Bridge Design Part 15: bridgework using CAD/CAM technology

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In the last article in the series, the author looks to the future with the latest developments in CAD/CAM and ceramic technology

With the increasing numbers of dental patients who have metal allergies or request metal-free restorations the latest Procera all ceramic bridge computer aided in design and machining is now available.

Since the 1960s alumina has been used in dental ceramics with increasing amounts being used in order to increase the strength of the material by using different manufacturing methods. Conventional laboratory techniques however could only take the alumina content to a certain level. To increase that further, a completely new production method was developed in 1994 by Nobel Biocare who introduced the Procera all ceramic CAD/CAM crown. It was possible to produce a densely-sintered alumina material consisting of 99.5% alumina. The strength of material is superior to those other ceramic reinforced systems that are out on the market today, exhibiting a biaxial flexural strength of 687 megapascals and has been suggested as being a metal free alternative to three unit porcelain fused to metal conventional bridgework.

This restorative system allows the fabrication of single crowns, three unit bridges and laminate veneers, and the combination of strength and beauty gives a simple, predictable clinical procedure and excellent aesthetic results.

Seven to ten year studies reveal a success rate comparable to standard porcelain-fused-to-metal crowns. The strength of the Procera all ceramic restoration comes from a core of densely-sintered biocompatible alumina, produced with high accuracy. The translucence gives a vitality, which, together with the veneering porcelain makes a highly aesthetic restoration. The surface roughness of the internal aspect of the Procera coping makes the restoration suitable for bonding without etching or for conventional cementation.

PREPARATION TECHNIQUES

The Procera coping is only 0.4mm thick for anterior and premolar crowns, whilst a 0.6mm thick coping is used for molar restorations and for bridgework. For molar preparations the occlusal surface should be relatively flat and not with deep

Figure 1: Close up of unaesthetic upper anterior crowns

Figure 2: Spacing between lower incisor teeth

fossa, as with the traditional porcelain fused to metal crown. The preparation techniques include a modified chamfer finish line, with the depth of 0.5 to 1.5mm, and an occlusal reduction in the region of 1.5 to 2mm with rounded, smooth contours and lack of sharp angles. The preparation techniques for bridgework is identical to those for molar crowns, although it is recommended that the edentulous space between unprepared teeth has to be less than 11mm, whilst the prepared teeth must allow a bridge with an occlusal gingival height of more than 3mm.

The following case study illustrates the use of Procera AllCeram three unit fixed bridge and anterior Procera AllCeram crowns in a patient refusing to have any type of metal placed in her mouth.

CASE STUDY

This middle-aged lady was referred to St Ann's Dental Clinic in Manchester from her general dental practitioner with unaesthetic upper anterior crowns (Figure 1) and spacing between her lower anterior teeth (Figure 2).

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Figure 3: Diagnostic wax-up

On examination it was noted that the crowns in the upper jaw looked rather wide and bulbous and the lower anterior teeth were thin in comparison to the amount of space available for them, and that they were not in the golden proportion as described by Levin (1981). From discussions with the patient she wished to have aesthetic improvements to her upper and lower teeth using a biocompatible restorative material without any metal substructure.

Initial diagnostic work included a full diagnostic wax up of the anterior teeth (Figure 3). The wax up indicated that in order to provide an ideal aesthetic result in the lower jaw the spacing in the lower left hand side would need to be restored with bridgework rather than over contoured and enlarged crowns, and hence the option of the CAD/CAM all ceramic Procera bridge.

Prototype restorations and preparation guides (Figures 4 and 5) were then fabricated from the diagnostic wax-up.

PREPARATIONS

Preparations proceeded along traditional lines using tooth preparation guides to visualize restorations of the same shape as those from the diagnostic wax up. The teeth were prepared with a 1.2 labial reduction for the crowns and 1.5mm for the bridgework with a deep chamfer finish line. In order to reduce the spacing between the lower left lateral incisor and canine and to open up the space between the lower left canine and premolar, a heavy tooth preparation was necessary from the distal of the canine and the mesial of the premolar (Figure 6).

Figure 4: Prototype restorations on the models

This would then open up the space between the canine and premolar to allow for the fitting of the all-ceramic bridge. A dual cord technique was used for recording the impression using Provil and Monophase (Heraeus Kulzer, 01635 30500) using a thin cord which stays in the sulcus during the impression procedures, and a thick cord which is placed into the sulcus on top of the thin cord. This second cord is removed prior to taking the impression and haemorrage is controlled by Astringident (Optident, 01943 605050).

After preparations One Step dentine bonding system (Optident, 01943 605050) was used in order to seal the dentinal tubules and stop any bacterial ingress into the dentine in line with the work of Brannstrom (1984). The teeth were first acid etched, dried and rehydrated with Tublicid (Fielding Dental, 01604 755586) anti-microbial agent, before painting on several coats of One Step dentine adhesive. This is air thinned before curing with a light curing unit for ten seconds. This also has the effect of significantly reducing post-operative sensitivity.

PROTOTYPES

The prototype restorations were then retrofitted over the top of the tooth preparations and relined with 'Prevision' chemical cure composite (Heraeus Kulzer, 01635 30500) after previously sandblasting the internal/external aspects of the acrylic prototypes and painting with Connector adhesive (Panadent, 01689 881788). In this way a bond is formed between the acrylic and the composite reline material to stop any fracturing at the margins. The composite reline also gives a stronger substructure to the acrylic prototype and as it does not shrink as much as acrylic and further relines are not necessary. Great care was taken to establish ideal marginal adaptation around the prototypes to encourage gingival health. The patient was seen one week later and the shapes of the prototypes were modified to give a softer, more feminine appearance and impressions taken for study models.

LABORATORY STAGE

The laboratory stages commenced with silver plating the

Figure 5: Preparation guide with holes in labial surface

Figure 6: Bridge preparation in lower left quadrant

Figure 7: Bridge preparations showing cast scoring technique

Figure 8: All Ceramic Procera Bridge in biscuit bake porcelain

master impressions for silver plated dyes, followed by the pouring of two further models to allow the crowns to be seated back on the master solid model (Figure 7) which was cast-scored in the area of the pontic (Stein, 1966) in order to provide the technician with a concave ridge onto which he could fabricate an ovate convex pontic (Garber, 1981).

The master silver dyes were scanned and the information was sent by modem to Sweden where Procera copings for the crowns and bridge units were milled. Porcelain was then applied to the crown copings to give the ideal aesthetic results and the copings for the bridgework attached to each other with the prescanned pontic by fusion using the Procera All Ceram connection and fusing material prior to having the porcelain applied. The study casts taken at the last appointment showed the working shapes of the prototypes and these were mounted and by the use of putty matrices, the incisal lengths and positions of the prototypes were copied in the final restorations (Figure 8).

BRIDGE FABRICATION

By using prescanned pontics from the selection supplied by Procera the laboratory procedure is simplified. The required angle of the connective area (25°) and minimum size (3mm length and 2mm width) is guaranteed. A wax layer of at least 0.6mm is required to join the pontic and the copings on the abutment teeth. This new shaped pontic is then scanned prior to milling. The AllCeram connection material is then mixed and applied to the joint areas in thin layers, prior to application of the Procera AllCeram fusing material.

This framework is then placed in the porcelain furnace at a firing temperature of between 1150-1200° centigrade. The bridge is then ready to be veneered with the AllCeram porcelain in the traditional method to create an aesthetic all-ceramic restoration.

AESTHETICS

The final restorations were cemented with resin modified glass ionomer cement (GC, 01908 218999) and the final result shows excellent aesthetics (Figures 9 & 10). Both central incisors identical, whilst the lateral incisors were non-identical but in harmony with each other to give a realistic appear-

Figure 9: Pre-operative unaesthetic upper anterior crowns

Figure 10: Post-operative aesthetic improvements

Figure 11: Pre-operative lower spacing

Figure 12: Post-operative crowns closing the spaces

ance. In the lower jaw the crowns were given a slight imbricated appearance with uneven incisal edges (Figures 11 & 12), and the bridgework reshaped and positioned so as to close the gaps present at the beginning of treatment (Figure 13).

CONCLUSIONS

The final predictable restoration is a combination of using the art and science of aesthetics, including use of the golden proportion as described by Levin (1981); soft tissue techniques, as reported by Touati and Tarnow (1992); laboratory techniques to produce CAD/CAM densely sintered aluminium Procera cores with ideal aesthetics; the use of the correct model type, as described by Geller and Stein, together with correct diagnostic procedures, including diagnostic wax up, preparation guides and prototype restorations.

Finally, the restorative dentist needs to know tooth anatomy so that the correct tooth reduction can be made without pulpal exposure as described by Shillingburg (1973) and by the use of modern bonding techniques to seal the dentine, pulpal health is maintained and post-operative sensitivity reduced. The final ingredient is knowledge of beautiful smiles, which can only come from close watching of the natural dentition as described by Winter (1993).

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Figure 13: Close up of final CAD/CAM Procera bridge

REFERENCES

Brannstrom M (1984). Communication between the oral cavity and the dental pulp associated with restorative treatment *Op Dent* **9:** 57-68

Garber D (1981). The Edentulous ridge in fixed prosthodontics *Com of Cont Ed* **11:** 212-223

Levin E (1981). Dental esthetics and the golden proportion *J Pros Dent* **40:** 244-252

Shillingburg H, Grace C (1973). Thickness of enamel and dentine *J South Cal Dent Assoc* **41:** 33-52

Stein R (1966). Pontic residual ridge relationship -A research report *J Pros Dent* **16:** 251-285

Tarnow D, Magner A, Fletcher P (1992). The effect of the distance from the contact point to the crest of bone on the presence or absence of the inter-proximal dental papilla. *J Periodontol* **63:** 995-996

Winter R (1993). Visualising the natural dentition. *J Esth Dent* **5:** 102-117