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Accuracy of Dental Procedures in Microgravity Is Comparable to Earth Conditions

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Objectives As humanity transitions towards long-duration spaceflight and extraterrestrial habitation, the long-term effects of microgravity become a significant concern. These effects can have deleterious impacts on the human body, including the oral cavity. The study aimed to build a simulated dental operator for a microgravity environment and use it to evaluate the accuracy of dental procedures.

Methods

Within SpaceDent project, three parabolic flights (Airbus-A310 Zero-G, Novespace, European Space Agency) were conducted with 90 microgravity intervals (duration=22s). A simulated dental operator (Fig. 1), conforming to standards for a microgravity environment was constructed, enabling simulated caries preparation and composite restoration placement in standardized cavities in artificial teeth of the phantom head. Senior dentistry student operators (n=2) performed preparations (n=72) and composite restoration (n=36) in different environments (n=3), namely ground (GND), microgravity (MIG), and steady flight (STF). The accuracy of preparation was evaluated by relative under- and over-preparation in relation to the area of simulated caries by computer-aided evaluation of 2D images. The accuracy of restoration was evaluated by volume of under- and over-fill in relation to original anatomy by computer-aided evaluation of 3D scans. Two-way ANOVA was used for statistical analysis.

Results No unexpected events occurred during experiments in all environments and all planned preparations and restorations were successfully completed as planned. For preparation accuracy, a significant difference was observed between operators, while there was no significant difference for environmental conditions ($p = .623$) or interaction ($p = .072$). For restoration accuracy, there was no statistically significant between operator ($p = .897$), environment ($p = .139$), and interaction ($p = .791$).

Conclusions Within the study's limitations, our simulated dental operator facilitates the performance of dental procedures in various environments. The results indicate that varying gravitational conditions do not significantly affect the accuracy of preparation and restoration procedures. However, differences between operators might be expected.