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Effect of Wall-Thickness on Fracture Resistance of 3D-Printed Zirconia Teeth H. Kobayashi¹, S. Rues², A. Tasaka¹, P. Rammelsberg², S. Yamashita¹, F. Schwindling³ ¹Department of Removable Partial Prosthodontics, Tokyo Dental College, Chiyoda, Tokyo, Japan, ²Department of Prosthodontics, Heidelberg University Hospital, Heidelberg, Germany, ³Department of Prosthetic Dentistry, Medical University Innsbruck, Innsbruck, Austria

Objectives The purpose of this study was to analyze how the wall thickness of 3D-printed hollow zirconia teeth affects the fracture resistance.

Methods Data sets for the different artificial teeth resembling a mandibular right first molar were created (Geomagic design X, 3D systems) with internal structure as hollow. The outer geometry was identical, and wall thicknesses of artificial teeth were 0.30 mm, 0.50 mm, 0.75 mm, and 1.00 mm, respectively. Twenty zirconia teeth were fabricated using a 3D printer (CeraFab 7500 Dental, Lithoz) for each group, and sintered before support removal. The artificial teeth were divided into subgroups of teeth which remained hollow (hollow teeth) or were filled with PMMA (filled teeth). After fracture load tests were performed, each artificial tooth was examined using a digital microscope and a SEM. ANOVA was used to compare the fracture resistance of the zirconia artificial teeth among the conditions, followed by pairwise Tukey tests. To compare fracture resistance between hollow and filled teeth within each wall thickness, t-test were applied. The significance level was $\alpha = 0.05$.

Results Fracture resistance of artificial zirconia teeth decreased significantly (P<0.001) with decreasing wall thickness. Mean fracture loads reached 500 N or higher values only for wall thicknesses of 0.75 mm and 1.00 mm. A resin filling of the crowns did only lead to a significantly improved fracture load for very thin walls. The microscopy and SEM observation showed that most of the occlusal surfaces of the hollow teeth were completely fractured, whereas all the fracture surfaces of the filled teeth were incompletely fractured.

Conclusions The wall thickness of 3D-printed hollow zirconia teeth affects the fracture resistance, and zirconia artificial teeth had sufficient fracture resistance for clinical use when the wall thickness is 0.75 mm or greater regardless of the presence of filling with resin.