Dental implants are susceptible to disease, and a brushing machine was used to reproducibly simulate both interproximal and subgingival plaque removal from peri-implant surfaces. Here, we developed a cost effective, fast and accurate way to measure the effectiveness of various oral hygiene products to maintain health of the implant and surrounding oral tissues using a 3D printed model system.

**Methods:** Digitalization of dentiform teeth and jaws provided the basis for 3D printed custom models. Simulated gingiva and genuine dental implants were incorporated into the design to simulate clinical relevance. Fabricated model teeth were analyzed for consistency of cusp heights, inter-cusp distance and mass. Mass was remeasured following water immersion. An artificial plaque substrate (APS) was applied to 3D printed and fabricated surface to ensure that consistent performance. A standard by which toothbrush mediated APS removal from the interproximal and subgingival areas was devised with varying brushing angle, force and toothbrush design.

**Results:** The 3D printed models had higher dimensional accuracy than the resolution of the 3D printer (0.0009-0.0020 mm). Immersion in water yielded an increase in mass that was correlated linearly with time ($r^2 = 0.9365$) and could be reversed upon desiccation. APS behaved similarly on the 3D printed surface as porcelin.

**Conclusions:** Lack of commercial available dental implants with accurate dental implant anatomy limited the ability to simulate implant systems in vitro. However, the advent of low-priced digital fabrication technologies enabled individuals to create such models rapidly and at low cost. We developed highly accurate, anatomically correct, 3D printed dental implant models, which mitigated flaws in extant designs and devised a high-throughput method for assessing in vitro plaque removal that is superior to existing methods. In the future, digital model files can be included in an electronic library for rapid manufacturing of identical models anywhere in the world.

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**Abstract**

**Objectives:** Currently, there is no consensus of how to best maintain dental implants. With over 2 million dental implants placed annually, there is an urgent need for objective ways to measure plaque removal from peri-implant surfaces. Here, we developed a cost effective, fast and accurate way to measure the effectiveness of various oral hygiene products to maintain health of the implant and surrounding oral tissues using a 3D printed model system.

**Methods:** Digitalization of dentiform teeth and jaws provided the basis for 3D printed custom models. Simulated gingiva and genuine dental implants were incorporated into the design to simulate clinical relevance. Fabricated model teeth were analyzed for consistency of cusp heights, inter-cusp distance and mass. Mass was remeasured following water immersion. An artificial plaque substrate (APS) was applied to 3D printed and fabricated surface to ensure that consistent performance. A standard by which toothbrush mediated APS removal from the interproximal and subgingival areas was devised with varying brushing angle, force and toothbrush design.

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