b**) confection anchor (castable).

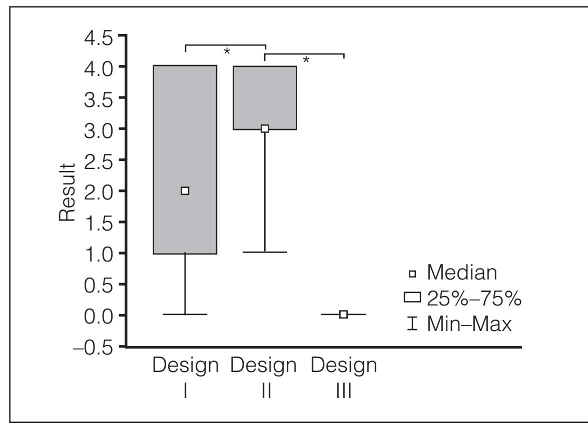

Fig 4 Median, minimum-maximum, and 25% to 75% percentiles of the failure scores for designs I, II, and III. Statistically significant differences are indicated with an asterisk.

use of extracted human molars versus artificial ceramic blocks in terms of intervariability, microstructure, and dentin bonding? What about the impact of an artificial periodontal membrane on the fracture limit of RBDPs?[5]

Conclusions

RBDPs, with the commercially available Crownless Bridge Works system incorporating a nonrigid joint, survived thermocycling and loading in a computer-controlled dual-axis chewing simulator for an equivalent of 5 years time of function. However, the hypothesis of a higher fracture strength for RBDPs with a nonrigid joint could not be sustained.

Acknowledgments

The authors acknowledge the support of CBW dental (Berlin, Germany) for supplying the materials used in this study. The Research Fund of the Catholic University Leuven (K.U. Leuven) is gratefully acknowledged for financially supporting K. Vandamme as a post-doctoral research fellow.

References

1. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications in fixed prosthodontics. J Prosthet Dent 2003;90:31–41.
2. Botelho MG, Dyson JE. Long-span, fixed-movable, resin-bonded fixed partial dentures: A retrospective, preliminary clinical investigation. Int J Prosthodont 2005;18:371–376.
3. Koutayas SO, Kern M, Ferraresso F, Strub JR. Influence of design and mode of loading on the fracture strength of all-ceramic resin-bonded fixed partial dentures: An in vitro study in a dual-axis chewing simulator. J Prosthet Dent 2000;83:540–547.
4. Creugers NH, de Kanter RJ, Verzijden CW, van't Hof MA. Five year survival of posterior adhesive bridges. Influence of bonding systems and tooth preparation [in Dutch]. Ned Tijdschr Tandheelkd 1999;106:250–253.
5. Kern M, Douglas WH, Fechtig T, Strub JR, DeLong R. Fracture strength of all-porcelain, resin-bonded bridges after testing in an artificial oral environment. J Dent 1993;21:117–121.