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Swirl marks on the internal surface of restorations during mill simulation: A pathway to catastrophic failures

KEYWORDS

CAD/CAM;
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Swirl marks

With CAD/CAM milling practices rising in popularity during the era of digital dentistry, the practitioner now has the ability to fabricate in-house restorations such as crowns and fixed dental prostheses. Today's intraoral optical scanners (IOS) have the ability to detect surface topography (roughness, waviness, and flatness) in detail, making them an accurate tool for digital impression making.^{1,2} After these scans are complete, a simulation of the proposed restoration is generated by the CAD/CAM computer system. At this point, the clinician can digitally edit the restoration's contours, contacts, and internal/external surfaces to produce an accurate digital model of the restoration to be sent for milling (Fig. 1A, B, C).

Most standard milling machines use a step bur and a cylinder-pointed bur to mill the internal and external surfaces of the restoration such as crown respectively.^{3,4} The cylinder-pointed bur has round end of 1.8 mm in diameter and the step bur has flat end of either 1 mm or 1.3 mm in diameter. This restricts the milling machines' ability to mill a restoration to the same accuracy of the digital impression. The result of this discrepancy is the excess removal of ceramic material from the intaglio surface of the restoration, which is vital for its success. This flaw is termed "overmilling" and is indicated by the presence of swirl marks on the internal surface of the digital prosthesis

generated by the CAD/CAM software during mill simulation step (Fig. 1D, E). If swirl marks are unnoticed by the practitioner and the restoration is sent to be milled, it will be more prone to fracture due to the thinning of material where the milling machine has overmilled (Fig. 1F). The chance of overmilling is especially higher with incisor teeth, which are tall and narrow.

To mitigate overmilling, clinicians must take a holistic approach when fabricating prosthesis with CAD/CAM techniques. This means the tooth preparation as well as the prosthesis fabrication must be considered when using this technology. If overmilling is suspected, clinicians can modify prepared tooth surfaces to ensure line angles are rounded and cusps are not too sharp/thin. This will reduce the milling machines likelihood of removing excess material when trying to compensate for its lack of milling accuracy caused by large bur size. Large burs can also be replaced with narrower alternatives, but narrower burs are more prone to bending, which results in inaccurate products. Prosthesis alteration by increasing the external thickness of material where it was lost due to overmilling can also be an option. While this compensating method may decrease the incidence of fracture it is not favored because it can alter occlusion and result in an esthetically compromised prosthesis.

While one may claim that overmilling discrepancies will be filled with a cement and provide the support needed for a successful prosthesis, there is no cement that is as strong as the material that was lost due to overmilling. This makes tooth preparation design and milling machine awareness critical for long-term restorative success. CAD/CAM technology offers clinicians a unique opportunity to experience the benefits of reduced overhead, increased predictability of outcomes, and the fabrication of same day prostheses if the clinician displays proficiency in its implementation.

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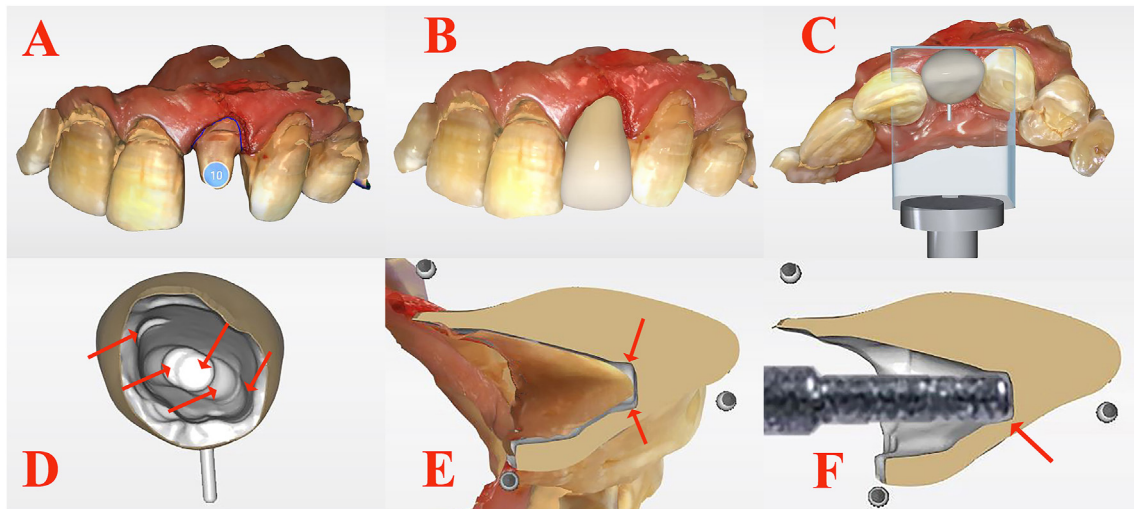


Figure 1 Digital impression of the prepared tooth (A). Digital design of proposed restoration (B, C). Swirl marks on the internal surface (D). Cross-sectional views of the prepared tooth, proposed restoration and overmilled areas (E, F).

As a conclusion, like all other innovative technologies, there is a learning curve for CAD/CAM restorations too, and it may be difficult to make the transition from an analog workflow to a digital workflow for some clinicians. Thus, it is imperative to emphasize that inexperienced dentists should attain comprehensive training and be familiar with all steps (image acquisition, digital design, and milling) before they attempt to execute this treatment modality to avoid costly complications.

Declaration of Competing Interest

The authors have no conflicts of interest relevant to this article.

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