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RESEARCH ARTICLE

ALL CERAMIC CANTILEVER BONDED BRIDGES

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ABSTRACT

In the context of respecting tissue economy, prosthetic implant prosthesis is the first therapeutic choice for the restoration of an anterior edentation, but this treatment option presents numerous medical and surgical contraindications. Therefore, bonded bridge is an interesting alternative rehabilitation. Its design has progressed over time. With the appearance of new ceramic systems, one of the retainers disappeared creating a new type of bonded bridge: "the all-ceramic cantilever bonded bridge". This therapeutic proposal, which remains largely unknown to practitioners, requires a description and a precise codification of its main clinical aspects in order to be able to democratize it with a maximum security. Our article aims to review the indications, clinical stages and longevity of bonded ceramic cantilever bridges.

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INTRODUCTION

Researches in the field of adhesion are still in progress. In addition, tissue economy has become a major objective in all prosthetic treatments undertaken. There are many situations, including the replacement of the lateral incisor, where the bonded bridge allows us to achieve all of our treatment objectives in a very favorable cost / benefit / safety ratio. Indeed, this therapy remains reversible through the conservation of the dental capital thanks to the minimum preparation of the abutment teeth (Attal, 2015) These bonded bridges have undergone an important evolution since their conception by Rochette until today. The first description concerned the bonding of a metal frame on the teeth adjacent to a toothless tooth. With the ceramic materials revolution, many authors proposed bonded bridges made entirely of ceramic, first with two retainers, then recently, a new configuration appeared: the all-ceramic cantilever bridge with a single retainer (Van Dalen *et al.*, 2004). The purpose of this article is to describe this new treatment option, through a narrative review.

Description: A cantilever-bonded bridge consists of a single retainer bonded to an abutment and secured by a connection to the pontic tooth, which is an element in extension (Barwacz *et al.*, 2014).

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The connection must be strong enough and the cantilever's extent must not be too great (only one tooth). This architecture has a multitude of advantages, namely: (Wei *et al.*, 2016)

- Reduction of treatment duration,
- Excellent cost-effectiveness,
- Very good biological integration, (Miettinen, 2013)
- A high degree of patient satisfaction,
- Oral hygiene facilitated by the possibility of passing a floss for cleaning under the element in extension (Soualhi, 2017)
- Simplicity of realization and tissue preservation (Botelho *et al.*, 2014; Attal, 2015)

Indications: The indications can be presented in two parts: the indications that they share with traditional bonded bridges and then the specific indications for cantilever bridges.

The indications common to bonded bridges:

Good quality of hygiene,teeth free from caries or restorations, favorable occlusion, absence of bruxism, overbite or any para-function (Galiatsatos, 2014; Sailer, 2014; Tezulas *et al.*, 2018) patient with an absolute or relative contraindication for implant surgery (Attal, 2008; Sailer, 2013).

Specific indications for cantilever bridges:

- Residual diastema in order to respect the harmony of the mesio-distal diameters of the anterior teeth,

- Prosthetic space of at least 0.8 mm to accommodate the retainer. Moreover, the retainer must be absolutely placed in a zone of non-occlusion, (Attal, 2015)
- Replacement of an absent tooth in a young patient (cranio-facial growth not yet completed) preferably located in the incisor areas (maxilla or mandibular).
- At the posterior level, only the ceramic-metal cantilever bridges are indicated (Botelho, 2014; KERN, 2017; Sailer *et al*., 2013). In addition, studies have shown a high failure rate of cantilever ceramic restorations replacing the canine (Barwacz, 2014)

Preparation Architecture: For an anterior cantilever bridge, the rational choice of the abutment tooth conditions the success and the sustainability of the prosthetic restoration. Whether for the replacement of the central or lateral incisor, the choice of the point of support on the central ass to be preferred. On the one hand to optimize the bonding area by a more favorable use of the developed surface of the palatal side in comparison with that of the lateral one (Tirlet, 2015). On the other hand, to avoid pressing on the canine, which remains the keystone of the dynamic occlusion, especially during the laterality movement (canine function). In addition, this tooth lays at the intersection of two curvature of the maxillary arch remains a privileged place for the storage of mechanical stresses. This pillar will be used in particular when there is an occlusion to find or when composites are present on the palatal side of the central (Tirlet, 2015). Regarding the architecture of preparations, all-ceramic systems require a more invasive preparation compared to ceramic-metallic systems. Different forms of preparation have been proposed depending on the ceramic systems used (Table 1)

For zirconia cantilever bridges, Klink *et al* as well as Sasse and Kern propose an enamel lingual reduction of the abutment tooth, with a supra-gingival cervical limit, a cingular pit and a shallow proximal box opposite the toothlessness (Klink, 2016; Sasse, 2014). For infiltrated ceramics (Inceram alumina / zirconia system), Kern and Sasse emphasize the need for a lingual reduction from 0.5 mm to 0.7mm and a proximal box of 2 mm x 1 mm x 0.5 mm to contain the connection, it must have a minimum thickness of 2mm with a height of 3mm (Sasse, 2014; Mourshed, 2018; Soualhi, 2017). For vitroceramics, the lingual preparation is 0.5 to 0.8 mm, with a supra-gingival cervical border. WALTER described an occlusal limit of the preparation, which must stop at 2 mm from the incisal edge so as not to weaken the free edge (Mourshed, 2018; Soualhi, 2017 ; Walter, 2003).

MATERIALS

The ceramics used: The practitioner must be vigilant in the choice of materials. Several studies recommend the use of zirconia (IPS e.maxZirCad veneered with IPS e.max Ceram) (Sasse, 2012; Mourshed, 2018). Indeed, the cantilever configurations in zirconia have shown promising results over a follow-up period of 6 years, (Kern, 2017; Sasse, 2014), this finding was recently confirmed in a systematic review, which reported a higher survival rate of bridges in zirconia, however the detachment of these bridges is more frequent compared to glass ceramic bridges (Chen, 2018; Miettinen, 2013). Other studies use infiltrated ceramics and lithium disilicates, given the excellent adhesion potential of glass-ceramics reinforced with lithium disilicate (Barwacz, 2014; Sailer *et al*., 2013; Sun *et al*., 2013; Mourshed *et al*., 2018)

Assembly materials: The surface treatment before bonding varies depending on the ceramic used. Zirconia cannot be etched by common acids used in dental technology. Clinically sufficient adhesion to zirconia can be achieved by the use of an adhesive containing phosphate monomers (eg Clearfil ™ Ceramic Primer (Kuraray), or Monobond® Plus (Ivoclar Vivadent)) or by composites containing phosphate monomers (egPanavia ™ family (Kuraray), Rely ™ Unicem (3M Espe)), in combination with preliminary treatment by: sandblasting with standardized aluminum oxide (50 µm) applied at low pressure. (1.0-2.5 bar) combined to using silane (4, 28, 29, 30)
A recent systematic review has described another technique for bonding anterior zirconia cantilevers, it consists of applying a layer of feldspathic ceramic to the lower surface (intaglio). In this situation, the protocol will be identical to that followed for bonding lithium disilicate bridges (Tezulas, 2015). This protocol includes etching the underside of the retainer with 5% hydrofluoric acid with the application of silane and then the bonding material (Launois , 2008; Tezulas, 2018; Viana, 2016; Zitzmann, 2015)

Longevity studies: Several studies have shown the longevity of ceramic cantilever bridges compared to ceramic restorations with two supports (Botelho, 2016; Kern, 2011; Saker *et al*., 2014). Indeed, in the case of a bridge with two bonded retainers, the differential mobility of the teeth bordering the edentulous involves stress on the retainers, which can lead to partial detachment. The relevance rests on obtaining a greater degree of movement of the abutment tooth, (Attal, 2015; Sasse, 2014) thus, during propulsion movements and the laterality the pontic must be discharged (Kern, 2017; Sailer, 2013; Mourshed, 2018). Irena Sailer *et al* shows a 100% survival of lithium disilicate cantilever bridges after an average follow-up of 6 years. Saker *et al*. in another clinical study, showed that there is no significant difference between bonded cantilever bridges made of ceramic (Alumina- Inceram) and metal (CoCr) (Sailer, 2013; Saker, 2014).

Kern M. and colleagues assessed the survival of full-ceramic bridges. They reported a survival rate of 73.9% at 5 years, for ceramic bridges bonded with two retainers, and a rate of 92.3% for cantilever bridges (Kern, 2005) Klink *et al* evaluated the anterior cantilever zirconia bridges. After 35 months of follow-up, they concluded that these designs remain a valid solution for replacing a single anterior tooth (Klink, 2016) More recently, a systematic review has also confirmed that cantilever bonded bridges can be a viable alternative treatment in the anterior sector compared to traditional bonded bridges (Sasse, 2014; Chen, 2018). However, the fracture in the connection is the main cause of failure, which requires the bridge to be redone. Hence the importance of great rigor in respecting the thicknesses of the connections (Kern, 2011; Mourshed *et al*., 2018) It seems that 12 mm² at the connection is really the minimum in the anterior sector (Attal, 2015). Some authors propose, with excellent results, minimum connections of 16 mm², or 2.6 times more than the connection required in high tenacity zirconia ceramic (table 2) Whether the bridge is made of zirconia or Emax, it is important to requirefrom the laboratory technician a careful validation of the connection thickness.

Table 1. Summary of preparation designs used for anterior cantilever RBFDPs

Study	Materials	Preparation designs
Klink and Huttig (2016)	Zirconia framework veneered with feldspathic ceramic	-The preparation included a lingual veneer, a groove on the cingulum, and a small proximal box preparation.
Sasse and Kern (2014)	Zirconia framework (IPS e.max Zir CAD) veneered with feldspathic ceramic (IPS e.max Ceram)	- The preparation used a notch and a shallow proximal box. - The preparation of the abutment teeth provided a definite seat for the restoration but without mechanical retention.
Sailer and Hammerle (2014)	Zirconia (IPS e.max ZirCAD) veneered with feldspathic ceramic	- The minimally invasive preparation design was a mesial and distal vertical groove (6° taper) and a tiny slot at the lingual cingulum region
Sun and al (2013)	Glass Ceramic (IPS e.max Press) veneered with feldspathic ceramic	- The axial surface reduction ranged within 0.5 to 0.8 mm, with window preparation without incisal edge involvement. Cervically, a shallow chamfer (0.5 mm) was prepared equigingivally. - The proximal reduction was within 0.5 to 1 mm. The chamfer on the cervical area should be at the supragingival margin to avoid the exposing of the root cingulum area.
Kern and Sasse (2011)	Glass-infiltrated alumina/ zirconia (In-Ceram) veneered with feldspathic ceramic	- The preparation of the abutment teeth was conservative and only within the enamel. It included a lingual veneer, a groove on the cingulum and a small proximal box preparation (dimensions: 2 mm × 1 mm× 0.5 mm).

Table 2. The surface of the connections according to the ceramic system (Soualhi, 2017)

Ceramic system	Flexion MPa	Surface of connexion
IPS Empress	350	12 à 20 mm²
Inceram alumina	500	12mm²
Inceram zirconia	700	12 à 20mm²
Zircone (Y-TZP)	1100	9 mm²

Conclusion

Traditional bonded bridges are clearly a recognized prosthetic treatment and therefore deserve their place in the clinician's therapeutic arsenal. Without opposing them, cantilever bonded bridges represent a credible alternative to traditional two-retainer bonded bridges. However, the practitioner is required to establish a well-reasoned pre-prosthetic study to choose the abutment tooth, the ceramic system used and the suitable bonding material. Today, the converging body of positive studies on cantilevered ceramic bridges, associated with the positions of European (University of Kiel and Geneva) and Asian (University of Hong-Kong) leaders seems dense enough to offer them as a viable alternative treatment in well selected cases.

Competing interests: The authors declare no competing interest.

Authors' contributions

Ichraq Benazouz provided the electronic search and realized the synthesis and the writing. Imane Boujoual realized writing. Moussaoui H. and A.A gave their corrections and appreciations. All authors read and approved the final manuscript.

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