Monolithic zirconia: a source of temporomandibular disorders in the future?

Background

Proven porcelain fused to metal restorations are increasingly being superceded by milled zirconia ones. Initially, in the 1960s the porcelain fused to metal crowns were quite resistant to abrasion which led to the "softer" opposing tooth showing significant signs of wear. Figure 1 shows such a case. The upper arch was restored with a fixed horseshoe shaped, porcelain fused to metal construction which occluded against a mixture of natural teeth and precious metal crowns. Over the subsequent years the patient had abraded his mandibular anterior teeth down to the level of the marginal gingivae. Latterly, the veneering porcelains have become "softer" so that such clinical cases are less often seen nowadays.

Occlusal surfaces milled from zirconia are considered to be very wear resistant [8, 11, 12]. This raises the issue of what are the consequences of such wear resistant materials on the cranio-mandibular system? Do they damage the temporomandibular joint (TMJ)? Do they trigger parafunctional habits? Do they result in wear of the occluding dentition? Presently, there is insufficient evidenced based research to answer these questions adequately, there being only a few in-vitro and in-vivo studies [4, 6, 7]. In-vitro studies have

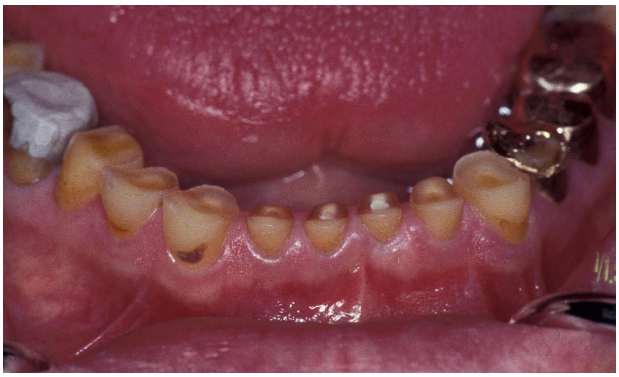

Figure 1 Lower jaw teeth with attrition down to the level of the marginal gingiva; antagonist: metal ceramic reconstruction

Figure 2 Monolithic zirconia restoration; crown 36 and 37 were occusally distal adjusted. Staining and gloss were removed. The surface was not polished after adjustment.

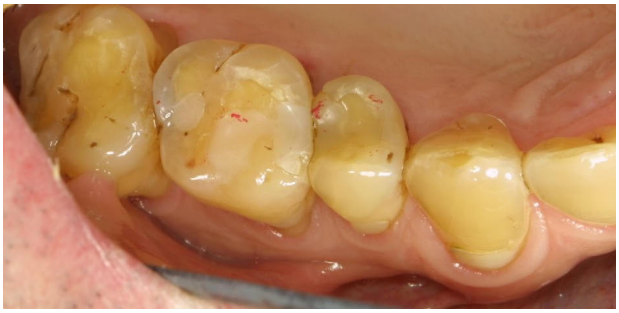

Figure 3 Antagonists to the fixed partial denture shown in Fig. 2; tooth 26 was occusally adjusted. The adjusted surface is very rough and unpolished.

Translation: Graham Wroe
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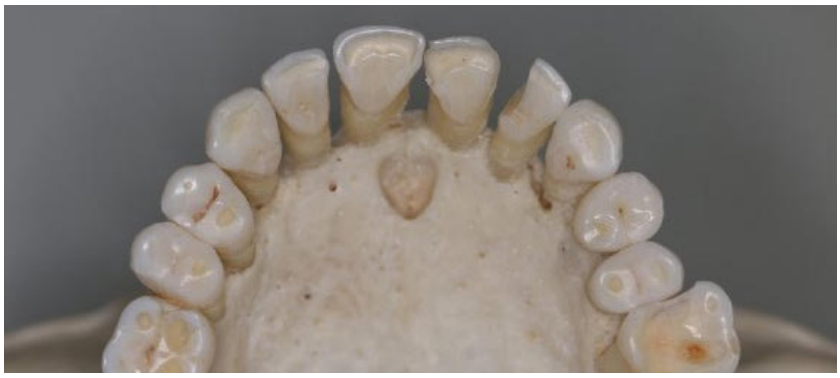

(Fig. 4a/4b: P. Proff)

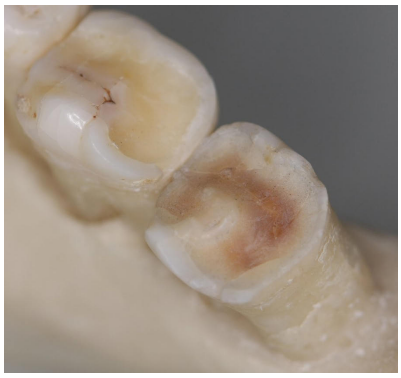

Figure 4a Example of a dental arch of elder patient with attrition of enamel and dentine

Figure 4b Teeth with attrition: no cusps are seen anymore.

(Fig. 1–3 and 5: M. Behr)

Figure 5 Tooth 46 is one of the first monolithic crowns. The other teeth had on the occlusal surface enamel or resin composite.

shown that highly polished zirconia surfaces will not "wear out" tooth enamel or other silicate based ceramics [8, 10]. However, this does not apply to rough, unpolished zirconia. This is often discovered, for example, after making occlusal grinding adjustments. Figures 2 and 3 show an example. Both the opposing teeth (Fig. 3) and the restoration (Fig. 2) have become severely abraded through use. All the outer surfaces were insufficiently polished after making grinding adjustments. The area of contact on the occluding tooth is badly worn down. In-vitro and as the first in-vivo studies demonstrate [3, 8, 11]: non or poorly polished zirconia surfaces can cause considerable abrasive damage to the opposing dentition. So, one of the basic tenets is that occlusal surfaces fabricated from zirconia must be highly polished.

Taking these factors into consideration the following question remains. What happens in the masticatory system to the position of the occlusal plane, when over the years natural wear results in one part of the dentition but not another? (Fig. 4a, Fig. 4b). In the 1950s Begg [1, 2] and Pedersen [9] studied the dentitions of Australian aborigines and eskimos and then compared them to people who had "western" lifestyles. The elderly from these indigenous groups had substantial wear of their teeth. The cusps and occlusal enamel were totally abraded and the remaining dentin surfaces had been ground flat in a circular manner. However, they had no gaps in their dental arches with periodontally closed, small papillary spaces and edge to edge bite relationships. Evidently, the masticatory system was able to adapt to a lifetime of hard tooth substance loss by compensation of the jaw bones and periodontium, the TMJs and also the muscles of mastication to prevent any occlusal dysfunction. In other words: The masticatory system is set up to cope with lifelong tooth wearing phenomena and to compensate for hard tooth substance loss. Of the components of this system, the bones, periodontium, muscles and associated fascia are all flexible elements, whereas once the permanent dentition is established this represents an inflexible non-adaptive component.

Against this background we must ask ourselves: How does the masticatory system respond over years/decades when occlusal surfaces are restored with abrasion resistant materials in the neighborhood of less wear resistant hard tooth substance or dental restoratives such as composite resins or silicates. Figure 5 shows a possible situation. Molar tooth 46 has been restored with a zirconia crown. The adjacent teeth have "softer" occlusal surfaces comprising composite fillings, enamel or dentin exposed surfaces. It must be anticipated that the occlusal level will bend or tilt depending on the position of the less malleable components. Overall, the interaction of the various factors such as stress, Angles classification, cranial morphology and the direction of muscle forces can over the years cause a temporomandibular dysfunction; or else the masticatory system is adaptible enough to accommodate the morphological dynamics and can correspondingly compensate for the resistant occlusal surfaces. The masticatory adaptations become even more difficult when implants are restored using milled zirconium dioxide crowns. Here the tactile feedback of the chewing forces cannot be compared to that of the periodontium.

Also implants are unable to "cushion" against occlusal loads or easily divert the direction of a force as is possible within a healthy periodontium.

There is no evidence for the frequently expressed view that a "hard" occlusal surface causes damage to the TMJ. A physiologically working TMJ functions with chewing forces in such a way that the articular surfaces can move freely without being loaded. Torque built up in the musculature around the condyles is such that the chewing forces are not transmitted directly into the articular fossae [5]. A bone thickness analysis of the skull demonstrates that the thickest part is anteriorly towards the articular eminence. Directly towards the brain the bone above the articular fossa is very thin. Nature would have formed our skulls otherwise, if when chewing our condyles were moving towards the cranium with any substantial forces. A TMJ having to function under high loads on its articular surfaces also couldn't perform the quick precise movements required for speaking or singing. Therefore the physiological functioning of the TMJ is more akin to a needle bearing rather than say to a roller bearing. If load triggering does not play a major role, then occlusal surface hardness is irrelevant. Indigenous populations also demonstrate the obvious compensation of the masticatory system due to the differences between the initially hard enamel and the subsequent exposure of softer dentin.

Statement

During occlusal reconstruction, it should be taken into account that every dentition will be subject to considerable abrasion throughout its lifespan. Therefore, when planning occlusal rehabilitations it is advisable to use materials whose wear characteristics are similar to those that were previously used in the oral cavity. It is currently difficult to estimate how the masticatory system will tolerate occlusal surfaces of vastly different abrasive resistances which lead to tipping and changes in the position of the bite plane. It follows that temporomandibular/masticatory dysfunction cannot then be excluded.

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(Photo: UKR)

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