

Finishing and polishing porcelain surfaces chairside

Siobhan Owen,¹ David Reaney² and Philip Newsome³

Introduction

It is not uncommon for porcelain-fused-to-metal (PFM) and all-porcelain restorations to require adjustment to the ceramic occlusally, marginally or in the region of the contact area(s) prior to cementation.

A Clinical Research Associates study carried out in 2006 reported on the status of 226 ceramic three-unit bridges and found that, at cementation, 32% required no occlusal adjustment and of the remaining bridges that did require adjustment, 14% had 75% or more of the occlusal surface adjusted. This article looks at how best to deal with this common need to adjust porcelain surfaces clinically.

Restorative material

Ever since porcelain was introduced as a restorative material, it has been accepted that the best surface for porcelain is a high-gloss glaze, which is effective by sealing open pores in the porcelain surface (Figure 1). The smooth surface produced by such a glaze is widely regarded as having the following positive effects:

- Reduced wear of the opposing dentition (in comparison to unglazed porcelain)

- Improvement of oral function and mastication, since food slides more easily over the restoration surface
 - Facilitates oral hygiene procedures
 - Allows for a more aesthetic, light-reflecting restoration.
- Whenever this glazed surface is adjusted at the chairside and left in a rough state, the resulting coarse surface will likely lead to a variety of unwanted effects:
- Abrasive wear of the opposing dentition (Clayton 1970; Monasky, 1971)
 - Increased plaque accumulation, which in turn leads to inflammation of the adjacent soft tissues (Swartz 1957; Kawai, 2000)
 - Reduced restoration strength (Bessing, 1983).

For these reasons it has long been held that any adjusted surfaces should be reglazed prior to cementation for optimum longevity and smoothness (Barghi 1976; Newitter, 1982).

Christensen (2007) has even suggested adjusting the opposing dentition rather than the restoration in those cases where the amount of tooth adjustment required is minimal. He advocates warning the patient prior to the seating appointment that the teeth on the opposing arch may need to be smoothed and that minor adjustments can be made in opposing enamel without a problem.

This approach results in a restoration with the smooth, long-lasting glaze still intact.

Polished surfaces

It has been suggested, however, that surfaces polished after chairside adjustment may be as acceptable as those that are glazed and there are now many studies that endorse this view (Sulik, 1981; Klausner, 1982; Haywood,

¹ Siobhan Owen BDS is in private practice and is managing director of Southern Cross Dental Laboratories (Swindon, UK).

² David Reaney is in private practice in Moy, Co Tyrone, and is managing director of Southern Cross Dental Laboratories (Ireland).

³ Philip Newsome is associate professor at the Faculty of Dentistry, University of Hong Kong.



Figure 1a: Here upper and lower anterior veneers have been placed and yet gingival inflammation is restricted to two restorations where glazed surfaces have been damaged during finishing procedures.



Figure 1b: This inflammation began to resolve following careful and thorough re-polishing of the affected surfaces.

1988; Goldstein, 1989; Wiley, 1989; Raimondo, 1990; Scurria, 1994; Sarac, 2006).

It has also been suggested that there is an added advantage to polishing in that the fracture toughness of polished porcelain has been shown to be greater than that of glazed porcelain (Rosenstiel, 1989).

If all this is in fact the case then being able to polish adjusted porcelain restorations would make our lives as clinicians much easier, as we would not then have to put up with the inconvenience of having to continually be sending work back to the laboratory for reglazing.

However, there are studies that have come to the opposite conclusion, namely that currently available polishing systems cannot recreate a surface that is as smooth as the original glaze, Karan and Toroglu's 2008 is one such study.

In this study, three different types of porcelain, namely feldspathic (IPS d.sign, Ivoclar Vivadent), leucite-based (IPS Empress I, Ivoclar Vivadent) and lithia disilicate-based (Empress II, Ivoclar Vivadent), all had their final glaze disrupted by means of a 12-fluted tungsten carbide bur and polished by means of either:

- A porcelain polishing wheel (Cera Master, Shofu Dental) followed by a rubber cup and polishing paste (Ultra II, Shofu Dental)
- A series of course, medium, fine and extra-fine Sof-Lex discs (3M Espe), as recommended by the manufacturer.

The conclusion was that the final roughness of the polished ceramic surfaces was greater than that of the original, glazed surface. In other words, while abrasives can remove irregularities from the porcelain surface, the restoration cannot be returned to its original condition.

Interestingly, the differences among the three types of porcelain with respect to roughness after polishing were statistically insignificant, suggesting that it doesn't really matter which finishing system you use and on whatever type of porcelain, the end result will be pretty much the same.

The key question though is: how clinically significant are such research findings? Does it make any real difference whether the surface is glazed or polished after adjustment, as long as the resulting surface does not cause damage to the opposing dentition and does not increase plaque retention on the surface of the restoration?

Perhaps the most striking research finding in this respect is that of Jagger (1994), who found that while the rate of enamel wear produced by glazed and unglazed Vitadur porcelain was similar, polished porcelain produced substantially less enamel wear. This finding led the author to suggest that porcelain be polished instead of reglazed after chairside adjustment.

A broad view

Taking a broader view, such studies – see also Jagger (1995a), Jagger (1995b) and Hudson (1995) – illustrate the relative wear of all restorative materials and the importance of choosing the most appropriate materials for each particular case. What is clear is that however it is finished, porcelain is always likely to produce greater opposing tooth wear (Figure 2) than, say, amalgam, gold or composite, and in those cases where tooth wear is of concern, porcelain is unlikely to be the material of choice.

The most practical approach to adopt in the vast majority of clinical situations involving chairside adjustment of



Figure 2: The treatment plan for this patient was upper and lower full arch rehabilitation. The upper arch was completed using full coverage pressed ceramic crowns anteriorly. However, the patient failed to have the lower arch work carried out and returned to the dentist three years later, during which time considerable wear of the opposing lower teeth had taken place.

porcelain would therefore appear to be the use of one of the specifically designed polishing systems to return the ceramic surface to a clinically acceptable level of smoothness.

Similar refinishing may also be necessary following removal of orthodontic brackets bonded to ceramic restorations, a process that has been shown to disrupt the ceramic glaze and produce a rough surface (Karan, 2008).

Finishing and polishing

Jefferies (2007) has defined the various stages of finishing dental restorations as follows:

- Finishing – removing marginal irregularities, defining anatomic contours and smoothing away surface roughness of a restoration

- Polishing – carried out after finishing and aimed at removing minute scratches from the surface of the restoration to obtain a smooth, light-reflective lustre. The polishing process is also intended to produce a homogeneous surface with minimal microscopic scratches and defects.

Whatever the restorative material under consideration, the effectiveness of the finishing/polishing process is influenced by the following factors:

- Structure and mechanical properties of the substrate restorative material

- Difference in hardness between the abrasive and the substrate. Hardness is measured using Moh's hardness scale and, clearly, the greater the differential between the abrasive and the restorative material, the more abrasive the effect will be (see Table 1)

- Particle hardness, size and shape of the abrasive used

- Physical properties of the backing or bonding material used to carry the abrasive material (e.g. rigidity, elasticity, flexibility, thickness, softness, porosity)

- Speed and pressure at which the abrasive is applied to the substrate

- Lubrication during the application of the abrasive (e.g. water-soluble polymers, glycerol, silicon grease, petroleum jelly).

A selection of currently available ceramic finishing and polishing products is detailed in Table 2.

Table 1

The relative hardness of restorative materials and abrasive compounds (using Moh's hardness scale)

| | | |
|------------------------------|--------------------|---------|
| Restorative materials | Porcelain | 6 – 7 |
| | Gold alloys | 2.5 – 4 |
| | Resin composite | 5 – 7 |
| | Amalgam | 4 – 5 |
| Abrasive materials | Diamond | 10 |
| | Silicon carbide | 9 – 10 |
| | Tungsten carbide | 9 |
| | Aluminium oxide | 9 |
| | Zirconium silicate | 7 – 7.5 |
| | Pumice | 6 |

Table 2

Details of ceramic finishing and polishing systems currently available

| Manufacturer | System name | Delivery system |
|--|--|--|
| Axis www.axisdental.com | Chairside dental designer kit | Range of rotary diamond polishers |
| | DiaSheen polishing paste | Diamond polishing paste in fine, medium and coarse grits for use with stiff bristles or felt wheels |
| DiaSheen polishing paste | CeramiPro | Assorted polisher shapes, grits and sizes, ranging from gross trim (green), reduction and contour (blue) and pre-polish (pink). Finally, fine grit (grey) polishers to achieve final, high gloss, 'wet look' |
| | Dialite | |
| Dental Ventures of America www.dentalventures.com | Briteness | Diamond polishing paste for use as final polish |
| Ivoclar-Vivadent www.ivoclarvivadent.com | OptraFine | Diamond impregnated rubber discs, points and cups in two grits for chairside polishing of all IPS Empress restorations |
| Shofu www.shofu.com | CeraMaster Super-Snap buff disc Ultra II Diamond polishing paste | Range of bullet, knife, cup, mini-points and wheels. They use a blend of silicone and diamond particles. They range from CeraMaster Coarse (blue) through to CeraMaster (blue and white bands). Ultra II Diamond Polishing Paste, which comprises ultra-fine diamond particles, used with Super-Snap buff disc to create final polish. Also available, Super-Buff Set CA – aluminium oxide impregnated felt discs, for use without polishing pastes after first soaking in water |
| VH Technologies www.vhtechnologies.com | Diashine polish VH intra-oral brush range | Range of diamond grit polishes for use with soft brushes for final polish of ceramics |

Conclusion

Conventional wisdom holds that all adjusted porcelain surfaces should ideally be reglazed following chairside adjustment and prior to cementation.

Current research suggests, however, that this is not necessarily the case and that in most situations it is perfectly acceptable to finish and polish the adjusted restoration, provided that an appropriate polishing system designed specifically for the purpose is used.

References

Barghi N, Alexander L, Draugh RA (1976) When to glaze – an electron microscope study. *J Prosthet Dent* 35: 648-53
Bessing C, Wiktorsson A (1983) Comparison of two

different methods of polishing porcelain. *Scand J Dent Res* 91: 482-7

Christensen GJ (2007) Ask Dr Christensen. *Dental Economics* 97(4)

Clayton J, Green E (1970) Roughness of pontic materials and dental plaque. *J Prosthet Dent* 23: 407-11

Clinical Research Associates (2006) CRA Status Report: Zirconia vs. porcelain-fused-to-metal (PFM) clinical performance at 1 year. 1-4

Goldstein RE (1989) Finishing of composites and laminates. *Dent Clin North Am* 33: 305-18

Haywood VB, Heymann HO, Kusy RP, Whitley JQ, Andreus SB (1988) Polishing porcelain veneers: an SEM and specular reflectance analysis. *Dent Mater* 4: 116-21

- Hudson JD, Goldstein GR, Georgescu M (1995) Enamel wear caused by three different restorative materials. *J Prosthet Dent* 74: 647-54
- Jagger DC, Harrison A (1994) An in-vitro investigation into the wear effects of unglazed, glazed and polished porcelain on human enamel. *J Prosthet Dent* 72: 320-3
- Jagger DC, Harrison A (1995a) An in-vitro investigation into the wear effects of selected restorative materials on dentine. *J Oral Rehabil* 22: 349-54
- Jagger DC, Harrison A (1995b) An in-vitro investigation into the wear effects of selected restorative materials on enamel. *J Oral Rehabil* 22: 275-81
- Jefferies SR (2007) Abrasive finishing and polishing in restorative dentistry: a state-of-the-art review. *Dent Clin N Am* 51: 379-397
- Karan S, Toroglu MS (2008) Porcelain refinishing with two different polishing systems after orthodontic rebonding. *Angle Orthodontist* 78: 947-953
- Kaai K, Urano M, Ebisu S (2000) Effect of surface roughness of porcelain on adhesion of bacteria and their synthesising glucans. *J Prosthet Dent* 83: 664-7
- Klausner LH, Cartwright CB, Charbeneau GT (1982) Polished versus autoglazed porcelain surfaces. *J Prosthet Dent* 47: 157-62
- Monasky GE, Taylor DF (1971) Studies on wear of porcelain, enamel and gold. *J Prosthet Dent* 25: 299-306
- Newitter DA, Schlissel ER, Wolff MS (1982) An evaluation of adjustment and post adjustment finishing techniques on the surface of porcelain-bonded-to-metal crowns. *J Prosthet Dent* 48: 388-95
- Raimondo RL Jr, Richardson JT, Wiedner B (1990) Polished versus autoglazed dental porcelain. *J Prosthet Dent* 64: 553-7
- Rosenstiel SF, Baiker MA, Johnston WM (1989) A comparison of glazed and polished dental porcelain. *Int J Prosthodont* 2: 524-9
- Sarac D, Sarac YS, Yusbasioglu E, Bali S (2006) The effects of porcelain polishing systems on the colour and surface texture of feldspathic porcelain. *J Prosthet Dent* 96: 122-128
- Scurria MS, Powers JM (1994) Surface roughness of two polished ceramic materials. *J Prosthet Dent* 71: 174-7
- Sulik WD, Plekavich EJ (1981) Surface finishing of dental porcelain. *J Prosthet Dent* 46: 217-21
- Swartz ML, Phillips RW (1957) Comparison of bacterial accumulations on rough and smooth enamel surfaces. *J Periodontol* 28: 304-7
- Wiley MG (1989) Effects of porcelain on occluding surfaces of restored teeth. *J Prosthet Dent* 61: 133-7