Encode Protocol Versus Conventional Protocol for Single-Implant Restoration: A Prospective 2-Year Follow-Up Randomized Controlled Trial

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The Encode protocol for restoring single dental implants simplifies the implant impression technique by using a specially coded transmucosal healing abutment. It allows recording of the implant position without the removal of the healing abutment. This prospective randomized controlled clinical trial compares the 2-year clinical performance of the Encode and the conventional protocols for restoring single implants. A total of 47 implants were randomly allocated for restoration by the Encode (24 implants) and the conventional (23 implants) protocols. The implants were reviewed after 2 years to evaluate patient satisfaction, esthetics, prosthesis cleansability, mucosal health, bleeding on probing (BoP), metallic discoloration, probing pocket depth (PPD), marginal bone level (MBL), and quality of the proximal and occlusal contacts. In addition, all forms of complications were reported. Twenty Encode and 17 conventional implants were reviewed. The 2 protocols were comparable in all variables. A consistent increase of open proximal contacts was detected for the 2 protocols. Two Encode (10.0%) and 4 conventional (21.1%) crowns had screw loosening that was predominantly associated with cross-pins. This had led to the failure of 2 conventional crowns. Three Encode (15.0%) and 2 conventional (11.8%) crowns displayed ceramic chipping. The Encode and the conventional crowns had survival rates of 100.0% and 89.5%, respectively. From the biologic, prosthetic, and esthetic perspectives, the Encode and the conventional protocols provided a comparable clinical outcome over a 2-year duration.

Key Words: Encode, implant impressions, cross-pin screw, CAD/CAM, survival

INTRODUCTION

Since the introduction of oral implants, there have been several attempts to simplify the surgical and restorative aspects of implant treatment. This involves modifying the implant impression technique to reduce the clinical time while maintaining accuracy. Accurate implant impression is essential to precisely record the implant position in relation to surrounding hard and soft tissues.[1–3] The conventional impression technique for single implants involves removing the healing abutment and attaching an impression coping to the implant. Subsequently, an open-tray or closed-tray technique is used along with elastomeric impression materials to record implant position. Once the impression is completed, the healing abutment is reattached to the implant.[1–3]

In 2004, Biomet 3i (Palm Beach Gardens, Fla) introduced the Encode system, which simplifies implant impression with specially coded transmucosal healing abutments.[1] The occlusal surfaces of these abutments have grooves that serve as codes. A closed-tray impression is taken with elastomeric material without the removal of the healing abutment. On the master cast, the healing abutment codes can be read by an optical scanner to determine implant size, hex position, location, and the diameter of the implant.[2,3] Subsequently, individualized abutment with appropriate margin heights and emergence can be designed and milled using computer-aided design and computer-aided manufacturing (CAD/CAM). An implant analogue is placed within the master cast by robotic drilling and placement. The modified master cast and the milled abutment are shipped back to the dental technician for crown fabrication.[3,4] The key merit of the Encode protocol is avoiding the need to remove the healing abutment during the impression procedure. Fewer abutment swaps have been shown to prevent mechanical disruption of the mucosal barrier and prevent a more apical position of the connective tissue attachment.[5] As a result, the Encode impression technique is less invasive and more comfortable to patients than the conventional impression, especially when access is difficult or angulation of adjacent teeth/implants hinders the insertion of impression copings.[4] Further, the Encode impression technique is quicker and involves fewer clinical steps than the conven-

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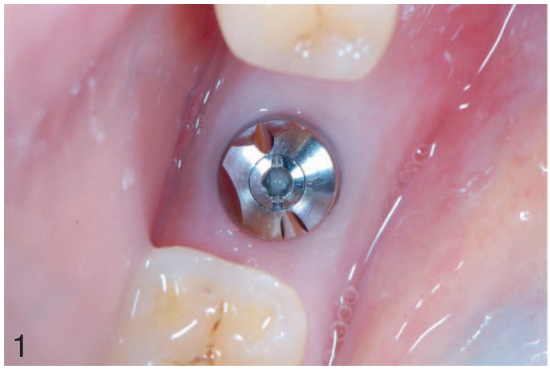
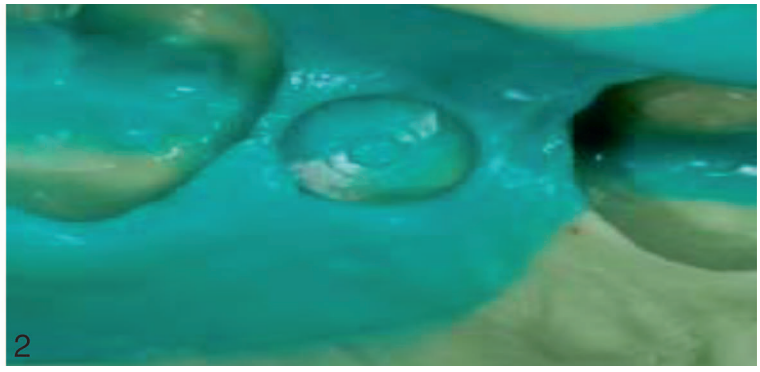




Figures 1 and 2. Figure 1. An example of the Encode healing abutment with grooves that serve as codes. **Figure 2.** An example of a closed-tray impression of the Encode healing abutment.

tional impression technique.[1,6,7] However, the Encode protocol is restricted to 3i implants and requires a healing abutment that extends 1 mm circumferentially above the soft tissues, which may cause esthetic problems in some patients.[3]

Currently, there is a limited number of studies that clinically compare the Encode and the conventional protocols for implant restoration. There have been several case reports with preliminary results indicating the potential of the Encode protocol to reduce clinical time and improve patient satisfaction.[1,3,8,9] To the best of our knowledge, this prospective randomized clinical trial is the first study on this topic. Initial results indicated the similarity between the 2 techniques in producing clinically accurate and satisfactory restorations.[6,7] The aim of this prospective study is to compare the 2-year clinical performance of the Encode and the conventional protocols. The study covers the biologic and prosthetic variables. The null hypothesis is that the 2 protocols are comparable clinically.

Materials and Methods

Participants

The trial was registered at the Australian New Zealand Clinical Trial registry (trial ID ACTRN12611000578909). The methodology and the statistical analyses were reviewed and confirmed by an independent statistician. All treatment was provided at the Royal Dental Hospital of Melbourne (Victoria, Australia), and the study was approved by the Human Research Ethics Committee of the University of Melbourne and Dental Health Services Victoria (No. 1034995.2). All patients were entitled to receive the treatment at the public sector. The study followed the criteria of the World Medical Association Declaration of Helsinki (2013). A plain language statement outlining the study details was given to each participant, and a written informed consent to participate in the study was obtained. Routine treatment was provided for patients who refused to participate in the study. At any time, the participants had the option to withdraw from the study. The authors followed the CONSORT guidelines for clinical studies.[10] The inclusion criteria were the requirements of single implants, minimum age of 18 years, minimum of 20 teeth in the mouth, and ability to tolerate implant surgery. The exclusion criteria were uncontrolled diabetes, history of head and neck radiation treatment, severe parafunction, metabolic bone diseases, pregnancy, active caries or periodontal disease, major bone grafting, or a smoking habit. A total of 47 Biomet implants (Osseotite Implant, Biomet 3i) were placed in 44 patients, with the implants randomly allocated to either the Encode group (24 implants) or the conventional group (23 implants). Power calculation was performed using G*Power software (version 3.1.9.2; University of Dusseldorf, Dusseldorf, Germany) with the assumptions of 80% statistical power and a 5% significance level. As a result, a minimum of 21 implants were required in each group. Three of the 44 participants received 2 implants. The surgical and restorative treatments were completed by a group of postgraduate students. The students were qualified dental practitioners undertaking the postgraduate diploma in clinical dentistry in the discipline of oral implants.

Treatment protocol

The detailed treatment protocol was discussed in an earlier publication.[6] In summary, implant placement followed either a 1- or 2-stage surgical protocol. All implants received Encode healing abutments, with at least 2 mm of height above the soft tissue at the time of implant placement or second-stage surgery (Figure 1). The implants were restored after 3 months of placement. The impressions for the Encode and the conventional groups were taken by a combination of light- and heavy-body polyvinyl siloxane impression materials (Aquasil, Dentply Caulk, Milford, Del). The Encode impressions were taken via a custom whole-arch closed tray, without removing the Encode healing abutment (Figure 2). The impressions for the conventional group were taken by a custom whole-arch open tray and implant-level impression copings. The impressions were poured with type IV dental stone. For the conventional impressions, implant replicas were fitted on the impression copings. All impressions were sent to a single commercial dental laboratory familiar with both protocols, and one dental technician fabricated all crowns. The definitive crowns were porcelain fused to metal crowns, fitted on abutments and retained by a cross-pin (lateral prosthetic screw) to ensure retrievability.[11]

For the Encode group, the poured casts were sent to the Biomet 3i scanning and milling center in Florida for scanning, CAD/CAM abutments fabrication, and implant replicas insertion within the casts. The milled abutments and the modified casts

were then received by the dental laboratory for the fabrication of the final crowns. For the conventional group, stock titanium abutments were attached to the implant replicas. Stock abutments were chosen for the conventional group to ensure comparable component numbers, retention mechanisms, and degree of fit to the Encode group. Most of the stock abutments required customization of the morphology and the margin location to enable ideal crown design. At the time of clinical insertion of the abutment and the crown, a standardized periapical radiograph was taken to confirm an accurate fit of the prosthesis and to record the baseline marginal bone level (MBL). The abutment screw was tightened to the manufacturer's recommended value, while the cross-pin was hand tightened.

Data collection

During crown insertion, the baseline proximal and occlusal contacts were recorded. Dental floss (Colgate Dental Ribbon, New York, NY) and foil shim stock (Coltene/Whaledent, Langenau, Germany) were used for the evaluation of proximal contacts. Ideal proximal contact allowed for resistance to flossing and shim stock placement. Tight proximal contact prevented passing of dental floss or shim stock, whereas open contact had no resistance to flossing or shim stock. The baseline occlusion was checked by shim stock, and the planned occlusion was to hold the shim stock during clenching. The occlusal contact was considered heavy if the shim stock was held after simple closure and received minor chairside adjustment. If the shim stock passed after clenching without resistance, the crown was considered out of occlusion. Any adjustment was considered minor if it was completed clinically and major if the restoration was returned to the laboratory. Every patient was reviewed after 1–4 weeks to evaluate patient satisfaction, esthetics, and probing pocket depth (PPD), to generate the baseline data for subsequent comparisons. The esthetics were evaluated by the patient and the clinician as acceptable or unacceptable according to the shade, shape, or a combination of both. Patient satisfaction was rated on a scale of 1–10 (10 being the highest). The PPD was measured in 6 sites around each implant crown (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual, and distolingual) using the Williams probe (Hu-Friedy MFG. Co. LLC, Chicago, Ill).

Patients were recalled for review and data collection after 1 and 2 years. Patient satisfaction, esthetics, biological outcomes, and prosthetic outcomes were documented. A standardized periapical radiograph was taken for each implant to evaluate the MBL and compare it against the baseline MBL. Patient satisfaction and esthetics were recorded as per the baseline visit. The following biological variables were reported: prosthesis cleansability, mucosal health (presence or absence of inflammation), bleeding on probing (BoP; present or absent), metallic discoloration (present or absent), PPD, and MBL. The PPD and MBL data of each year of review were compared against the baseline data. The quality of each proximal and occlusal contact was evaluated and rated as per baseline evaluation. All forms of biological and prosthetic complications were reported, and the survivals of implants and prostheses were calculated. This involved evaluation of crown stability and visual examination of the crown to evaluate ceramic fractures. Any required modifications were documented, with mild chairside adjustments considered to be minor and adjustments that required returning the crown to the laboratory considered to be major. The data collection was standardized by having the operator complete a questionnaire during each visit. To ensure consistency, the clinicians were calibrated prior to data collection, and they were supervised by an experienced clinician who was familiar with the trial protocol.

Statistics

Descriptive and statistical analyses were performed by SPSS statistics software (SPSS for Windows, version 23, SPSS Inc, Chicago, Ill). The normality of the data was evaluated by the Shapiro-Wilk test. If the data were not normally distributed, the Mann-Whitney *U* test was used to compare continuous variables (patient satisfaction, PPD, and MBL changes). The chi-square test was used to compare the categorical variables (cleansability, mucosal health, BoP, metallic discoloration, proximal contacts, and occlusion). The level of significance was set at .05 for all tests.

Results

One early implant failure had occurred for the conventional group prior to restoration and was excluded from the study. Two conventional implant restorations failed before the 2-year review and were subsequently excluded from the analysis. However, they were used to calculate the prosthesis survival. Five patients with 7 implants were not able to attend the 2-year review (4 Encode and 3 conventional implants). Therefore, from the 47 implants, 37 implants were reviewed (78.7% recall rate of the implants; Figure 3). Twenty implants were restored according to the Encode protocol, and 17 implants were restored conventionally. Because all of the restored implants maintained osseointegration following restoration, the 2-year implant survival rate was 100.0%. For the 2 protocols, the 2-year prosthesis survival rate was 94.9%.

Patient satisfaction and esthetics

At baseline and at the 2-year review, all restorations were rated as esthetically acceptable by patients. At baseline, mean patient satisfaction was 9.0 $\pm$ 1.4 for the Encode group and 9.5 $\pm$ 1.5 for the conventional group. After 2 years, the mean Encode patient satisfaction was 9.0 $\pm$ 2.1 and 9.0 $\pm$ 1.2 for the conventional group. Patient satisfaction for the 2 groups was statistically similar ($P = .14$).

Biological factors

All of the crowns were cleansable, as all of the reviewed patients were able to maintain an appropriate hygiene level around the implant crowns. All implants from both groups had healthy peri-implant tissues, with the exception of 1 crown within the conventional group that displayed mucosal redness (5.9%). No significant difference was observed between the groups ($P = .46$). Peri-implant tissues of 18 crowns presented with BoP. This involved 9 Encode crowns (45.0%) and 9 conventional crowns (52.9%). The 2 groups were statistically

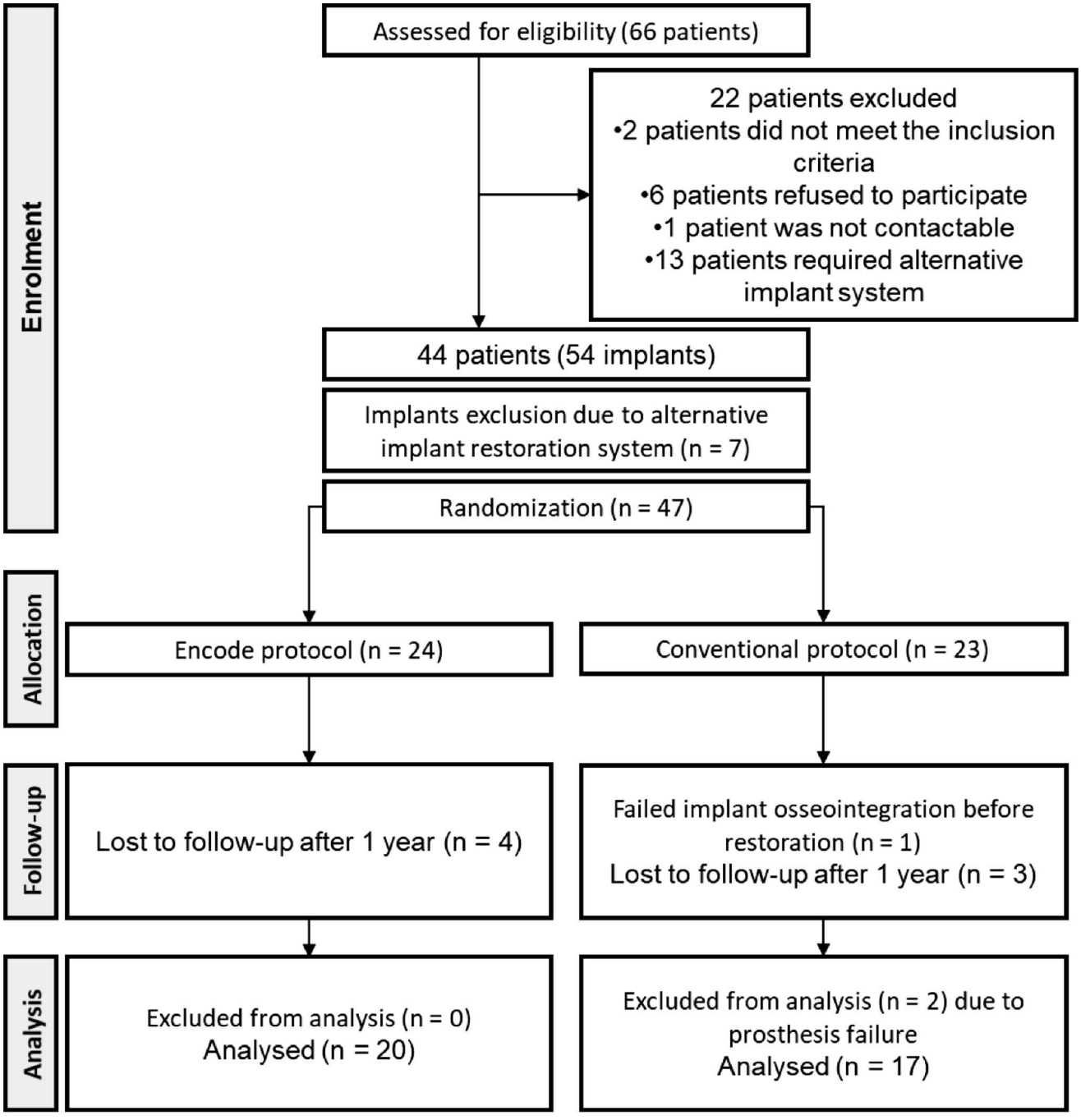
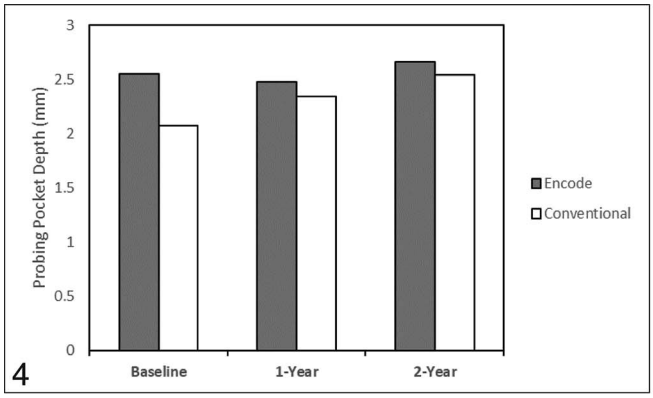


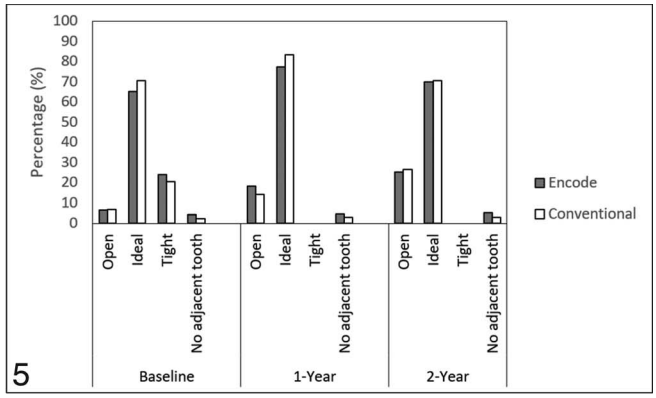
Figure 3. The CONSORT flow diagram.

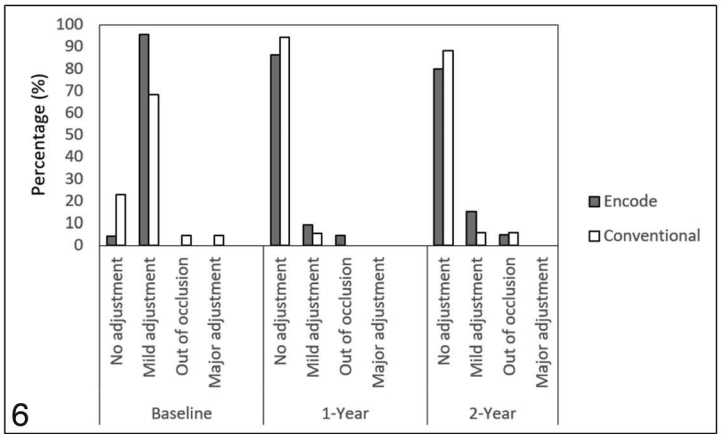
similar ($P = .75$). Metallic discoloration of the mucosa was observed around 3 Encode implants (15.0%) and 1 conventional implant (5.9%), and no significant difference was observed between the groups ($P = .61$).

Over the duration of the study, there was no significant change from the baseline measurements in the mean PPD for any of the crowns ($P = .49$; Figure 4). Table 1 summarizes the average PPD for the Encode and conventional groups at baseline and after 2 years. After 2 years, the PPD of the 2 groups was 2.60 ± 1.02 mm, the PPD of the Encode group was 2.66 ± 0.96 mm, and the PPD of the conventional group was 2.54 ± 1.09 mm. The increase in PPD from baseline for all crowns was 0.65 ± 1.25 mm. The Encode group had a PPD increase of 0.49 ± 1.17 mm, and the conventional group had a PPD increase of 0.83 ± 1.33 mm. The PPD difference between the Encode and the conventional groups after 2 years was insignificant ($P = .49$).

The mean MBL loss for both groups was 0.74 ± 1.33 mm after 1 year and 0.76 ± 0.71 mm after 2 years. The mean 2-year MBL loss was 0.88 ± 0.70 mm for the Encode group and 0.60 ± 0.71 mm for the conventional group, which was found to be statistically similar for the two groups ($P = .36$).







Figures 4–7. Figure 4. Probing pocket depth of the 2 groups at baseline, 1-year review, and 2-year review. **Figure 5.** Percentages of proximal contacts of the 2 groups at baseline, 1-year review, and 2-year review. **Figure 6.** Percentages of the different occlusal contacts of the 2 groups at baseline, 1-year review, and 2-year review.

Prosthetic factors

The quality outcomes of the proximal contacts and occlusal contacts are outlined in Table 2. A total of 74 (40 Encode, 34 conventional) mesial and distal proximal contacts were included in the analysis. The patterns of proximal contacts for the 2 groups after 1 and 2 years were similar ($P = .93$). After 2 years of service, there were no tight contacts in either the Encode or conventional groups. Most proximal contacts were considered ideal for the 2 groups. The Encode group had 28 (70%) ideal contacts, and the conventional group had 24 (70.6%) ideal contacts. However, the presence of open contacts increased consistently after 1 year and 2 years for the 2 groups (Figure 5) and occurred in a quarter of proximal surfaces (25.7%). The Encode group had a total of 10 (25.0%) open contacts, and the conventional group had 9 (26.5%) open contacts. Among all the open proximal contacts, 63.2% were on the mesial surfaces and 36.2% were on the distal surfaces. There was no significant difference in the prevalence of open contacts between the mesial and distal proximal surfaces ($P = .26$).

The 2 groups exhibited a similar pattern of occlusal contacts ($P = .80$; Figure 6). Over the 2-year period, there was a slight increase of occlusal surfaces requiring mild adjustments. Sixteen Encode (80.0%) and 15 conventional (88.2%) crowns required no adjustment. One Encode (5.0%) and 1 conventional (5.9%) crowns were out of occlusion. Three Encode (15.0%) and 1 conventional (5.9%) crowns required mild adjustment, which was managed in the clinic.

Over the 2-year period, screw loosening was observed for a total of 6 crowns (15.4%). Two were for the Encode group (10.0%), and 4 were for the conventional group (21.1%). All instances of screw loosening were related to the loosening of

Table 1

Probing pocket depth, mean and standard deviation (SD), at baseline and after 2 years

	Baseline		2 Years		Increase After 2 Years	
	Mean, mm	SD, mm	Mean, mm	SD, mm	Mean, mm	SD, mm
All	2.33	1.04	2.60	1.02	0.65	1.25
Encode	2.55	1.00	2.66	0.96	0.49	1.17
Conventional	2.07	1.03	2.54	1.09	0.83	1.33

Table 2

Quality of proximal contacts and occlusal contacts at baseline and after 2 years

	Proximal Contacts (Mesial and Distal)				
	Open	Ideal	Tight	No Adjacent Tooth	Total
Encode (baseline)	3 (6.5%)	30 (65.2%)	11 (23.9%)	2 (4.3%)	46
Encode (2-year)	10 (25.0%)	28 (70.0%)	0 (0.0%)	2 (5.0%)	40
Conventional (baseline)	3 (6.8%)	31 (70.5%)	9 (20.5%)	1 (2.3%)	44
Conventional (2-year)	9 (26.5%)	24 (70.6%)	0 (0.0%)	1 (2.9%)	34
	Occlusal Contacts				
	No Adjustment	Mild Adjustment	Major Adjustment	Out of Occlusion	Total
Encode (baseline)	1 (4.3%)	22 (95.7%)	0 (0.0%)	0 (0.0%)	23
Encode (2-year)	16 (80.0%)	3 (15.0%)	0 (0.0%)	1 (5.0%)	20
Conventional (baseline)	5 (22.7%)	15 (68.3%)	1 (4.5%)	1 (4.5%)	22
Conventional (2-year)	15 (88.2%)	1 (5.9%)	0 (0.0%)	1 (5.9%)	17

cross-pins, except for 1 conventional crown that also suffered from abutment screw loosening. There was no significant difference in the prevalence of screw loosening for Encode or conventional crowns over the 2-year period ($P = .41$). Of the 6 crowns, 1 Encode and 1 conventional crowns required gasket application of temporary cementation material and retightening of the cross-pin. One conventional crown was managed by retightening of the abutment screw and the cross-pin. One Encode crown required retaping of a new cross-pin. Repeated cross-pin screw loosening resulted in prosthetic failure of 2 conventional crowns prior to the second-year review, resulting in exclusion from further analysis. Therefore, the Encode crowns had a survival rate of 100.0%, and the conventional crowns had a survival rate of 89.5%.

Ceramic chipping occurred in 5 crowns after 2 years of service (13.5%). Two conventional crowns experienced ceramic chipping at the first-year review (11.8%). One of the crowns required minor chairside polishing, whereas the other crown was major and was sent to the laboratory for repair. Three Encode crowns displayed minor ceramic chipping at the second-year review (15.0%) and were managed by chairside polishing. No significant difference was found between the 2 groups ($P = .77$).

Discussion

The present study supports that the Encode and the conventional protocols produce comparable outcomes in all evaluated parameters. This leads to the acceptance of the hypothesis that the 2 protocols are clinically comparable. Therefore, the present study confirms the findings of the 2-year report of coded healing abutments by Vafiadis.[8] In addition, the complications rate and pattern for the 2 protocols were very similar. These results indicate that although the Encode protocol implies a simpler impression technique and less clinical involvement,[12] it is capable of producing a similar outcome to the conventional protocol with the open-tray impression technique. Nevertheless, regardless of the implemented protocol, cross-pin loosening, ceramic veneer chipping, and the opening of proximal contacts were found to be common prosthetic complications.

For all evaluated biological variables, the 2 protocols were similar and consistent with observations of previous studies on single implants. The PPD measurements of the present study correspond to the anticipated 3-mm PPD around healthy implants.[13,14] Clinical studies over the duration of 2 years reported PPD in the range of 2.5–4.0 mm.[15–17] Bengazi et al[16] found that the mean PPD alteration was 0.2 mm over a 2-year duration,[16] which was similar to the observed alteration reported in this study (0.16 mm).

According to the criteria of implant success, it is recommended that radiographic MBL loss of no more than 2 mm occur within the first year of function, followed by a maximum of 0.2 mm annual loss.[18] In the current study, the average MBL loss over the 2-year duration was less than 1 mm for the 2 groups, which was similar to previous clinical studies. For example, the 2-year study by Bilhan et al[19] showed the change in MBL varied from 0.66 mm to 1.1 mm. Likewise, in another study, the radiographic MBL loss ranged from 0.67–0.72 mm over a period of 2 years.[15]

BoP has been used as an indication of the presence or absence of inflammation. Bengazi et al[16] reported a 2-year BoP prevalence of 37%, which was slightly less than what was reported in the present study. According to the study by Aimatti et al,[20] their patients had a bleeding index of 25%. On the contrary, Schnider et al[17] reported a high BoP prevalence of 83% around single implants. Such differences in the occurrence of BoP can be due to the inevitable variations in probing and bleeding reporting among the different studies. Nevertheless, the similarity between the 2 protocols in the biological variables support that the frequencies of healing abutment removal, and the extra impression steps will not necessarily influence the biological variables.

Because all of the abutments survived the duration of the study, the study confirms the similarity of CAD/CAM abutments in comparison with conventional stock abutments.[21,22] Further, it can be stated that neither the impression techniques nor the manufacturing procedures influence patient acceptance or outcome esthetics.[17,23] The occurrence of ceramic veneer chipping in this study (13.5%) was comparable with earlier studies of a similar duration.[21,22,24] A systematic review reported that the prevalence of ceramic veneer fracture was 14%.[23] Pjetursson et al[25] estimated annual ceramic chipping

rate to be 0.64% to 5.82%. Despite the similarity of the Encode and the conventional protocols in the occurrence of ceramic chipping, the severity of ceramic fracture appeared to be greater for the conventional crowns. This could be due to the customization of the Encode abutment, which ensures an even thickness of the ceramic of the porcelain fused to metal crown, as opposed to the conventional stock abutment, which lacks the anatomical details.[4]

The reported annual incidence of screw loosening from the recent literature was 0.62%–2.29%,[25] which was mainly related to abutment screw loosening. This is less than the rate of screw loosening reported in this study, which was predominantly due to loosening of cross-pins. The concept of cross-pin retention was proposed as an alternative to crown cementation on implant abutment.[11] Specifically, it is more indicated if a direct to fixture screw retention is not feasible because of less ideal implant angulation. It has the advantages of retrievability and avoidance of cementation, which simplifies the management of biological and mechanical complications. However, it is vulnerable to more frequent loosening. The high rate of screw loosening reported in the present study (15.4%) was similar to that reported in earlier studies. Krennmair et al[26] reported a 9.6% incidence of frequent cross-pin loosening over a 7-year duration, which was 3 times greater than the incidence of abutment screw loosening. In a 5-year retrospective study, Lee et al[27] reported that screw loosening was predominantly associated with cross-pins and occurred in 12.3% of cases. This frequent loosening can be attributed to the sensitivity of the fabrication technique of cross-pinned restorations and the generally small screws that are tightened to low torque.[11] In addition, the occlusal forces are applied horizontally to the screw, rendering it more susceptible to distortion and loosening. The conventional crowns appeared to be more prone to severe complications and failure due to the roundness of the stock abutments and the lack of antirotational and resistance features that can stabilize the crowns.[4] Eventually, there will be greater reliance on cross-pins of the conventional group to stabilize the crowns. As a result, the use of cross-pins in this study should be considered a limitation that influences the generalization of study outcome. More recently, with the advent of angulated screw channels and biaxial screws, the indications for cross-pin are reduced.[28]

At the 2-year review, there was an increase in the prevalence of open proximal contacts in comparison with the baseline, and it appears that a quarter of proximal contacts were considered open. The frequency of open contacts recorded in this study indicates that it is a fairly common event that can develop between an implant and an adjacent tooth. The increased prevalence of open proximal contacts corroborates earlier cross-sectional studies, which found that 34% to 60% of proximal contacts of implant restorations were open.[29–32] Most of the available studies indicated a greater prevalence (2–3 times) of open proximal contacts on the mesial surfaces than on the distal surfaces.[29,30,32] This has been attributed to the ankylotic nature of integrated implant within the bone, whereas the adjacent teeth may move forward through physiological drifting that can cause mesial contact opening.[33] It has been speculated that distal contact can be affected by the dynamic nature of the dentoalveolar complex. With the continual eruption of the adjacent natural teeth, the relationship with the implant crown will be altered and result in an open proximal contact.[31] However, although there is a potential for the open contacts to cause food impaction, peri-implant complications, and dental caries, this was not observed in the present study, and the patients were generally satisfied with their treatments.

Although this study has been designed as a prospective randomized controlled trial, it has several limitations related to study protocol. For example, it was not possible to blind the clinicians from patient allocation into the Encode and conventional groups. The study involved a limited number of implants provided for public patients over a 2-year duration, which restricts the generalization of the data. Since this study was provided in a university setting, and by several postgraduate students, inevitable variation in data recording may exist. However, the variation between the different clinicians was managed by calibration and completion of standardized questionnaires. Future studies are needed to evaluate the validity and cost-effectiveness of the Encode protocol in a private practice setting. Further, it is relevant to compare the Encode protocol to the more recent digital protocols that involve intraoral scanning and chairside fabrication.

Conclusion

Within the limitations of the present study settings, it seems that the Encode and the conventional protocols provide comparable clinical outcome over a duration of 2 years. The cross-pin retention mechanism appears to increase the mechanical complications in the form of screw loosening. The proximal contacts tend to change over the duration of service, and the prevalence of open contacts increases consistently.

Abbreviations

BoP: bleeding on probing
CAD/CAM: computer-aided design/computer-aided manufacturing
MBL: marginal bone level
PPD: probing pocket depth

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Note

The authors declare no conflict of interest in the products listed in the article.

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