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What's new for the clinician?
- Excerpts from and summaries of recently published papers

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Compiled and edited by V Yengopal

1. Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region

S Mühlemann, T Lakha, RE Jung, CH Hämmerle, GI Benic. Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region: 1-year results of a RCT. Clinical Oral Implants Research. 2020; Jun 19.

INTRODUCTION

Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region.

Different restoration materials are available for the fabrication of implant-supported single crowns. Porcelain-fused-to-metal (PFM) implant crowns are considered the gold standard presenting an estimated 5-year survival rate of 98.3%[1] However, fracture of the ceramic veneering is reported as the most frequent technical complication and this then leaves the metal exposed which is a problem aesthetically.

Ceramic materials for the fabrication of implant crowns has largely replaced PFM crowns as a treatment option but implant-supported all-ceramic crowns are known to exhibit a relatively high rate of technical complications. Both these crowns are made in dental laboratories. However, advances in dentistry has allowed for chairside construction of crown using CAD/CAM technology which has shown significant savings in costs and chairside time.

Monolithic zirconia restorations, manufactured exclusively by the CAD/CAM technology, have considerable advantages: they exhibit high flexural strength, require more conservative dental preparation, minimize wear on the antagonists, exhibit satisfactory aesthetics, require less laboratory time and fewer dental sessions, and as monolithic, they lack the unwanted complication of chipping.[1]

Their main disadvantage until a few years ago was their low aesthetic performance due to the inability to achieve satisfactory transparency. However, recent modifications in composition, structure, and fabrication methods have led to monolithic zirconia ceramics of superior translucency.

Mühlemann and colleagues (2020)[1] reported on a randomized controlled trial that sought to test whether CAD-CAM monolithic zirconia implant crowns show less technical complications as compared to PFM implant crowns in the molar region. The study hypothesis was that CAD-CAM monolithic zirconia implant crowns present a lower technical complication rate.

MATERIALS AND METHODS

This was a randomized controlled clinical trial with two parallel study groups involving seventy-six partially edentulous patients in need of a single implant-supported crown in at least one maxillary or mandibular molar site.

The subjects had to fulfill the following inclusion criteria: 18–80 years of age; In need of a single implant crown in the maxillary or mandibular molar region; Implant position allowing a screw-retention of the crown; Presence of an antagonist. Patients were excluded if they were pregnant; had a history of known or suspected non-compliance, drug or alcohol abuse; had a full-mouth plaque score (FMPS) >30%; smoked more than 15 cigarettes per day or had a history of temporomandibular disorders.

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Implant surgery among included patients were performed according to standard protocols and following the implant manufacturer's instructions for the placement of the implants. All sites received titanium–zirconium narrow diameter implants (Straumann® Standard Plus SLActive RN, Roxolid, 3.3 mm diameter).

Three to 6 months after implant placement, the implant impression was taken. At this time point, patients were randomly allocated to one of the treatment modalities according to a computer-generated randomization list. The test group received a monolithic zirconia crown (Lava Plus, 3M) bonded to a titanium base abutment (Straumann® RN Variobase with 1 mm mucosal height). Patients in the control group received PFM crown consisting of a gold abutment (Straumann® RN synOcta cast gold abutment) with castable high noble gold alloy and feldspathic veneering ceramic.

An intraoral scanner was used to take an impression of the quadrant with the implant and the scan body, of the opposing quadrant, and of the bite in maximal intercuspation. All crowns were fabricated by one experienced master dental technician. In the test group, Mono-ZrO2 crowns were fabricated using a laboratory-based CAD and an industrial CAM process. In case of a conventional impression, models were poured in dental stone. After at least 24 hr, a laboratory scanner was used for model scanning and further processing in the same CAD-CAM workflow.

In the control group, either the milled digital model or the conventional model was used for the fabrication of the PFM crown.

At a try-in appointment, all implant crowns were evaluated and if needed chairside adjustments were performed. Thereafter, the laboratory finalization of the Mono-ZrO2 crowns included polishing and staining procedures. The submucosal part of the crown was left unstained to keep a highly polished zirconia surface in contact with the peri-implant mucosa. The titanium base abutment was abraded applying air-borne particles of 50 µm aluminium oxide (Rocatec) from a distance of 1 cm for 15 s using 2.8 bar blast pressure The abutment and the crown were cleaned with ethanol and the bonding surfaces were treated with a primer. Subsequently, the crown was luted onto the abutment using a chemically curing composite cement (Multilink Hybrid Abutment). The laboratory finalization in the PFM crowns included veneering, glazing, and polishing procedures.

Each implant crown was screw-retained with the implant specific torque of 35 Ncm. The screw access hole was filled with Teflon tape and sealed with a composite filling (Filtek).

All patients were recalled for the baseline examination 1–2 weeks after crown insertion (BL) and 1 year later (1y-FU). For standardization purposes, two calibrated operators performed all clinical examinations. Prosthetic parameters were evaluated using modified USPHS (United States Public Health Service) criteria which included items such as patient satisfaction, ceramic fracture, abutment fracture, marginal fit, anatomical form, proximal contact, colour match and occlusal wear. All implant crowns were checked for further technical complications: abutment screw loosening, fracture of the abutment screw, fracture of the implant, and loss of the occlusal composite filling. Specifically, the Mono-ZrO2 crowns were controlled whether debonding of the crown from the abutment was detectable.

The total technical complication rate on the prosthetic level (primary outcome) included fracture of the veneering ceramic, fracture of the crown, fracture of the abutment, fracture of the abutment screw, loosening of the abutment screw, loss of the occlusal filling, and decementation.

Periodontal parameters were assessed at six sites around each study implant and the mesial and distal dentition. These included probing pocket depth (PPD), bleeding on probing score (BOP), plaque control record (PCR). The width of the keratinized mucosa (KM) was assessed at the mid buccal aspect of the study implant and the teeth mesially and distally. MBL changes were calculated from baseline to one year follow-up (BL to FU-1Y).

RESULTS

In total, 76 patients were included in this study. Of these, 39 patients (mean age 57.7 years; 17 females and 22 males) were in the Mono-ZrO2 group and 37 patients (mean age 56.4 years; 17 females and 20 males) in the PFM group.

At 1 year, 74 of the 76 patients attended the follow-up examination. No adverse events were recorded. One crown in each treatment group was lost due to loss of the implant. In the Mono-ZrO2 group, one implant fractured after 11 months, whereas in the PFM group one implant was lost without any signs of inflammation after 3 months. These failures yielded an implant/crown survival rate of 97.4% and 97.3%, respectively.

At the 1y-FU, in 4 PFM crowns a fracture of the veneering ceramic was detected (11.1%), whereas none of the Mono-ZrO2 crowns showed a ceramic fracture. All fractures in the PFM crowns were polishable. No further technical complications were observed. The difference in the total technical complication rate between the treatment groups was statistically significant ($p = .024$).

Patient satisfaction was high in both groups with no significant difference between treatment groups at BL ($p = .7$) and at the 1y-FU ($p = .26$). In the Mono-ZrO2 group, the anatomical form and the colour match as compared to the neighbouring dentition were significantly better rated for PFM crowns ($p = .005$ and $p = .0035$).

After 1 year, in 3 Mono-ZrO2 crown the mesial contact point was lost, whereas in one PFM crown the distal contact point was lost. In the same time period, the occlusal contact was lost in 4 Mono-ZrO2 crowns and in 6 PFM crowns. After 1 year of clinical service, significantly more occlusal wear was detected in the PFM crowns as compared to the Mono-ZrO2 crowns ($p = .02$).

No statistically significant difference was calculated for plaque control record (PCR) and bleeding on probing (BOP) between the Mono-ZrO2 group and the PFM group neither at baseline (BL) nor at one year follow-up (1y-FU). The mean change of probing pocket depth (PPD) and MBL after one year was not statistically different between treatment groups.

CONCLUSIONS

The researchers concluded that the short-term results of the present randomized controlled clinical trial suggest that monolithic zirconia crowns are a valuable alternative to PFM crowns for restoring single implants in the molar region.

Implications of practice

The clinical results of the present study showed that the use of monolithic zirconia for implant crowns in the posterior area eliminated the risk for ceramic fractures and consequently positively influenced the total technical complication rate after 1 year.

Reference

1. Mühlemann S, Lakha T, Jung RE, Hämmerle CH, Benic GI. Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region: 1-year results of a RCT. Clinical Oral Implants Research. 2020; Jun 19.

2. The effect of using a mobile application to improve oral hygiene among adolescents receiving fixed orthodontic treatment: A RCT

JF Scheerman, B van Meijel, P van Empelen, et al. The effect of using a mobile application ("WhiteTeeth") on improving oral hygiene: A randomized controlled trial. International Journal of Dental Hygiene. 2020; 18: 73-83

INTRODUCTION

Oral hygiene is an important factor controlled by the patient during orthodontic treatment, which can affect the quality and timing of the therapy. Previous studies have demonstrated a rapid decline in oral hygiene compliance after the initial bonding, and the appliance favours plaque accumulation and represents an obstruction to the hygiene procedures.[1]

Failure to practise good oral hygiene results in prolonged accumulation of biofilm (dental plaque), which potentially increases levels of cariogenic bacteria such as *Streptococcus mutans*. These produce acids that cause enamel demineralization.[1] As a result, many patients with fixed appliances have dental caries, specifically white-spot lesions, which can lead to aesthetic problems that potentially cancel out the beneficial effect of the orthodontic treatment.

To prevent the development and the progression of dental caries, orthodontic healthcare providers recommend their patients to adhere to a good oral hygiene regimen involving the use of fluoride-containing mouth rinses, toothpastes and varnishes.[1] However, adherence to these recommendations is low, and oral hygiene in adolescent orthodontic patients is often inadequate.[1] This indicates a need for interventions to improve oral health behaviour and oral hygiene in this special-risk population.

The high use and various features of mobile phones make them suitable for the delivery of health promotion programmes. As portable devices tend to be switched on and to remain with the owner throughout the day, they provide opportunities to bringing behavioural programmes into important real-life contexts involving people's decisions about their health and the barriers they encounter to behaviour change.[1] Currently there are over 500 apps on orthodontics across Android and Apple operating systems. Most of them have very simple functions and do little more than provide basic dental information. Despite the high number of orthodontic apps now available, very few apps have been evaluated for their effectiveness.

Scheerman and colleagues (2020)[1] from Netherlands developed the WhiteTeeth app, a mobile-delivered oral health promotion program for adolescents with fixed orthodontic appliances. This app provides oral health education and an automatic coaching programme intended to help users maintain good oral health behaviour and oral hygiene. Sheerman et al (2020)[1] reported on a randomized controlled trial that sought to evaluate the app's effectiveness on dental plaque and marginal bleeding (primary outcomes), and self-reported oral health behaviours and their psychosocial factors (secondary outcomes). They hypothesized that dental plaque and marginal gingival bleeding would be reduced more in participants who combined use of the app with usual care than in controls.

MATERIALS AND METHODS

This was a two-armed, parallel-group; single-blinded randomized controlled trial (RCT) that tested the effect of the WhiteTeeth app against a usual care group in 12- to 16-year-olds with fixed orthodontic appliances.

The study population consisted of adolescents with fixed orthodontic appliances visiting orthodontic clinics. All eligible adolescents were invited to participate by

their dental-care provider and were randomized into either the control or intervention group.

Those assigned to the control group received usual care, which consisted of routine oral health education and oral health instructions during their visits for orthodontic treatment.

Participants randomized to the intervention group were asked to download the WhiteTeeth application (app), which was available free of charge in the App Store and Google Play store and was locked with a login code. Each participant received a unique personal login code for the app. The app was designed on the basis of the Health Action Process Approach (HAPA) theory, which has been shown to be a useful approach to understanding the oral health behaviours of adolescents with fixed orthodontic appliances. Using behaviour change techniques (BCTs) that target the psychosocial factors outlined by the HAPA theory, the app focused mainly on improving oral health behaviour, and thereby reducing dental plaque levels and gingival bleeding.

An independent researcher gave brief instructions and information on how to use the app and on how to share their user data with the research team. Afterwards, the participants received an email containing these instructions and information.

Upon opening the app, participants were required to answer registration questions and to provide personal details on their oral health behaviour and their motivation for maintaining good oral health. The app used this information to create positive reinforcement and to provide feedback on the participants' oral health performance. During registration, the app asked participants to use disclosing tablets and to take a selfie of their teeth on which any dental plaque had been disclosed red.

Next, the app asked the participants to register the amount of plaque by clicking the disclosed areas on the selfie (BCT: self-monitoring of behavioural outcomes). After interpreting the amount of plaque on the basis of the number of clicks, the app provided tailored feedback on the basis both of this plaque assessment and of the answers to the registration questions on oral health procedures. This feedback was provided as positive reinforcement regarding participants' behaviour, as oral health education, and/or as instructions in short videos (BCT: providing information on health consequences and demonstrating the desired behaviour).

Next, the app invited the participants to set a particular goal regarding oral health behaviour (BCT: goal setting) and to formulate when and where they would perform the oral health behaviour (BCT: implementation intentions). The app provided an option for setting the time at which they wished to receive daily push notifications to remind them of their oral health behaviour tasks and then to monitor them (BCT: behavioural goal reminders).

Every day throughout the 12-week intervention period, push notifications were sent instructing users to enter whether or not they had accomplished their daily oral health behaviour tasks (BCT: self-monitoring of behaviour) and to remind them to use the brushing timer when brushing their teeth. As well as showing where and how to brush teeth as recommended, the timer showed the time elapsed during brushing (BCT: practical support). When users had completed brushing, the app provided positive reinforcement.

Each week, the app asked users to evaluate their dental plaque levels by following the same procedure as in the registration phase: using a disclosing tablet, taking a selfie of their teeth and clicking the disclosed areas on the selfie (BCT: self-monitoring of behavioural outcomes). On the basis of the information registered on the amount of plaque and of the activities reported daily over the previous week, the app concluded whether the user's goals had been attained. Users were then invited to adjust their goals. If they had failed to attain their goals, they were invited to formulate coping plans, that is, "if-then" plans specifying how they could deal with difficult situations (BCT: coping planning). For this purpose, the app contained volitional sheets, that is, sheets outlining pre-established difficult situations and solutions.

The outcome measures were collected through clinical assessments and self-administered digital questionnaires. At baseline (T0), and at 6 weeks (T1) and 12 weeks (T2) of follow-up, the data were collected before the orthodontic check-up.

The primary study outcomes were the amount of plaque and the total number of gingival bleeding sites in the incisors, canines and first premolars of the maxilla and mandible. The Al-Anezi and Harradine plaque index was used to measure the amount of plaque on the buccal surfaces. The buccal surfaces of the first premolars, canines and incisors were divided into four sites according to the position of the orthodontic bracket: mesial, distal, gingival and incisal to the bracket.

Each of the four sites of the buccal tooth surface was given a score ranging from 0 to 3, where 0 indicated the absence of dental plaque, 1 indicated no plaque visible but an accumulation of soft deposit on a probe when used to clean the surface, 2 indicated a moderate accumulation of soft deposit on the tooth that could be seen with the naked eye and 3 indicated an abundance of soft matter on the tooth.

For the analysis, the scores per site were summed to obtain a total score for the amount of dental plaque accumulation per patient. Higher scores indicated greater accumulation. The range was from 0 to 192 (16 elements*4 sites*3 scores). To explore the effect on the presence of plaque in the mesial, distal, gingival and incisal sites, the plaque scores were dichotomized, with 0 indicating the absence of dental plaque and 1 indicating the presence of dental plaque. The score for the number of sites covered with plaque ranged thus from 0 to 16 (16 elements) per site and from 0 to 64 per patient (16 elements*4 sites).

Gingival bleeding was assessed using the Bleeding on Marginal Probing Index (BOMP). The mesio-buccal, buc-

cal and disto-buccal sites of the buccal surfaces of the first premolar, canines and incisors were assessed to determine whether probing elicited marginal bleeding (score 1) or not (score 0). For the analysis, all scores were summed to obtain the total number of bleeding sites per patient (ranging from 0 to 48; 16 teeth * 3 sites). Higher scores indicate more gingival bleeding.

To ensure the reliability of the clinical measurements, the clinical examiners were trained and calibrated by an experienced examiner. The secondary study outcomes were self-reported oral health behaviours and their psychosocial factors (HAPA factors).

To measure these outcomes, a self-administered digital questionnaire containing questions with both single and multiple response items was used. The questionnaire included questions on the frequency of oral health behaviours with which the following were used: a toothbrush, an interproximal brush, a toothpick, mouth rinse and other dental aids (such as dental floss).

The weekly frequencies for the use of each of the dental aids or products were summed to obtain a total oral health behaviour score that ranged from 0 to 122.5. Higher scores indicate a higher frequency of oral health-related activities. Self-reported tooth-brushing frequency and tooth-brushing duration were measured on the basis of two open questions, that is, “In the last four weeks, how many times have you brushed your teeth per day?” and “How much time do you spend on brushing your teeth at a time?”

The following psychosocial factors - HAPA factors - were assessed: risk perception, action self-efficacy, intention, maintenance self-efficacy, recovery self-efficacy, action control, action planning, coping planning, social influences and outcome expectancies. Risk perception was assessed on 5-point scales ranging from “very low” (1) to “very high” (5). Coping planning and action planning were assessed on 4-point scales ranging from “no plan” (1) to “a very clear plan” (4). For the remaining variables, a 5-point scale was used, ranging from “totally disagree” (1) to “totally agree” (5).

The following variables were regarded as potential confounders or effect modifiers and collected at baseline: (a) age (in years) (b) sex (boy/girl); (c) level of education (primary education, prevocational education, senior general secondary or pre-university education); (d) cultural background; (e) smoking status (smoker or non-smoker); and (f) the number of times of exposure to the acids or sugars in foods and/or drinks between main meals (times per day). Orthodontic patient files also provided information on baseline covariates: (g) the type of orthodontic bracket used (e.g. self-ligating or conventional brackets) and (h) the treatment duration (in days).

App usage data and the usability of the app and the user’s perceptions of several components of the app were collected during the 12-week intervention period using a System Usability Scale (SUS). The SUS ranges from 0 to 10, with responses ranging from “strongly agree” to “strongly disagree.” A SUS score above 68 was considered to be above average.

RESULTS

132 of the 230 eligible adolescents with fixed orthodontic appliances agreed to participate (response rate 57%); they provided informed consent, attended baseline and were randomly assigned to one of the two experimental arms.

Five patients dropped out of the intervention group, and three patients dropped out of the control group. One patient in each group dropped out because their appliances had to be removed prematurely due to poor oral hygiene. The total number of participants who completed all three questionnaires was 121 (92%).

Between T0 (baseline) and T1 (6 weeks), the mean number of weeks (SD) between each appointment was 6.2 weeks (1.4) for the intervention group and 6.2 weeks (1.1) for the control group (P = .997). Between T1 (6 weeks) and T2 (12 weeks), it was 6.6 weeks (2.1) for the intervention group and 6.7 weeks (2.3) for the control group (P = .962).

Due to technical complications, occasional malfunctions meant that the user data - including selfies - were not always sent during the intervention period. For this reason, less user data were available than expected. But according to the user data we received, 40 participants (65%) sent their user’s data an average of 4.94 times (SD = 5.2) to a secure server owned by the Academic Centre for Dentistry Amsterdam.

After 6 weeks, most patients used the app less often. In total, reminders were set by seven participants for brushing, by nine participants for rinsing, by 16 for self-monitoring of behavioural tasks and by 11 for taking a selfie. During the intervention period, 20 participants used the brushing timer an average of 9.61 times (SD = 27.8). In total, 38 participants took at least one selfie with the app; the mean number of selfies taken per person was 6.63 (SD = 4.46).

Thirty-six participants entered action plans into the app, and seven used the volitional sheets to set a coping plan. Thirty-four participants watched at least once the video on dental plaque and/or on cleaning their teeth with a manual toothbrush, an electric toothbrush and/or interproximal brushes. Personal appearance and attractiveness (white teeth) were given as the commonest motives for cleaning their teeth. The mean SUS was 75 (range 0-100), which indicated a good score for usability.

At 6-week follow-up, the intervention effect on the total amount of dental plaque and the total sites covered with plaque was not significant. Nonetheless, at 12-week follow-up, the reductions in dental plaque accumulation and in the presence of dental plaque were significantly greater in patients in the intervention group than in the controls: while, on average, plaque was present on 62% of teeth in the intervention group, it was present on 73% of teeth in the control group.

Regarding the intervention effects on gingival bleeding, bleeding scores had improved more in participants in the intervention group than in controls at 6 weeks of

follow-up ($p<0.05$). At 12 weeks of follow-up, however, the intervention effect was no longer significant ($p>0.05$).

In terms of oral health behaviour, the only significant intervention effect was for fluoride use at the 6-week follow-up; it favoured the intervention group. No significant intervention effects were found for the oral health behaviour score, tooth-brushing (frequency and duration) and interproximal brush usage.

With regard to the psychosocial factors, significant adjusted effects were found for coping planning regarding tooth-brushing and intention towards fluoride mouth rinse use at both 6-week and 12-week follow-up. Although not significant, the scores on most psychosocial factors at 12-week follow-up were better in the intervention group than in the control group.

CONCLUSIONS

The results show that adolescents with fixed orthodontic appliances can be helped to improve their oral hygiene when usual care is combined with a mobile app that provides oral health education and automatic coaching.

Implications for practice

This trial has provided clear evidence of the benefits of using mobile apps as an adjunct to the usual oral hygiene methods to improve oral hygiene among adolescent orthodontic patients.

Reference

1. Scheerman JF, van Meijel B, van Empelen P, et al. The effect of using a mobile application ("WhiteTeeth") on improving oral hygiene: A randomized controlled trial. International Journal of Dental Hygiene. 2020; 18: 73-83

Do the CPD questionnaire on page 518

The Continuous Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

Online CPD in 6 Easy Steps

1. Go to the SADA website www.sada.co.za.
2. Log into the 'member only' section with your unique SADA username and password.
3. Select the CPD navigation tab.
4. Select the questionnaire that you wish to complete.
5. Enter your multiple choice answers. Please note that you have two attempts to obtain at least 70%.
6. View and print your CPD certificate.