ABSTRACT

Background: The development of refined, tougher, and stronger ceramic core materials in recent years has led to the wider use of new, strong all-ceramic systems based on oxide ceramics. Results from in-vitro studies investigating the use of oxide ceramics in shorter all-ceramic fixed partial dentures (FPDs) have been positive, but clinical studies and additional in-vitro studies are needed to confirm the advisability of such procedures. Aims: One aim of this thesis was to investigate whether alumina-based and zirconia-based material systems are adequate for use in shorter (≤ five-unit) FPDs and to evaluate the clinical results. Additional aims were to investigate how to achieve optimal fracture strength in an all-ceramic FPD by varying the try-in procedure, the cervical shape of the abutments, and the support of the FPD (abutment teeth or dental implants). The final aim was to compare the strength of a zirconia material system with that of an alumina equivalent with known long-term clinical performance. Materials and Methods: Two clinical studies investigating one alumina-based and one zirconia-based material system were performed. Twenty posterior, three-unit FPDs (glass-infiltrated alumina) were followed for 5 years and 20 three–five-unit FPDs (HIP zirconia) for 2 years. Long-term follow-ups were made after 11±1 (glass-infiltrated alumina) and 3 years (HIP zirconia). In three in-vitro studies, the following variables were investigated: 1a) the flexural strength of porcelain specimens depending on whether they were exposed to saliva before the glaze firing (n=20) or first after the glaze firing (n=20), 1b) the fracture strength of three-unit all-ceramic FPDs (glass-infiltrated alumina) supported by abutments prepared with cervical shoulder preparations (n=9) and abutments with cervical chamfer preparations (n=9), 2) the fracture strength of crowns (n=30) made of a zirconia material system (densely sintered zirconia) and of crowns (n=30) of an alumina material system (densely sintered alumina) that had undergone three different pre-treatment modalities (water storage only; water storage and cyclic pre-loading; water storage, cyclic pre-loading, and thermocycling), 3) the fracture strength of all-ceramic FPDs (densely sintered alumina) supported by simulated teeth (n=12) or by dental implants (n=12). Results: The success rate of the clinical alumina study was 90% after 5 years. Six (±1) years later (after a total of 11 ± 1 years), the success/survival rate was 65%. In the second
clinical study, the success rates of the 2- and 3-year follow-ups were 100%. In the three *in-vitro* studies, the following results were found: 1a) the mean flexural strength of the specimens in the group that was exposed to saliva first after glazing was significantly higher ($P < 0.001$) than that of the specimens in the group that was exposed to saliva before glazing, 1b) the FPDs luted on shoulder preparations resisted higher loads than the FPDs luted on chamfer preparations ($P = 0.051$), 2) total fractures were more frequent in the alumina than in the zirconia group ($P < 0.001$), 3) FPDs loaded on implants resisted higher loads (mean = 604 N, SD=184 N ) than FPDs loaded on abutment teeth (mean= 378 N, SD=152 N, $P = 0.003$).

**Conclusions:** This thesis justifies the use of shorter alumina- ($\leq$ three-unit) and zirconia-based ($\leq$ five-unit) FPDs as the clinical results are acceptable. The clinical performance of alumina is, however, not as good as that of comparable high-gold alloy based porcelain-fused-to-metal FPDs concerning fracture resistance. Within the limitations of the *in-vitro* studies: Saliva exposure of porcelain before glaze firing should be avoided to optimize the strength of the porcelain. Shoulder preparations can be beneficial for the strength of all-ceramic FPDs compared to chamfer preparations, as can support by dental implants compared to abutment teeth. The fracture mode of alumina crowns (total fractures) differs from that of zirconia crowns (veneer fractures), suggesting that the zirconia core is stronger than the alumina core.