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Storing Lesion-free Tooth Morphology for Biomorphic Dental Restoration Design

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Abstract

The goal of dental restoration is to restore and reconstruct the function, integrity, and morphology of missing tooth structures. At present, dental crowns are usually fabricated by referencing the homonym and adjacent teeth to design the morphology of the restoration, followed by empirical modifications on the restoration morphology. The original morphology of an intact natural tooth, if available, would allow for a balance of the horizontal and vertical forces generated by the surrounding tissues. Otherwise, it is hard for a restoration to reproduce the original tooth morphology. Discrepancies between original tooth morphology and restorations, such as axial over-contour or inappropriate occlusion, may break physiologically established balance, causing patient discomfort or even malocclusion and occlusal diseases. Therefore, to design and fabricate dental restorations with the original tooth morphology could be of great value to oral health. Literature indicates that physiological changes in tooth morphology slowly progress throughout one's life. We present a hypothetical biomorphic dental restoration design that records the intact tooth morphology of a patient before lesions occur to allow for future design and fabricate of dental restorations. Using a copy of the pre-existing tooth abutment for restoration could result in none or fewer adjustments needed for restoration, and harmony with the surrounding tissues.

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Dental restoration is an effective treatment to restore and reconstruct the function, integrity, and morphology of missing tooth structures. At present, technicians or dentists usually fabricate dental crowns by referencing the homonym and adjacent teeth to design the morphology of the restoration. Empirical modifications on the restoration morphology are then made. Thus, it is not surprising that discrepancy exists between the original tooth morphology and that of the restoration. Previous studies have shown that the occlusal surfaces of restorations are about 300 μm higher than the original surfaces (1), and the buccal or lingual surfaces of restorations tend to be over-contoured (2). As a result, chair-side adjustments are needed to minimize the discrepancies between the original tooth morphology and that of the dental restoration. But the adjustments are not that easy to perform. A study showed that insufficient occlusion was observed in about 25% of restorations after chair-side adjustments (3); chewing rhythm would be affected under such a situation (4).

Physiologically, the position of human teeth in the alveolar bone is vertically and horizontally guided by forces generated by the surrounding tissues until they are equal to each other (5). Obviously, the buccal and lingual surfaces of the teeth are critical to the horizontal forces generated by buccinators and tongue, while the occlusal surfaces of the teeth are critical to their vertical relationship with the opposing teeth. The changes of tooth morphology due to dental restoration, tooth decay, dental trauma, etc., may disturb the established balance. Although adaptive mechanisms could re-establish the balance, this process could last for a long time (6). Meanwhile, impaired masticatory efficiency would decrease the quality of life in effected patients. In addition, these restoration-associated adaptations sometimes cause malocclusion and occlusal diseases (7). Therefore, the key to solving this problem is how to best minimize the discrepancies between the original tooth morphology and that of the dental restoration.

Many researchers believe that adjusting the occlusal surfaces of the restorations under dynamic occlusion could remove occlusal interference and minimize discrepancies on occlusal surfaces. Mechanical articulators simulate mandibular movements by transferring hinge axis and recorded hinge movements using several parameters and are recommended (8). However, drawbacks include technique sensitivity and no consideration of the buccal/lingual surfaces are major concerns for this approach. Since the original tooth morphology is physiologically adapted for its function in the oral cavity, a practical solution would be to design and fabricate dental restorations with the original tooth morphology (9). However, it is usually hard to copy the original tooth morphology practically because of the existed lesions.

We present an opinion to use individual intact tooth morphology information digitally stored before lesions occur for future dental restoration design.

The opinion is based on two key points:

(1) Computer aided design and computer aided manufacturing (CAD/CAM) technology enables us to collect and store individual tooth morphology information with high precision and efficiency to aid in the design and fabrication of dental restorations.

(2) Physiological changes in tooth morphology slowly progress throughout one's life (10), which usually take couples of years (11).

We describe this hypothetical design as "biomorphic design". The biomorphic design first collects healthy individual tooth morphology and stores the information in an individual database using CAD/CAM. When pathological lesions are detected, the biomorphic design extracts the stored individual morphological information of the tooth to fabricate restoration using CAD/CAM copy mode (Fig. 1). Regarding to the second point mentioned above, the original tooth morphology should be similar to the intact tooth morphology collected right before lesions occur. As a result, the biomorphic design would result in none or fewer adjustments needed for restoration, and this

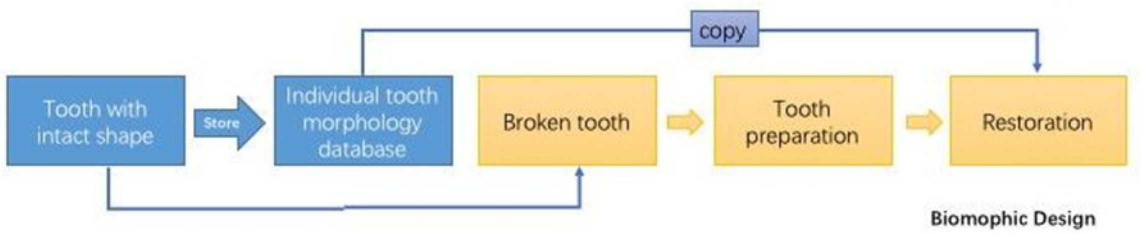

Figure 1. Flowchart of the biomorphic design procedure. Healthy intact tooth morphology is stored in the individual tooth morphology database for future use. When the tooth is broken, technicians can extract the stored tooth morphology with intact shape and copy it for biomorphic restoration design.

method would simplify restoration design procedures. In addition, chair-side time would be reduced and the harmony of the restorations with the surrounding tissues would be improved. On the other hand, the individual database of tooth morphology needs to update in a constant time period in case the tooth morphology differs significantly from the original tooth morphology of the tooth abutment.

However, the biomorphic design is not without limitations. It is suitable for patients with normal occlusion, but it could not be useful for patients with malocclusions or TMD, since the occlusal relationship needs to be adjusted for these patients. The application of the biomorphic design is limited to single crown or three-unit bridge, which accounts for the majority of daily clinical practice of fixed prosthesis. With the accumulation of experience, we expect such thresholds to be defined.

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References

1. Makino, S. , Okada, D. , Shin, C. , Oaura, R., Ikeda, M. , et al. (2013) J. Med. Dent. Sci. 60, 73-81.
2. Alhouri, N. , Watts, D. C. , Mccord, J. F. , Smith, P. W. (2004) Dent. Mater. 20, 893-899.
3. Qian, S. , Hui, W. , Chunlei, W. , Ying, L. , Yang, J. , et al. (2016) China. J. Conserv. Dent. 26, 86-90.
4. Watamoto, T. , Egusa, H. , Mizumori, T. , Yashiro, K. , Takada, K. , et al. (2008) J. Dent. 36, 984-992.
5. Dawson PE. (2007) Functional Occlusion: From TMJ to Smile Design, Mosby Inc. , St. Louis, MO
6. Sarrafpour, B. , Rungsiyakull, C. , Swain, M. , Li, Q. , Zoeliner, H. (2012) Arch. Oral. Biol. 57, 1070-1078.
7. Faggion, C. M. Jr. , Giannakopoulos, N. N. , Listl, S. (2011) J. Dent. 39, 108-116.
8. Mehl, A. (2012) Int. J. Comput. Dent. 15, 109-123.
9. Patel, D. (2016) Compend. Contin. Educ. Dent. 37, 126-130.
10. Van't Spijker, A. , Kreulen, C. M. , Bronkhorst, E. M. , Creugers, N. H. (2015) J. Dent. 43, 72-77.
11. Vervoorn-Vis, G. M. , Wetselaar, P. , Koutris, M. , Visscher, C. M. , Evalahti, M. , et al. (2015) J. Oral. Rehabil. 42, 600-604.