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3D Printing in Restorative Dentistry

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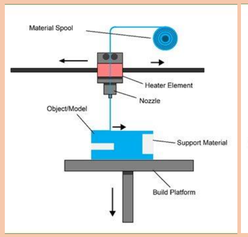
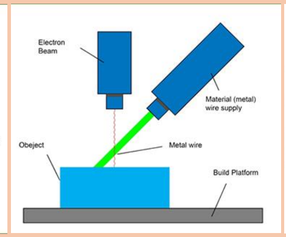
Objective

The term 3D printing is generally used to describe a manufacturing approach that builds objects one layer at a time, adding multiple layers to form an object. The presentation aims to provide a comprehensive understanding of the use of 3D printing technology in restorative dentistry and its potential impact on the field.

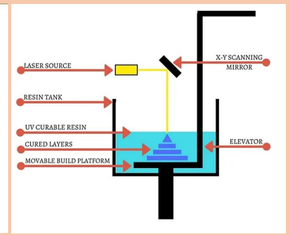
Types of 3D Printing Technologies



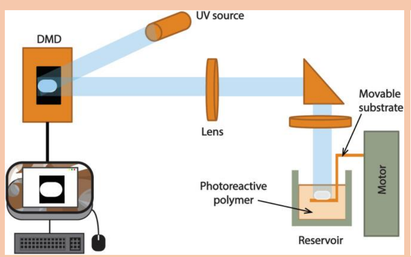
Fused Deposition Modeling (FDM)



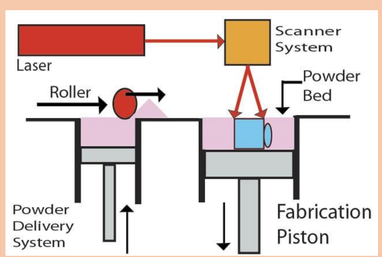
Directed Energy Deposition (DED)



Stereolithography (SLA)



Digital light processing (DLP)



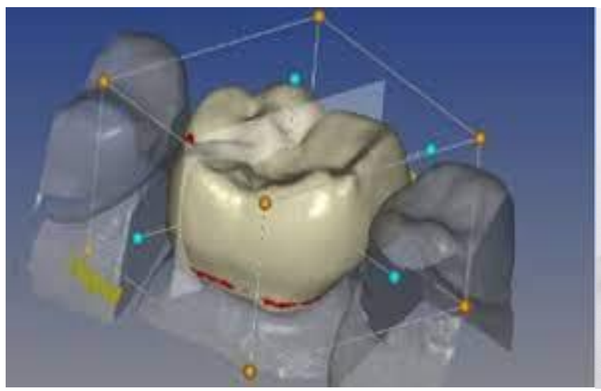
Selective Laser Sintering (SLS)

Single Tooth Crowns

1. **Direct Inkjet Printing of Crowns:** High accuracy with minimal material consumption. Strength and fracture toughness comparable to conventionally produced zirconia. (Ebert, 2009)
2. **Solid Freeform Fabrication of Porcelain Crowns:** “Green" model in 30 minutes with uniform shrinkage. Properties comparable to conventional materials. (Wang, 2006)
3. **Additive Manufacturing of Photopolymerized Resins:** Marginal, cervical and occlusal gaps differ with build angles. Angle of 150 or 180 degrees achieve the best fit. (Ryu, 2020)
4. **Laser Sintering of Metal Crowns:** Superior marginal fit but less accurate occlusal fit than CAD/CAM crowns (Tamac, 2014). Marginal and internal accuracy is comparable to conventional procedures (Quante, 2008).

Fixed Prostheses

1. **Comparison of SLS and Conventional Methods:** Better adapted at the margin ends compared to the conventional ones (Örtorp, 2011). Significantly better adaptation than the milled group using the Co-Cr framework (Pompa, 2015).
2. **Comparison of DMLS and Lost Wax Techniques:** Internal discrepancy was the highest in the DMLS group (159.5 µm), nearly double that in the lost wax technique (82 µm) (Kim, 2013).
3. **Effects of Layer Thickness on Marginal Discrepancy:** Significant discrepancy exists when using a 50 µm layer thickness compared to a 25 µm layer thickness. However, both methods were considered clinically acceptable. (Kaleli, 2020)
4. **Effect of Build Orientation and Layer Thickness:** Build orientation of 45 and 60 degrees are recommended for the fabrication of a prosthesis by 3D printing. Park et al. (2019)
5. **Dimensional Changes in Ceramics and Resins:** Printed prosthesis can shrink by a factor of 53.608% for a 3-unit bridge. (Chang, 2015)
6. **3D printing for provisional prosthesis:** 3D-printed provisional crown and FDP resin materials have superior mechanical properties, but inferior physical properties compared to CAD/CAM milled and other conventionally fabricated ones. Jain et al. (2022)



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for references and the original presentation!

3D printing dental composite resins with sustaining antibacterial

1. Adding Ag-HNT as an antibacterial agent into SLR.
2. Significantly improves the flexural property.
3. The curing performance is not affected.
4. Release Ag+ in saliva to have sustained antibacterial properties.

4D Printing

1. Fourth aspect is **time!**
2. Capacity to alter shape over time.
3. This technique can manufacture materials similar to the hard and soft natural tissues in dentistry.
4. Adapted to the stresses in the mouth cavity.

Limitations

1. Build speed and size of build space.
2. Printing Ceramics
3. Printers use photopolymers, limiting range of resins.
4. Need more data on 3D printed devices' behavior in oral cavity
5. Scarce data on biocompatibility, plaque formation, and elution behavior of 3D printed polymer materials