ae

aesthetics

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Lithium disilicate special

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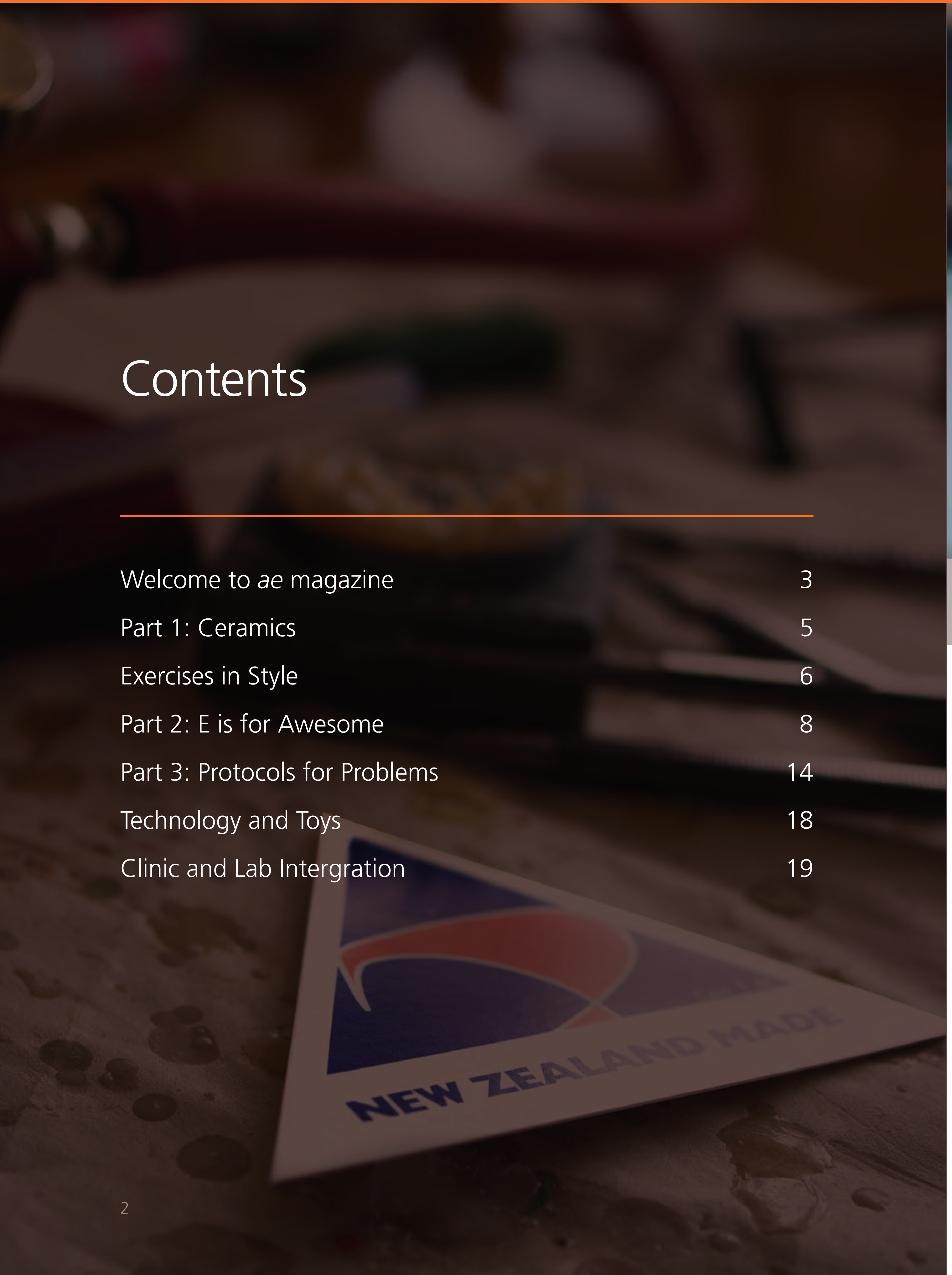
Technology and Toys

Novodente Lab Connection



Contents

Welcome to ae magazine

So here we are at issue two of *ae* magazine. *ae* was named from the diphthong at the beginning of the word aesthetics. It is an idea that comes up again and again in our industry, but what does it mean?

In almost every definition that I have come across, aesthetics is described as a philosophy. The study of the general fundamental problems.

It is described as the philosophy of beauty, but beauty being subjective, aesthetics is also the philosophy of taste. In trying to solve the problems in the study of aesthetics we have created rules that we hold to be true. We have decided that certain things are empirically beautiful and others are not. We no longer use our eyes, our 'aesthetic sense', instead we rely on a golden rule: a calculation of beauty.

Maybe we can do this, or maybe we can only use these tools to set us off in the right direction and we must still use our intrinsic kinaesthetic check, 'does this feel right?' Maybe we need to throw out these rules all together and allow ourselves to use our aesthetic sense or to be a medium for our patients'.

And then what of becoming close to our work? As professionals working with detail, we often become over-absorbed by some fine mathematical relationship. Upon forcing it unnaturally onto a situation, we can feel a sense of achievement that we have succeeded at something that is difficult. Can we only see what we are looking at and not really what is there?

And our kinaesthetic check? Can we rely on it to let us know the correct feeling has been created? Shapes give us feeling. Some teeth can make us feel as if they are cute while others may be grotesque. Some might be sexy and others robust or strong. Some might tell lies and others a goodnight story.

A rule with exceptions and counter rules, I feel, is not the way. So let us explore together, looking for the elegant solution. Let us take time to embellish the possibilities so that as what is less right fades you find yourself reaching for, not a philosophical ambiguity, but the satisfaction of doing something 'just so'.

—Tim Broadbent

Part 1: Ceramics

Dental technology has materials. We use these materials.

The scope of dental technology includes the design and selection of materials for the construction of prostheses. When we make a crown we have to understand the attributes of the different materials before we can go ahead and select the correct material.

All-ceramics is something in which I am particularly interested. I recall a time when I was discussing a case with a dentist who had an aversion to all-ceramic restorations, and him saying 'I could never put an *all-ceramic* on that'. That may well have been true, but the choice of words made me wonder 'which all-ceramic material, which construction method, which technique?'

So, what are ceramics? Ceramics are non-metallic solids that are formed by some kind of heating and cooling process (1). There are three main constituents in ceramic materials: diatomaceous earth, glass and feldspar. Different ceramics consist of different ratios of these three materials, producing the different properties of each ceramic material.

Diatomaceous earth is basically fine particles of sedimentary rocks. As ceramics, they have a crystalline structure which is formed as the individual particles touch and stick together when heated; which is to say, they are sintered. Examples of ceramics with high levels of diatomaceous earth are pottery and earthenware. In dentistry, highly refined diatomaceous earth ceramics are referred to as metal oxide ceramics. Examples include zirconium dioxide and aluminium oxide. Because diatomaceous earth is crystalline, it tends to keep its structure when heated. A trade-off from having a crystalline structure is that the ceramic is invariably opaque because the light is diffused as it travels across the crystal boundaries (2).

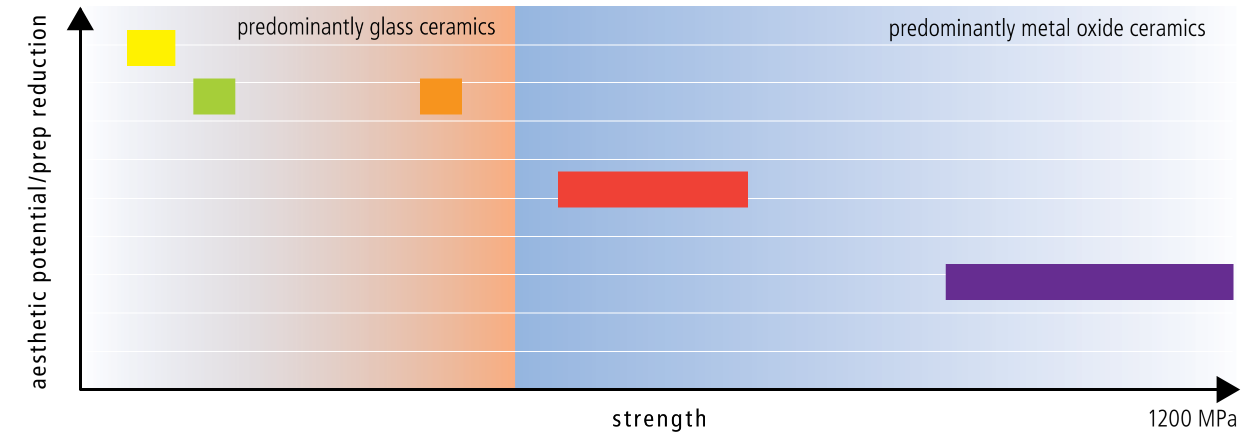
Glasses differ from diatomaceous earth in that they have an amorphous structure and they undergo a glass transition at a certain temperature where they will change from a hard brittle material into a soft gooey toffee. Glass will tend to lose its structure when it is heated above its glass transition temperature.

Because of the non-crystalline structure of glass, light tends to travel through the material without being diffused. This means that glasses tend to be transparent to some degree. Examples of glass are window glass, glass homeware, and in dentistry for the glaze on a crown. Glass is also a component of dental layering ceramics and glass-ceramic materials, such as leucite reinforced glass and lithium disilicate glass ceramic.

Feldspar has a very fine crystalline structure. It is formed of igneous rocks and is used as a flux in ceramics to lower the firing temperature (3) and act as a glass matrix to bond the other materials together. Examples of ceramics that use feldspar are porcelains and bone china.

In dental ceramics these three types of ceramic material are also used, albeit in a more refined form. Most dental ceramics will be a combination of two or three of these ceramic types but they tend to be formed predominantly of one type. There are generally two ways of classifying dental ceramics, either by micro-structure or processing technique. For simplicity the two classifications can be combined (with some exceptions) into feldspathic porcelains, glass ceramics and metal oxide ceramics (4).

Feldspathic porcelains are usually a mixture of feldspar and glass. The fine crystalline structure of the feldspar



- layered felspatic porcelin/layered nano-apatite glass ceramic: 50-100 MPa
- hot pressed/milled lucite reinforced glass: 120-160 MPa
- hot pressed/milled lithium discilicate glass ceramic: 360-400 MPa
- milled aluminium oxide (layered with >1 mm of 90 MPa layering ceramic): 500-700 MPa
- yttria-stabilised ziconic (layered with >1 mm of 90 MPa layering ceramic): 900-1200 MPa

gives a basic level of strength to the material, and with the glass many varying translucencies and colours can be created. This makes feldspathic porcelains perfect for highly aesthetic work where layering of complex colour schemes is required. It can also be veneered onto other materials such as metal or zirconia to make porcelain fused to metal or zirconia crowns. Feldspathic porcelains have a similar composition to some glass ceramics. In this classification we will separate them by construction technique and say that feldspatic porcelains are layered, like a sand castle, from wet ceramic sand and fired.

Indications: single unit thin veneers and partial crowns with high aesthetic requirements.

Glass ceramics are generally a glass which is reinforced with some form of metal oxide ceramic. Because a large part of these materials is amorphous and structureless glass, these materials are usually hot pressed into a mould or milled in a solid state.

The metal oxide ceramic reinforcement such as leucite or lithium disilicate increases the strength of glass ceramics while the glass matrix allows for the transmission of light and colour to be modified to match natural tooth tissue. Although these restorations are monolithic they can be layered with feldspathic porcelains or glazed to allow for variations of shade and effect. Glass ceramics therefore have the advantage of being both beautiful and somewhat strong.

Indications: single unit veneers, crowns and partial crowns, anterior 3-unit bridges and implant abutments.

Metal oxide ceramics are predominantly strong and opaque. Their polycrystalline matrix creates strength but tends to disrupt any light transmission. They must, therefore, always be layered with a feldspathic type layering ceramic to mask this opacity and create a translucent tooth-like restoration. Because of the non-aesthetic properties of metal oxide ceramics they require a large reduction during preparation, similar to PFMs.

Indications: single unit thick veneers, crowns, bridges and implant abutments.

The combination of two classification techniques, although simple, does result in a somewhat clumsy classification. For a more in detailed classification of ceramics please refer to reference 5.

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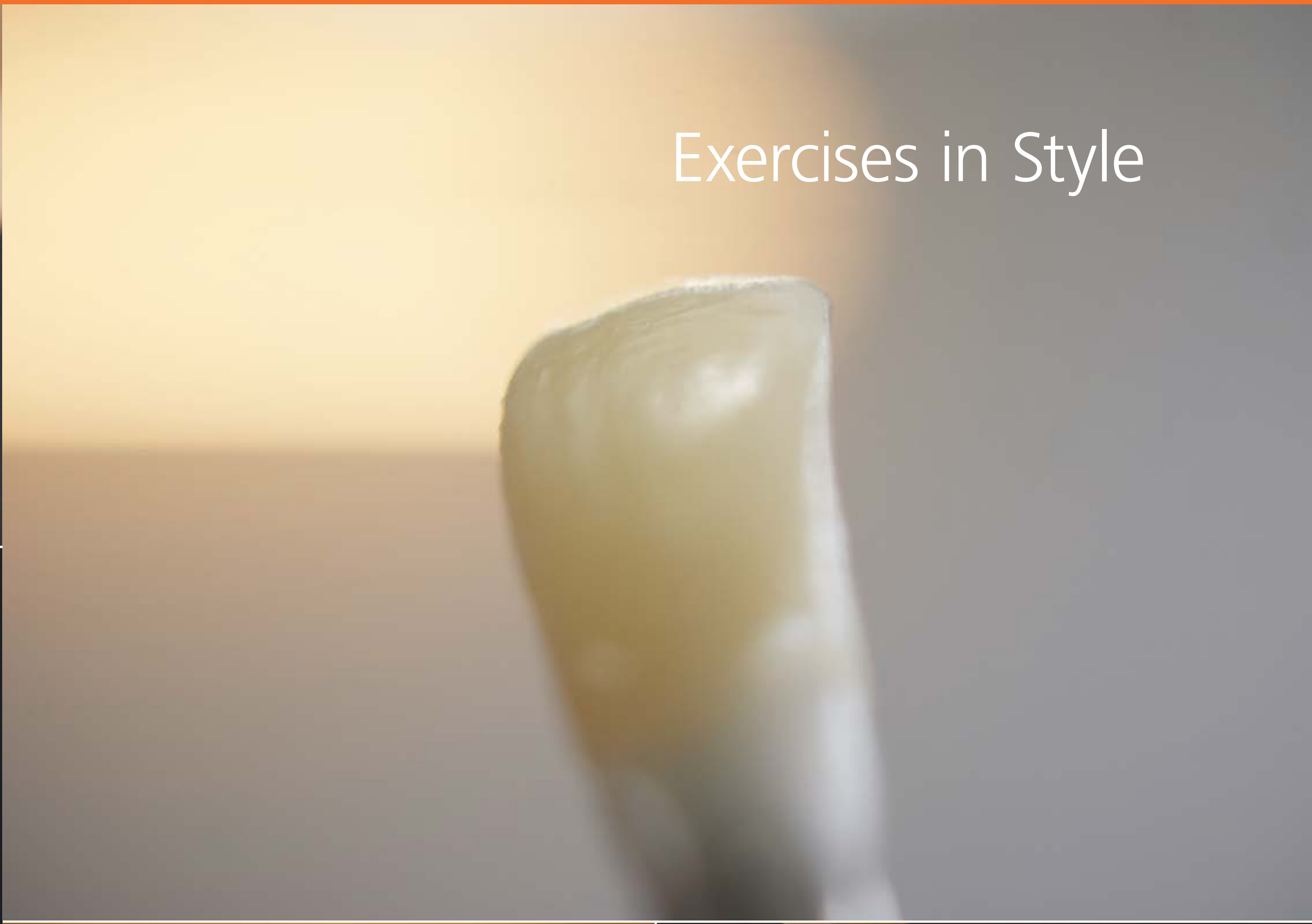
Exercises in Style



Part 2: E is for Awesome

An investigation of the IPS e.max system

So we have discussed how there are different ceramic materials, each with different properties. Some materials exhibit a high level of strength while others are more suited to aesthetic circumstances. We look through these materials and wonder 'how do we choose the right one?'

We can begin with an idea of what we have, then move towards a better way a step at a time. When starting on a journey, however, I think it is always important to have some idea of where you are trying to get – to start with the end in sight. With the idea of fixed prosthodontics it is relatively simple to conceptualise what we want to achieve. We want to make a tooth. The best material to use, therefore, would be natural tooth tissue laid down in the same way that tooth tissue is naturally laid down.

Although research is being done into growing replacement body parts, this is not currently in the scope of practice of a dental technician.

Because we cannot use natural tooth tissue we should use a material that emulates tooth tissue in as many respects as possible, in a manner in which it can become one with the remainder of the body.

It is not necessary for us to have only one material that does it all. It will always be important for the clinician and technician to select the materials based on the patient's situation.

As we examine natural teeth we begin to realise that from a mechanical, biological and aesthetic perspective these structures are simply very complex.

Porcelain-fused-to-metal (PFM) crowns were the aesthetic standard for larger restorations for decades. They use the affinity of ceramics to metal oxides to facilitate the metal reinforcing of feldspathic porcelain. Although this technique *does* produce a restorative option where previously there was little success, it does not come close to emulating natural tooth tissue.

From an aesthetic perspective, PFMs are constructed from a highly reflective/opaque metal coping which is coated in an opaque ceramic. These structures do not represent any structures in natural tooth tissue; and therefore produce, to describe it kinaesthetically, an anaesthetic result. The only way to produce a beautiful crown is to bury these structures deeply under an increasingly thick facade of aesthetic feldspathic porcelain, at the cost of natural tooth tissue. In the real world this is very rarely possible.

So we could say that we need a strong material with better aesthetics to support a layering ceramic. Such materials exist, such as zirconia and alumina. They allow some light transmission, have high strength and do not require opaque ceramic to cover them. However, they still do not look like any part of the tooth. Zirconia, with its stark white iridescence, can add a whole new dynamic to a crown and will become very obvious if it is allowed to come to the surface of a restoration. To work from this perspective is to try to work along a skill set we learnt from PFMs rather than to work towards our goal of making a natural tooth.

Lucite reinforced glass was a truly beautiful material for crowns. It relatively predictably produced a core that was available in different shades that represented the colours of dentine. Lucite reinforced glass, being much the same material as the layering feldspathic porcelain, could come


fig 1. Diagnostic Wax-up


fig. 2. Preparation with putty guide showing reduction


fig 3. Anatomical wax coping pattern


Fig 4. Putty guide showing anatomical cutback of coping


fig 5. Wax pressing pattern sprued on base former


fig 6. Investment ring burning out in burnout furnace

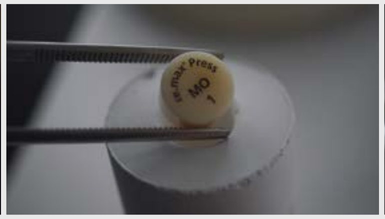


fig 7. IPS e.max Press MO1 ingot being place in investment ring


fig 8. Investment ring with plunger about to be plunged

all the way to the surface because it is optically similar to tooth tissue. Translucent, chromatic and finish-able.

Lithium disilicate is an evolution of this philosophy with increased strength leading to increased versatility. The common brand of lithium disilicate glass ceramics also has an extended palate: this means the ceramic (IPS e.max PRESS system, Ivoclar Vivadent, Schaan, Lichtenstein) can be used in increasingly diverse situations. As always, it is important to select the right material to use with any particular case. Because of the varied opacities and higher strength, there are several techniques in constructing lithium disilicate crowns; and as much as it is important to select the right material, it is also important to select the right technique.

Layered lithium disilicate technique

The layered technique uses a core of lithium disilicate and is layered with a nano fluorapatite glass ceramic. This technique is quite versatile and can be used with low translucency lithium disilicate ingots and must be used with medium opacity and high opacity ingots. With the more opaque ingots it is possible to block light from discoloured underlying tooth tissue, and with the low translucency ingots you can achieve a very natural translucent richness. The layering technique, of all the techniques, allows for the most individualisation and allows a skilled ceramist to place detailed internal effects. By creating the effects inside the teeth rather than on the surface, the tooth has a depth that creates similar optical anisotropic effects to natural teeth.

Materials and methods

Again, it is important to start with the end in mind. The first step in creating any restoration is to do the appropriate diagnostic work. In this case we have constructed a diagnostic wax up (figure 1). From the diagnostic wax up, putty guides were made and a preparation was created with 1mm buccal reduction at the middle third, increasing to 1.3mm at the incisal edge (figure 2).

On a working model a coping was formed in wax, using conventional crown and bridge waxing techniques, to a minimum thickness of 0.4mm (figure 3) with an anatomical cutback allowing for more layering ceramic towards the incisal edge on the labial (figure 4).

The wax pattern was sprued with a 3mm diameter wax wire and attached to a pressing base (figure 5). The investment powder (IPS PressVest Speed, Ivoclar Vivadent AG, Schaan, Liechtenstein) was mixed with a predetermined ratio of expansion liquid and water to reproduce an accurate fit, and poured into an investment ring containing the pattern.

The investment was allowed to bench set in the ring former for 30 minutes before it was removed and allowed to set for 5 more minutes.

fig 9. Working off sprues with grinding stones

fig 10. Completed coping on model

fig 11. Wet wash of ceramic on coping before first firing

fig 12. Internal staining before internal characterisation firing

fig 17. Third firing, effects, the cutback dentine with incisal halo effects OE3 + EProfundo

fig 18. Third firing, enamel layer, over contoured crown with enamel porcelains Ti1 +10% Tc and OE3

fig 19. Crown directly after third firing

fig 20. Fourth firing, correction with enamels Ti1 + 10% Tc and OE3

fig 13. Dusting wet characterization firing with Transparent Neutral

fig 14. Coping after first two firings

fig 15. Third firing, layering of the opacious dentine ODB2

fig 16. Third firing, translucent dentine layer built to full contour DB2

fig 21. Crown directly after the fourth firing with extended contacts

fig 22. Crown fitted down to model after the fourth firing

fig 23. crown during contouring

fig 24. Glazed and polished completed crown

Once set the investment was placed into a burn-out furnace, preheated to 850°C. The ring was placed in such a way that the wax from the pattern and sprues would flow from and burn out of the investment (figure 6).

The ring was allowed to burn out and heat soak for 45 minutes. An ingot of MO1 shade (figure 7) (IPS e.max Press, Ivoclar Vivadent AG, Schaan, Liechtenstein) was pressed into the investment in a pressing furnace (Austromat 644, Dekema Dental-Keramiköfen GmbH, Freilassing, Germany) over a 27 minute pressing cycle at 930°C with ~200N of force (figure 8). Once pressed, the investment was allowed to air cool.

The investment material was removed from the lithium disilicate coping by sandblasting with 50um glass beads (Sheraglanzstrahlperlen, Shera GmbH, Lemförde, Germany) at 0.3MPa pressure. A layer of ceramic that reacted with the investment was left behind on the pressing after devesting. To remove this the pressing was soaked in <1% hydrochloric acid in an ultrasonic cleaner for 10-30 minutes, and re-sandblasted with 110um aluminium oxide sand (Sheraaluminiumoxid, Shera GmbH, Lemförde, Germany) at 0.2MPa pressure.

The devested copings were removed from their sprues fitted down onto the dies and the sprues worked off (figures 9 and 10). The coping was thoroughly cleaned with steam, in preparation for application of layering ceramic (IPS e.max Ceram, Ivoclar Vivadent AG, Schaan, Liechtenstein).

The first layering firing was a wash firing. A very thin layer of layering ceramic, of shade deep dentine B2, was coated evenly over the copings surface. This was to create a strong bond between the lithium disilicate and the layering nano fluorapatite glass ceramic (figure 11). The wash firing was fired to 750°C over a 15 minute firing program in a ceramic firing furnace. (Austromat 644, Dekema Dental-Keramiköfen GmbH, Freilassing, Germany)

The second layering was a characterisation firing (figure 12). Stains are applied to the coping to correct the chroma and hue of the restoration. While the stains are still wet, the coping was dusted with a translucent ceramic, transparent neutral, to make an irregular surface (figure 13). This irregular surface helps to diffuse the light that reaches the coping rather than reflect it in straight lines. The characterisation firing is also fired at 750°C over 15 minutes (figure 14).

Now begins the layering proper with the first dentine firing. In this case we planned to do a very simple layering scheme to produce a simple Vita classic B2 shade.

An opacious dentine, deep dentine B2, was the first to be applied. This gives chroma to the crown and was used to check the translucency of the crown, and also to break the lines of the coping (figure 15). We layered on top of the opacious dentine a translucent dentine to the full contour of the final crown, being careful not to disturb the structure of the opacious dentine (figure 16). The dentine was cut back to produce the dentine cones and a dynamic surface for light reflection between translucent enamel and less translucent dentine.

In this layering we allowed for an effect of a very faint violet beneath the incisal edge. This was a mixture of opalescent porcelain, opal effect 1, and a violet stain, essence profundo (figure 17). The final layers are the enamels. In this case we used a transparent enamel, transpa enamel 1, with a little extra transparency mixed in, 10% transpa clear. On the marginal ridges we used opal effect 3 which is a slightly higher value enamel. This was layered oversize to allow for the shrinkage in firing (figure 18).

The crown was now removed from the model, the contacts supplemented, and fired at 750°C over a 14 minute firing cycle.

Figure 19 shows the crown directly after it had cooled from firing, and fitted down to the model. You can see the degree to which it has shrunk and rounded during the firing process. A second dentine firing was performed to correct for shrinkage with further enamel ceramics. The crown was re-fired at 745°C over 14 minute firing cycle (figure 20).

The crown, after the second dentine firing, would not go down onto the model, as the contacts had been supplemented to ensure solid inter-proximal contacts in the final restoration (figure 21). These need to be worked off (figure 22). The contours of the crown could now be analysed and adjusted with diamond burs as necessary. A surface texture was developed and the crown was ready to be glazed (figure 23).

The crown was wet with a glaze liquid and the shade was checked. Minor adjustments to chroma and value could be achieved at this stage with stains which were mixed with a glaze paste. The glaze firing was conducted at 725°C over 15 minutes.

To finish the crown, it was polished with rubber wheels, brushes and diamond polishing paste to develop the ideal surface lustre.

The finished crown could now be cleaned, checked, packed and shipped (figure 24).

Cutback technique

The cutback technique is a variation on the layered technique. It is only possible with low translucency ingots. These ingots have a similar effect to that of dentine porcelain, and come in various dentine shades. They are slightly more translucent than natural dentine and slightly less translucent than natural enamel. The low translucency lithium disilicate, therefore, appears similar to the cervical area of a tooth, where the enamel is thinner and the dentine closer to the surface.

Often the vivid noticeable effects are at the incisal third of the tooth where there is a thicker layer of translucent enamel. We want to layer this part of the tooth. The


fig 25. Wax pattern showing incisal cutback


fig 26. Pressed coping in shade LTB2


fig 27. Second firing, dentine layer DB2


fig 28. Second firing, dentine cut back


fig 33. Wax pattern for stain and glaze technique


fig 34. Pressing with HTB2 Ingot


fig 35. Working off crown


fig 36. Contoured crown on model


fig 29. Second firing, effects, the cutback dentine with incisal halo effects OE3 + EProfundo


fig 30. Crown after the second firing


fig 31. Worked of crown


fig 32. Finished cutback technique crown


fig 37. Stains on the ceramic palate ready to be applied


fig 38. Finished stain and glaze technique crown


fig 39. Three different techniques side by side: left – stain & glaze; middle – cutback; right – layered


fig 40. Three different techniques showing the different values that varying translucency can cause

cutback technique allows us to do minimal layering, create an aesthetic tooth and have a higher ratio of strong lithium disilicate to weaker layering ceramic.

This technique often helps us out of a jam when there is very minimal space, because in the cut back technique the cervical two thirds of the tooth require no layering at all.

Materials and methods

The process began in the same way as with the layering technique: with a diagnostic wax up. After the working model was prepared, the wax pattern was waxed up for pressing. For the cut back technique, the coping was designed to be at full contour, with a slight cut back in the incisal third (figure 25).

The same spruing, investing, pressing and devesting technique was used as with the layering technique, except this time a ‘dentine like’ low translucency LTB2 ingot was used (figure 26).

A wash firing was conducted on the areas of the coping where ceramic layering was intended, using a translucent dentine. If an internal characterisation stain is conducted it would be important to make sure that it does not cross any areas where the crown may be ground later, such as the junction of where the layering ceramic ends. Partially trimming off internal staining that reaches the surface is usually irreparable and produces a clumsy effect. In this case we chose not to do a characterisation firing.

The first dentine layering began with a translucent dentine. Because the low translucency B2 coping already contains plenty of chroma, we can avoid using an opacious dentine. Placing opacious material over translucent material is not usually recommended because it can create shadows. The dentine build up was conducted to full contour (figure 27) and cut back (figure 28) to create the internal structure of the incisal edge.

We can layer in a slightly violet effect to help with the creation of a halo (figure 29). The layering was finished with the same selection of enamels as used in the layered technique, and fired at 750°C over 14 minutes.

The fired crown can have the contacts worked off and be fitted down to the model (figure 30). With far less layering ceramic, there was far less shrinkage of the ceramic during firing. In this case, the crown could be worked off after the first dentine firing and no second dentine firing was required (figure 31). Should any correction be required to the shape or shade, it may be conducted now, with a second dentine firing. Minor adjustments were made to the shade with stains as required. The crown was selectivly glazed to try to maintain a similar texture on both the lithium disilicate and the nano fluorapatite glass ceramic. The crown’s surface was polished, to obtain the correct surface texture and lustre (figure 32).

The cutback crown is a technique to produce a strong anterior all ceramic crown that looks good and a technique that can be used to get the technician out of a tough spot when there is less than the ideal amount of space. The downside is the difficulty of producing a nice surface texture on lithium disilicate, and the glaze appearing differently on the layered and pressed ceramics. As translucency increases, value tends to drop, so it was important for us to take care of the value in these restorations.

Stain and glaze technique.

The stain and glaze technique creates the strongest crowns, but this strength has a trade-off, and potentially produces a lower aesthetic.

Materials and methods

Once more, we begin with a diagnostic wax up. The wax pattern for the pressing of a stain and glaze technique is an exact duplication of the diagnostic wax up: a beautiful full contour tooth form (figure 33). The full contour crown was pressed following the same technique as the two previous mentioned techniques: using a high translucency ingot HTB2 (figure 34). Ingot selection is important for full contour restorations, and depends largely on the amount of preparation reduction. Once devested, the crown was worked off, to obtain the right shape and surface texture (figures 35 and 36).

Stains were applied directly to the lithium disilicate surface to correct the shade and give some minimal characterisation (figure 37). This was then fired onto the crown at 770°C, over a 16 minute firing cycle (figure 38). A glaze could now be applied to increase the surface lustre. This was fired again at 770°C over 16 minutes. The crown was polished with rubber wheels, brushes and diamond polishing paste, to finish the crown.

The stain and glaze technique is a straight forward way of making a crown. This technique may be particularly useful for lower incisors (which can be quite thin), partial crowns and crowns on premolars where aesthetics are less important than strength. Because of their high translucency, they tend not to forgive opaque cements and discoloured preparation and the colour of these will effect the whole restoration. (Figures 39 and 40)

The selection of pressing ingots and construction techniques should be considered carefully when making a restoration. There are several important factors that come into play, and understanding these compromises is extremely important. We need a protocol that we can follow to help us in material and technique selection. The first step is to create precise and repeatable results. Then only can we strive towards truly accurate restorations.

Part 3: Protocols for Problems

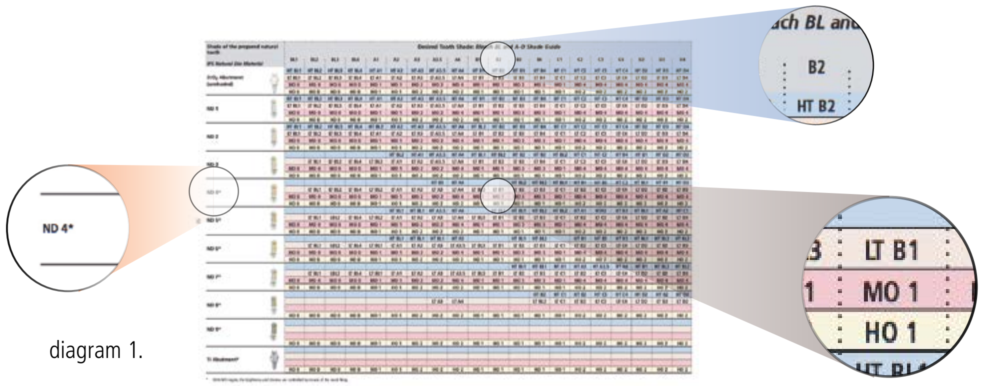


diagram 1.

As mentioned earlier, it is always important to select the right situation for a material. These articles have focused on lithium disilicate but do not cover mechanical characteristics, strength, fracture resistance, biocompatibility, recommended preparation designs nor clinical success rates. I encourage all readers to make themselves comfortable with the science behind every system they use through their own research (there are some links to manufacturers' recommendations at novodente.co.nz).

This section of the article is simply intended to illustrate several possible pitfalls with lithium disilicate ceramics that have been observed, based on a quote from an article in the International Journal of Periodontics and Restorative Dentistry (2006). In the article titled 'Optical behaviour of current ceramic systems', Raptis and Konstantinos et al describe:

> The overall optical behaviour of a permanently cemented all-ceramic restoration is dependent on three factors: 1, the underlying tooth structure, 2, the luting agent, 3, the structure of the ceramic material.

As each of these factors effect the appearance of a restoration they can be seen alone, but, for a successful result, if one of the factors is changed either one or both of the other factors must also be changed to continue to maintain a similar result.

1 The underlying tooth structure.

The underlying tooth structure is simply the appearance of the prepared tooth. The advantage of translucent ceramic materials is that they exhibit a life-like depth of colour. The light is able to interact dynamically with the underlying tooth structure. It is therefore a reasonable progression to say that underlying tooth structures with differing appearances will result in restorations with differing appearances. Consider, for example, a case where the preparation is severely discoloured (figure 1). With a translucent ceramic this discolouration is sure to come through the crown, leading to an undesired appearance. We have constructed a trial case to demonstrate this.

Trial 1

A die of a crown prep for a central incisor was selected. This die was digitally scanned and imported into 3Shape dental designer software. A coping was designed with a uniform thickness of 0.5mm. The coping was processed using using 3d printing CAM equipment to produce three identical copings in a burn-out wax-like material. The three copings were invested together and pressed, following the manufacturer's instructions, in Ivoclar e.max Press shade HTB2. The three identical copings' sprues were worked off with heatless stones, taking care to maintain an even thickness of 0.5mm.

Three shaded dies were constructed from IPS Natural Die Material (Ivoclar Vivadent, Schaan, Lichtenstein) by moulding a quantity of the material into the isolated copings and curing it under UV light. Three different shade dies were constructed: in ND1, ND4 and ND9. The dies were ground to a similar shape.

A cement try-in paste was applied to the insides of the copings (Variolink Veneer Try-in Medium shade, Ivoclar Vivadent, Schaan, Litchtenstein), to simulate a luting agent, and the copings were placed on different dies.

The dies and copings were placed in a photography lightbox with black card on the back and bottom. The otherwise dark

fig 1. Patient with a discoloured prep

fig 2. Three identical HTB2 copings on different natural die material dies to simulate different stump colours

fig 3. Four identical HTB2 copings on natural die material dies of shade ND1 with different cements

fig 4. Four different opacity ceramic materials on identical ND1 shade natural die material dies

box was lit from above with one 15watt 5500Kelvin 98CRI lamp, outside the lightbox. Photographs of the samples were taken using a tripod and appropriate exposure settings. One of these photos is reproduced in figure 2.

It is quite obvious to observe that with translucent ceramics, when the structure of the ceramic and luting material remain constant but the die material (simulating different preparation shades) is changed, the shade of the restoration is changed.

2. The luting agent

If a ceramic is translucent enough to have its colour changed by the prep underneath, it it is also reasonable to expect that the luting agent would have some effect. Lithium disilicate crowns may be luted by either being conventionally cemented with a glass ionomer cement or bonded with a resin cement. Due to this, and varying brands and philosophies, there are many different shades of luting agents.

Trial 2

Four copings were constructed using the same technique described in Trial 1, along with four corresponding natural die material dies, also constructed in the same way as Trial 1 except now all four are made with ND1 shade.

The copings were cemented onto their abutments with four different cements. The first with Variolink Veneer shade Low Value -3, the second with Variolink Veneer shade Medium, the third with Variolink Veneer shade high value +3 and the fourth with Kuraray Panavia F2.0 Opaque. Photographs were taken following the same procedure mentioned in Trial 1 (figure 3).

It is obvious from these photos that the luting agent has an effect on the final colour of the restoration. The left-most sample, with the Variolink Veneer -3, shows a higher chroma associated with the higher chroma cement. The third sample shows slightly more whiteness than the second sample. The three left samples all show a life-like level of translucency; the fourth sample uses an opaque cement. This cement drastically increases the value of the restoration and defeats the purpose of using a translucent restoration material.

Different studies have estimated the extent to which the colour of the luting material changes the colour of the final restoration. Some claim it can be from 10-15%, while others suggest it is less than 5% (1). These numbers are a little difficult to comprehend as it is likely that the influence of the luting ceramic will be reduced by thicker or more opaque ceramics and increased by thinner or more translucent ceramics.

3. The ceramic material

Each individual type of ceramic material has its own optical properties. Translucency, for example, is an important optical property to consider when selecting a ceramic material. On the one hand, more opaque core materials can create a safe compromise to use with discoloured stump shades, but when they are used over a vital stump with a good shade they can prove counterproductive.

On the other hand, too much translucency in a thick restoration can remove the dental technician's ability to control the value, resulting in grey-looking restorations. It is also important for the technician and clinician to consider bio-emulation, thinner restorations will need to be more translucent as they are replacing more translucent enamel materials and thicker restorations may need to have (and be able to get away with) a higher level of internal opacity matching the more opaque dentine structures.

As discussed in Part 1, one of the nice things about e.max lithium disilicate is the range of different translucencies for all requirements.

Trial 3

Four new coping patterns were produced following the same technique as described in Trial 1, except in this case

fig 5. Three B2 shade crowns constructed on different opacity core materials: left HTB2, middle LTB2, right MO1

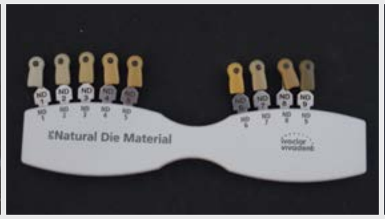


fig 6. Natural Die Material Shade guide from Ivoclar (please buy one)

fig 7. Ivoclar Vivadent Variolink Veneer shade guide, showing the different stages of cement in the system

fig 8. The 7 shades of Variolink Veneer cement

each of the copings were pressed in a different level of translucency. One coping in each shade: HTB2, LTB2, MO1 and HO1. According to the manufacturer's literature, each of these materials could be used to produce a restoration in the shade of Vita Classic B2 on a non-discoloured preparation.

Natural die material dies were also created in the same way as Trial 1, each in shade ND1. The copings were each placed on a natural die material die, with variolink veneer try-in paste medium to simulate cement.

Photographs were taken in the same manner as Trial 1 (figure 4).

It is obvious to see in these pictures that by varying the ceramic material, the appearance is changed.

In Part 1, we showed differing manufacturing techniques of lithium disilicate. Restorations that are created in each of these materials require slightly different techniques in construction.

If we place each of these completed crowns on ND1 natural dies, and take photos in the same way we can see that the restorations, although similar in colour, have slightly different appearances (figure 5).

On the left, the crown made with a stain and glaze technique on HTB2, appears to have a lower value than the other two restorations. It is transmitting light rather than reflecting it to the eye, making it appear greyer. On the right, the layered crown on an MO1 coping, appears to have a higher value than the other two restorations, especially in the cervical third. We took care to do some internal staining to prevent this at the beginning of construction. However, the relative opacity of the coping tends to reflect the light to the eye rather than transmitting it away, making it appear to have a higher value.

The crown in the middle, with a LTB2 cutback technique, appears somewhere in the middle of the crowns on either side.

So who, what, when, where, why, how?

How do we choose a cement? What do we do with discoloured tooth structure? And which coping material and technique do we use?

To answer these questions we need information. We need to know the colour of the prepared tooth. We need to know how the ceramic material will transmit this colour and we need to see how the cement will effect the restoration before cementation.

Protocol for deciding on the the correct combination.

Shade mapping is a very important step in selecting the combination of variants to be used. When we look at teeth, we can see that teeth will tend to exhibit more or less translucency in both the enamel and the dentine. At an in-lab shade mapping a technician can use a translucency guide to measure the translucency of the enamel. The technician, through close observation, can notice if the light tends to be reflected or transmitted at the dento-enamel complex and can determine how opaque the dentine appears. Where a shade is complex and varied, and in the aesthetic zone, a technician will tend to choose a layering technique so they can create the internal surfaces and structures of differing optical dentisties and colours, to produce a crown that appears identical to its natural counterpart.

An important stage of shade matching must occur in the dentist's surgery. A stump shade is simply the colour of the preparation, and it is *absolutely necessary* information for constructing a lithium disilicate crown. The shade of the preparation must be communicated objectively and accurately to the technician before any temporary restoration is fitted.

As darkened preparations can be significantly darker than the standard shades on, say, the Vita Classic shade guide, a stump shade guide is necessary. The natural die material shade guide (Ivoclar Vivadent, Schaan, Liechtenstein) is designed for this purpose (figure 6).

Photos of the preparation with the shade guides in the frame also assist the technician in determining the effect that the stump shade will have on the restoration. When taking photos of shade guides it is important to make sure they are touching the observed object, and in the same plane, so that both the tooth and the shade guide receive the same amount of light and are both the same distance from the lens.

If, when preparing the tooth, a darker stump shade is observed, it is important to consider that a more opaque restoration type requires more space to construct aesthetically, and therefore, more tooth reduction.

With the detailed and objectively communicated stump shade, the technician is able to use combination tables and their experience to determine the most ideal level of translucency of the material. For instance, in the IPS e.max system there is a combination table to guide in the selection of the lithium disilicate ingot to be used (diagram 1).

Only by knowing the exact stump shade and the final shade can this table be utilised. It is not sufficient to use subjective communication, such as 'yellow core' or 'dark stump'. But by using a more objective form of communication it become possible for the technician to have more certainty of how exactly the restorations will appear.

An accurate stump shade is useful in choosing the material but it is also useful when staining restorations and checking the colour before posting the job. As we know that what is under the crown will change the appearance of the crown it is not possible to check the colour of the restoration in the air or on the model because this will give a different shade to that in the mouth. For these parts of the laboratory procedure it is necessary to construct a stump replica. IPS Natural Die Material (Ivoclar Vivadent, Schaan, Licthenstein) (figure 7) is designed for this purpose and works well alongside the IPS Natural Die Material shade guide. By molding a measure of the correct shade into the crown and curing under UV light it is possible to anticipate how the crown will appear once cemented.

Cement selection is the final decision to be made in making restorations that integrate well in the oral environment. Once again, this article only considers the aesthetic elements of luting agent selection which should be considered alongside the other important considerations. We have seen earlier how opaque cements can drastically effect the bio-emulation of the restoration-prep system, and should therefore be avoided with translucent ceramics as a general rule.

All things being well, with the restoration and the shade appearing correct, at try-in, a neutral shaded translucent cement should be the first option.

When the shade is relativity close to the correct shade, and the restorations are of a thinner translucent type, it maybe possible to use the cement to slightly alter the overall shade of the restoration. To avoid the 'spray and pray' technique, it is useful for the clinician to have a way of visualising how the restoration will appear with any proposed luting agent.

Many resin cement systems have a variety of shades and try-in pastes. The clinician can apply the water-based try-in paste to the restoration to see how the restoration will appear once it has been cemented. For example, the Variolink veneer system (Ivoclar Vivadent, Schaan, Lichtenstein) has seven shades (figure 8): one neutral translucency shade, three shades designed to increase the value (to varying degrees, where, as the values increase, the transparency decreases) and three shades designed to lower the value (again, to varying degrees, which decrease in transparency as they darken (this is a light-cure-only cement, there are also duel-cure cements that follow a similar philosophy)).

Conclusion

Glass ceramics are a valuable tool in restorative dentistry where aesthetics are important. As with all systems, it is important to make sure that the correct protocols are followed to ensure excellent results. We have seen how the stump shade, ceramic materials, optical properties and cement selection are each interdependent. And we have discovered how, from a stump shade, we can select a ceramic material, and by trying in the restorations with try-in cement simulants we are able to correctly select a luting agent.

The real pleasure in creating beautiful restorations is in doing them right, doing them right the first time, by taking the required steps in: planning, test-driving, communication and construction. Now, as the final step is in sight, you can feel completely confident that this restoration will have a patient putting a smile on your face.

Reference:

1. Raptis NV, Michalakis KX, Hirayama H. Optical behaviour of current ceramic systems. The interntational journal of preiodontics and restoritive dentistry. 2006; 26 (1)

Technology and Toys

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