# What's new for the clinician?

## Summaries of and excerpts from recently published papers

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**Compiled and edited by V Yengopal**

## 1. Direct versus indirect digitalisation for CAD/CAM fabricated all-ceramic restorations: a double-blinded, randomised clinical trial

**Ahrberg D, Lauer HC, Ahrberg M, Weigl P. Clin Oral Investig. 2016;20: 291-300**

As technology continues its exponential increase in applications for dentistry, computer-aided design and computer-aided manufacturing (CAD/CAM) is becoming a common feature in the dental office. The transformation of the clinical situation into a three-dimensional dataset in the production process of dental restorations via CAD/CAM technology can be achieved by direct or indirect digitalization.[1] Indirect extraoral digitalisation starts with a conventional impression that is processed to a gypsum cast and then digitalized in the dental laboratory whilst direct digitalisation does not require the use of an impression material and trays, leading to improved patient comfort and reduced technique sensitivity. Using intraoral scanners, an accurate digital record of the contours of the soft and hard tissues is possible, and a virtual, three-dimensional model is directly produced. This three-dimensional stereolithography file can then be transferred to an automated production device.

Although there have been advances in impression material technology in providing adequate stability and precision, factors such as impression technique, impression trays, mixing techniques and transportation have been found to significantly influence the accuracy of the impression which impacts on the marginal fit of the restoration.

A consensus exists among various authors that marginal openings below 120 µm are clinically acceptable.[1]

CAD/CAM systems were introduced to dentistry with the aim of automating the production and standardising the quality of dental restorations.[1] Moreover, CAD/CAM technology enables the use of new restorative materials, e.g., oxide ceramics such as yttria-stabilized zirconia, hybrid ceramics resin nano-ceramics, zirconia reinforced lithium silicate, and pre-sintered cobalt-chrome alloys, and also allows digital veneering workflow in the dental laboratory.

### ACRONYMS

**CAD/CAM:** computer-aided design and computer-aided manufacturing
**CAI:** computer-aided impression group
**CI:** conventional polyether impression group
**FDP:** Fixed Dental Prosthesis

Ahrberg and colleagues (2016)[1] reported on a randomized clinical trial that sought to assesses the clinical fit of CAD/CAM-generated zirconia frameworks of single crowns and three-unit FDPs after indirect and direct digitalisation, and compares the efficiency of the impression methods. Two null hypotheses were defined for this study. The first null hypothesis was that single crowns and three-unit FDPs with zirconia frameworks fabricated from direct (computer-aided impression group; CAI) and indirect digitalisation (conventional polyether impression group; CI) would show equal values for marginal and internal fit. The second null hypothesis was that no difference in working time would be found between the two methods.

### MATERIALS AND METHODS

This prospective, randomized clinical trial from Germany consisted of 25 patients (15 females and 10 males) who had indications for indirect restorations. Seventeen single all-ceramic zirconia crowns and eight three-unit all-ceramic zirconia FDPs were fabricated and selected for evaluation of the fit between the frameworks and the abutment teeth under clinical conditions.

The exclusion criteria were as follows: a periodontal screening index >2, poor oral hygiene, bruxism, patients under the age of 18, and polyether or adrenaline intolerance. Two dentists with CAD/CAM experience in a private practice

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were assigned to treat the patients. Both examiners had undergone training in intraoral scanning; however, one dentist dropped out shortly after the study began, because of a severe health condition, and was not replaced.

The clinical procedures were standardised for all patients. Prior to preparation, all patients received local anaesthesia. Preparation of the abutment teeth was performed with distinct chamfer finish lines, where the location of the finish lines was considered optimal at an equigingival or 0.5-mm subgingival level. Guidelines for abutment tooth preparation for all-ceramic reconstructions comprised a tapering of the axial walls by 6–10°, a circumferential reduction of the tooth between 1.2–1.5 mm, and an occlusal reduction of approximately 2 mm. All edges were rounded using Arkansas stones and polishers. Temporary restorations were fabricated using a Bis-GMA Composite (Protemp 4) and seated with a non-eugenol temporary cement (RelyX Temp).

Approximately one week after preparation, the patients returned for a second appointment. The teeth were prepared for impression with two retraction cords, sizes #0 and #1 (Ultrapak), soaked in aluminum sulphate liquid (ORBAT Sensitive). The retraction cords were placed in the sulcus; the size #0 cord remained in the sulcus during the entire impression-taking procedure, and the size #1 cord was removed prior to impression-taking to allow an accurate display of the preparation and surrounding soft tissues. The same retraction cord technique was used for both the computer-aided impression group (CAI) and the conventional polyether impression group (CI).

For each patient, the impression method was randomly allocated by a sealed envelope chosen by the patient, with both the patient and examiner blinded to the group allocation. To evaluate the efficiency of intraoral scanning versus the conventional impression technique, the total working time was recorded with a stopwatch, with each step involved in the impression procedure recorded individually. The working time was defined as that time required to achieve an impression which met the acceptance criteria. Impression retakes and rescans of missing areas were recorded as additional time.

Direct digitalization was done with the Lava Chairside Oral Scanner (Lava C.O.S.). To enable the scanner to detect intraoral surfaces, a thin layer of titanium dioxide powder (Lava Powder for Chairside Oral Scanner) was applied. The superiorly placed retraction cord was removed, and the abutment teeth were lightly powdered. Phase One of time recording began with the powdering.

The scanning protocol for single crowns involved a quadrant scan capturing the prepared tooth, the opposing quadrant, and the buccal aspect of these quadrants in the intercuspal position. For three-unit FDPs, the scanning protocol consisted of a full-arch scan of the prepared teeth, the opposing quadrants, and the left and right buccal aspects with the teeth in the intercuspal position. After powdering, Phase Two (computer aided-impression of the prepared teeth) and Phase Three (computer-aided impression of the opposing teeth) of time recording were initiated. Phase Four of time recording began at the start of the bite registration procedure.

In total, the beginning sequence occurred 11 times with the computer-aided impression and 14 times with the conventional impression method.

Real-time three-dimensional models were viewed on a flat screen monitor, and after the preparation was approved, the data were sent electronically to the manufacturer in the USA via wireless internet connection for digital post-processing.

Prior to impression-taking for the conventional impression group, metal stock trays were selected and individualized with silicone stops and either alginate or polyether adhesive. Phase One of time recording for conventional impressions occurred up to the moment that the tray adhesive was applied. For all these impressions, the polyether material Impregum Penta Soft (3M ) was used with a Pentamix machine following the monophase technique, making up Phase Two of time recording. Following Phases Three and Four of time recording, opposing impressions were taken using the alginate material, Palgat Plus (3M), and a bite registration was taken in maximum intercuspation using Protemp 4 (3M).

The impressions were disinfected, and the models were poured with type IV plaster. The stone models were digitalized indirectly with an extraoral scanner using active triangulation (Lava Scan ST) and zirconia copings were designed using Lava Design Software (CAD).

Presintered zirconia blanks, which were coloured with a colouring liquid according to each patient's tooth shade, were used in a five-axis milling unit (Lava CNC 500) to produce the frameworks. Following the milling procedure, the frameworks were sintered to a full density and adapted onto the master casts. The frameworks were tried in and the fit was evaluated. If corrections were necessary, they were done with a red ring diamond bur under constant water-cooling. The frameworks were then veneered by one experienced dental technician with IPS e.max Ceram (Ivoclar Vivadent). Then, two finished restorations were blinded with a three-digit code.

The third clinical appointment comprised a double-blinded try-in of the copings from both groups. Then, at the last clinical session, two restorations were tried in and assessed for clinical parameters including occlusion, proximal contact, and marginal contour. This stage was also double-blinded. Finally, the best fitting crown or FDP, produced either by digital or conventional workflow, was seated using RelyX Unicem (3M).

To document the marginal and internal discrepancy between the inner surface of the restoration and the abutment tooth surface, a replica technique was applied at the try-in appointment. Zirconia copings were filled with a light body silicone material (Express 2 Light Body Flow Quick), seated on the abutment teeth with finger pressure for 10 seconds, and then fixed with a cotton roll while the patient closed his/her mouth. After setting, the silicone material that adhered to the internal surface of the framework was removed together with the framework, and this was stabilized to the framework with a silicone material of a different colour (Express 2 Ultra-Light Body Quick). After setting, both silicone materials were simultaneously removed from each framework. Because of differences in finger pressure, three replicas were made for each framework to obtain repeatability.

The silicone replicas were cut with a sharp razor blade in both mesio-distal and bucco-lingual directions, resulting in four sections to be measured per abutment. All sample measurements were carried out by one examiner. Cross-sections were adjusted horizontally on modelling clay

(Plasteline clay) to obtain a parallel orientation to the microscope's plate and to achieve a rectangular observation angle. Replica film thickness was examined at mesial, distal, buccal, and lingual locations using a light microscope at ×66 optical magnification and a digital camera that was connected to a computer. For each cross-section, the following four landmarks were assessed: marginal gap, mid-axial wall, axio-occlusal transition, and centro-occlusal site.

## RESULTS

The mean for the marginal gap was 61.08 μm (±24.77 μm) for CAI compared with 70.40 μm (±28.87 μm) for CI, which was a statistically significant difference. The other mean values for CAI and CI, respectively, were as follows in micrometers (± standard deviation): 88.27 (±41.49) and 92.13 (±49.87) at the mid-axial wall; 144.78 (±46.23) and 155.60 (±55.77) at the axio-occlusal transition; and 155.57 (49.85) and 171.51 (±60.98) at the centro-occlusal site. The CAI group showed significantly lower values of internal fit at the centro-occlusal site.

A quadrant scan with a computer-aided impression was five minutes and six seconds more time efficient when compared with a conventional impression, and a full-arch scan was one minute and 34 seconds more efficient.

## CONCLUSIONS

The authors concluded that Zirconia frameworks of single crowns and three unit FDPs fabricated from computer-aided impressions demonstrated significantly better marginal fit than those fabricated from conventional impressions. Additionally, both Zirconia frameworks of single crowns and three unit FDPs fabricated from computer-aided and conventional impressions showed clinically acceptable marginal fit.

They also concluded that computer-aided impressions may be more time efficient for both quadrant scans and full-arch scans when compared with conventional impressions.

## IMPLICATIONS FOR PRACTICE

The benefits of direct digitisation techniques have been well demonstrated in this trial and should be especially useful for patients who gag easily or suffer from extreme discomfort during the impression taking process. Also direct digitization saves time and eliminates the impression taking and pouring process which is also subject to its own issues in terms of inaccuracies. In essence, as these digital systems become more developed, the argument for continuing with the older methods will make even less sense.

**Reference**

1. Ahrberg D, Lauer HC, Ahrberg M, Weigl P. Evaluation of fit and efficiency of CAD/CAM fabricated all-ceramic restorations based on direct and indirect digitalization: a double-blinded, randomized clinical trial. Clin Oral Investig. 2016;;20: 291-300.

# 2. A randomised clinical trial on the use of intermediate bonding on the retention of fissure sealants in children

**McCafferty J, O'Connell AC. Int J Paediatr Dent. 2016; 26: 110-5.**

The effectiveness of pit and fissure sealants in preventing caries in permanent molars has been proven beyond any doubt in a number of high quality trials and systematic reviews. Resin-based sealant materials are most commonly used and are regarded as the 'gold standard' for sealing pits and fissures. Their caries- preventive effect relies on the sealing of pits and fissures through micro-retention, created through tags after acid etching of enamel.[1] However, these are easily destroyed by saliva contamination, reducing micro-retention and consequently, the caries-preventive effect The preventive benefits and resin-based sealant retention are gained and maintained only as long as the sealants remain completely intact and bonded in place.[1]

Recently, studies have been done wherein bonding agents have been used to try an improve the retention rate of resin based sealants

McCafferty and O'Connell (2015) reported on a randomised clinical study that sought to compare the retention of fissure sealants on first permanent molar teeth and surfaces to determine whether the addition of an ethanol-based etch-and-rinse primer and adhesive system significantly improved sealant retention after one year. The effect of the participant's behaviour on the retention of the fissure sealants was also assessed.[1]

## MATERIALS AND METHODS

Healthy children aged 5–16 years were identified via routine assessment clinics and treatment planned for fissure sealants of first permanent molars. A randomised split-mouth design was used. Paired, fully erupted, maxillary or mandibular molars were selected for fissure sealants as they would be exposed to the same oral environment and similar occlusal forces. One trained operator together with a dental assistant performed treatment for all participants. The matching arch-paired first molars were randomly designated to receive a bonded sealant (study group) or a conventional sealant (control group). Randomisation of the arch, tooth, and bonding was carried out using a coin toss by the nursing assistant on the day of treatment. The type of sealant placed on each tooth was recorded on a data collection sheet. The behaviour of the child was scored and analysed at the end of treatment based on the four-point Frankl Behaviour Rating Scale where 1 was "Completely uncooperative, crying, very difficult to make any progress" and 4 was "Completely cooperative and even enjoys the experience".

The technique for placing each sealant was standardised. The pit and fissures of the tooth were air-dried for five seconds to remove saliva. Total etch (37% phosphoric acid) was applied to the pit and fissure surface of each tooth for 30 seconds. The etchant was removed using water, air, and high-volume suction until the tooth appeared frosted. Both the bonding and fissure sealant bottles were agitated for ten seconds before application. Teeth in the study group had a layer of ExciTE F bond applied to the pit and fissure surface of the tooth with a microbrush and air thinned to allow the adhesive penetrate the fissure anatomy. Helioseal was then immediately placed on the fissures on the tooth using the tip. The light cure tip was placed as close as possible to the tooth surface, and both materials were photocured for 40 seconds simultaneously. In the control group, teeth were etched and the fissure sealant placed and cured in the same way as described above, the only difference being that no bonding adhesive was used. Each sealant was checked for retention using a periodontal probe. No occlusal adjustment was performed. One year after placement, all sealants were reviewed by two blinded examiners.

At the review appointment, each pit and fissure had a visual and tactile assessment of retention of the sealant. The sealants were scored as intact, partially intact, or not intact for each surface (occlusal, palatal and buccal). Partially intact and missing sealants were grouped together during statistical analysis. The data were analysed using GraphPad InStat 3.0 statistical software. Fisher's exact test was performed with a significance level of $P < 0.05$.

## RESULTS

A total of 112 patients (56% male and 44% female) with 424 erupted first permanent molars (848 surfaces) participated in this study. The mean age was 8.3 years with a range of 5.1–15.5 years (median age 9 years). Nine patients with 32 fissure sealed first molars were lost to follow-up (four patients had emigrated and five patients failed to attend). The remaining 103 patients with 390 sealed first molars were reviewed at 12 months and included for statistical analysis. Ninety-two patients received fissure sealants on all four-first permanent molars, and 11 patients received two fissure sealants on paired first permanent molars. Excellent intra-examiner and inter-examiner agreement was achieved (Cohens kappa score of 0.81).

The results showed that the higher the participant's behaviour score (Frankl Behaviour Rating Scale), the greater the number of intact sealants recorded at 12 months ($P$=0.0001). The majority of children (94%) had a behaviour score of four and were very cooperative. Children with a behaviour score of three had lower sealant retention (67%), and the two participants with a behaviour score of two had only 25% sealants intact after one year.

At 12 months, more bonded sealants (92%) were intact compared with control sealants (79%) when all surfaces are combined (Fisher's exact test $P$ = 0.0005). No significant difference was noted for sealant retention on occlusal surfaces between the bonded (98%) and control sealants (93%) ($P$=0.08). Retention of sealants was lower on buccal or palatal surfaces than on occlusal fissures. There was a significant increase in the retention of bonded (92%) compared to conventional sealants (82%) on these surfaces ($P$ = 0.0005).

A difference in sealant retention was also noted between the dental arches. In the maxilla, the retention of the bonded sealants (96%) was significantly greater than the retention of conventional sealants (75%) ($P$ = 0.0001). Sealant retention on the occlusal surface of the maxillary molars was excellent, 100% for the bonded and 93% for the conventional sealants ($P$ = 0.03). The number of intact sealants on the palatal surfaces was significantly higher for the bonded group (95%) compared with the conventional group (75%) ($P$ = 0.0004). There was no significant difference in the retention rate of bonded and conventional sealants in mandibular molars, 89% and 84%, respectively ($P$ = 0.41). Sealant retention was high for mandibular occlusal surfaces for both bonded 97% and 92% conventional sealants. Use of bonding agent had no effect on retention of sealants on the buccal surfaces of the mandibular molars. The variables identified in this study that significantly impacted the retention of resin fissure sealants were the use of the intermediate bonding agent; surface of the tooth and the behaviour of the patient were identified via logistic regression analysis ($P$ = 0.0001).

## CONCLUSION

This study has shown that addition of an ethanol-based bonding agent significantly increases the retention of resin sealants on first permanent molars at 12 months on all surfaces ($P$ = 0.0005).

## IMPLICATIONS FOR PRACTICE

This study reinforces the knowledge that the patient's behaviour during the placement of fissure sealants significantly affects the retention of the sealants regardless of the additional bond layer ($P$ = 0.001). Clinicians should advise parents of the reduced preventive effect of sealants where behaviour has been uncooperative for sealant placement. This is one of the very first trials that has been done on this topic but the promising results suggest that resin composites can be more effective when they are placed along with a bonding agent.

**Reference**

1. McCafferty J, O'Connell AC. A randomised clinical trial on the use of intermediate bonding on the retention of fissure sealants in children. Int J Paediatr Dent. 2016; 26: 110-5.