original research article

IN VITRO EVALUATION OF THE POST-SPACE DEPTH READING WITH AN INTRAORAL SCANNER (IOS) COMPARED TO A TRADITIONAL SILICON IMPRESSION

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SUMMARY

Objectives. The aim of the study was to assess the depth and quality of the post-space reading, using an IOS without scan-post, compared to a traditional silicon technique.

Methods. Six extracted bicuspids were decoronated and endodontically treated. After having prepared the space for the posts, a structure in pink acrylic resin was created with two resin elements. At the center of the structure one sample was put at a time. Digital and traditional impressions were taken for each sample.

Digital impressions were developed through the Computer-aided design (CAD) software in order to integrate the scanner results into a three-dimensional grid to make the measurements. A K-file was used to measure the length of the post-space of each sample obtained through the traditional silicon impression and subsequently the measurement results were reported on a millimeter gauge. Furthermore, an assessment of the width of the entrances of the post-spaces was carried out.

Results. The mean reading depth discrepancy expressed in percentages (19.58%) indicates that the digital impression with current technologies fails to impress clearly the post-space. Standard deviation of the data expressed in percentage is 13.89, suggesting that the values were not similar to each other. In two cases the digital technique has achieved less than 10% difference compared to the traditional technique, but there have been also cases in which the variation in depth has reached almost 40%.

The samples that showed the minor discrepancy between the two techniques expressed the widest post-space entrance.

Conclusions. In this *in vitro* study, the application of the IOS for the post-space reading in order to deliver an anatomic post has been proven to be still not reliable, as there are still depth reading limitations for the narrow root channels. In fact, in this type of channels it is difficult to reach with the light beam of the IOS the deepest areas of the post-space, with a consequent incomplete post-space reading.

Key words: digital impression, intraoral scanner, post space, anatomic post, Cad-Cam.

Introduction

Endodontically treated teeth usually require a post for the die reconstruction and the application of a fixed dental prosthesis (FDP) in order to handle tooth structure loss due to the endodontic treatment itself (1). In fact such teeth are exposed to a higher fracture risk compared to vital teeth (2).

The difference between the metallic custom-cast post and the dentin elastic modulus has been proved to be responsible for a stress concentration in the cement layer with a consequent possible restoration failure or even root fracture (3). For this reason, different prefabricated post ma-

terials have been introduced, as well as new cementation system to increase the longevity of the restoration (3, 4). The ideal post should have mechanical properties similar to the ones of the dentin, and should be cemented with a thin, uniform, and bubbles free layer of cement to increase the survival of the post-endo restoration (1, 5-8). A cement layer between 250 and 500 µm as to be considered acceptable (9). Anyway, one of the main issue is the discrepancy between the prefabricated post shape and the post space shape (10, 11). In fact, root channels can express different anomalies influencing the restoration such as an oval shape, cavities, previous restorations with excessive preparations, overstrumentation, incomplete root formation, internal resorption or development anomalies (11-13). The gap between the prefabricated post and the dentin lead to a thick and non-uniform layer of cement, with a consequent higher risk for structural discontinuity. Besides, the increased polymerization contraction creates internal stresses responsible for fractures and post debonding (8, 11, 14). Polimerization contraction stress has been identified as the main reason for post based restoration failures (15, 16). Several techniques have been proposed to reduce the discrepancy between the prefabricated fiber post and the root channel anatomy such as the composite filling of the root channel (11, 17), the anatomic shaping of the post through a direct resin application (11, 18-21) and the use of an extra post (11, 18, 22).
Anyway, it has been proved that anatomic posts are the gold standard for wide root channels for an adhesion reason, better fracture resistance, polymerization contraction stress limitation and reduction in bubbles and gap production during the cementation (11).
The development of the Cad-Cam (Computer aided design-Computer aided manufacturing) technology and its application in the field of dentistry has brought to innovative treatment solutions (23) like the production of tailored posts made in zirconia or glass-fiber (24-26).
Furthermore, the new generation of intraoral scanner (IOS) has been validated as an efficient alternative to the traditional impression in the field of prosthodontics (27, 28).
Consequently, the application of IOS for the post-space impression and the use of Cad-Cam technology for the anatomic post production should be tested.
The aim of the present study was to evaluate *in vitro* the depth reading and impression quality of the post space through the use of an IOS compared to a traditional silicon impression.

Materials and methods

Six bicuspids, free of caries and fractures, were extracted for periodontal reasons and used for the present study. X-rays with a mesio-distal and vestibular-lingual projection were executed prior the root canal treatment, and just with a vestibular-lingual projection after the root canal treatment and the post space preparation. The elements were stored in distilled water throughout the sampling period. The elements were decoronated using a separator disk mounted on a straight handpiece, 1 mm coronally to the cement-enamel junction and perpendicular to the long axis of the tooth. Each channel was prepared with Ni-Ti Mtwo rotating instruments (Sweden & Martina) 10/04; 15/05; 20/06; 25/06 mounted on an endodontic motor. Five percent sodium hypochlorite (Niclor 5, Ogna) was used as root irrigant. The channels, so shaped and cleansed, were closed with Microseal technique (Sweden & Martina) and endodontic cement (Pulp canal Sealer, Kerr).
Each post-space was created with Mtwo post file (Sweden & Martina). It is a Mtwo 55/06 instrument, designed to remove gutta-percha and to create space for the post without changing the shape of the previously prepared channel. It does not alter the shape and does not work on the walls, if not to create the minimum space for the cement. The post-spaces were prepared with a depth between 8.5 and 9.8 mm. After having prepared the space for the posts, a structure in pink acrylic resin (Jet Kit, Lang dental manufacturing) was created with two resin elements, placed

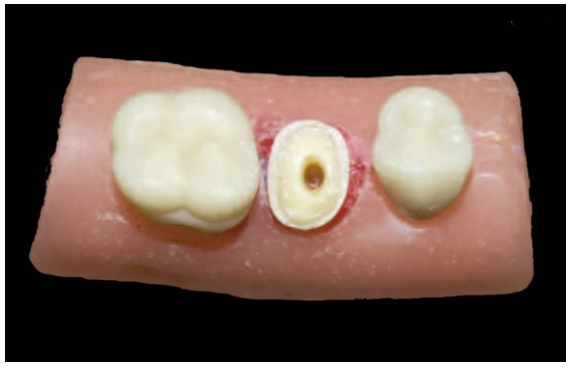

Figure 1
Pink acrylic resin model with one of the samples in the center and two resin elements on the sides.

one mesially and one distally to the space for samples in order to simulate a clinical real situation. At the center of the structure one sample was put at a time (Figure 1). Digital and traditional impressions were taken for each sample in order to compare the reading depth of the digital impression of the post-space with the reading depth of the traditional impression. The first group of impressions of the post-spaces was made with the digital technique. The IOS used was the 3shape TRIOS (3hape) (Figures 2, 3). The digital files, produced through the IOS, were sent to the laboratory (Figure 4). Through the CAD program, the scanned spaces were developed in order to integrate the scanner results into a three-dimensional grid to make the measurements. For each sample a light-cured resin individual tray was prepared, taking care to eliminate any undercuts with red wax (Figure 5). It was carried out a two-component single-phase impression with the use of a calcinable plastic post inside the post-space to give higher stiffness to the light silicon (Aquasil, Dentsply).
It was thus obtained the traditional post-space silicon impression of the samples (Figure 6). A digital grid was used to measure the depth of the post-space scanned through the digital technique of each sample from the coronal margin to the most apical part of the preparation (Figure 7). A K-file was used to measure the length of the post-space of each sample obtained through the traditional silicon impression and subsequently the measurement results were reported on a millimeter gauge (Figure 8).
Furthermore, an assessment of the width of the entrances of the post-spaces was carried out. Diameters and areas of the post-space entrances were measured with a dedicated software (Image Tool 3.0) (Figure 9).

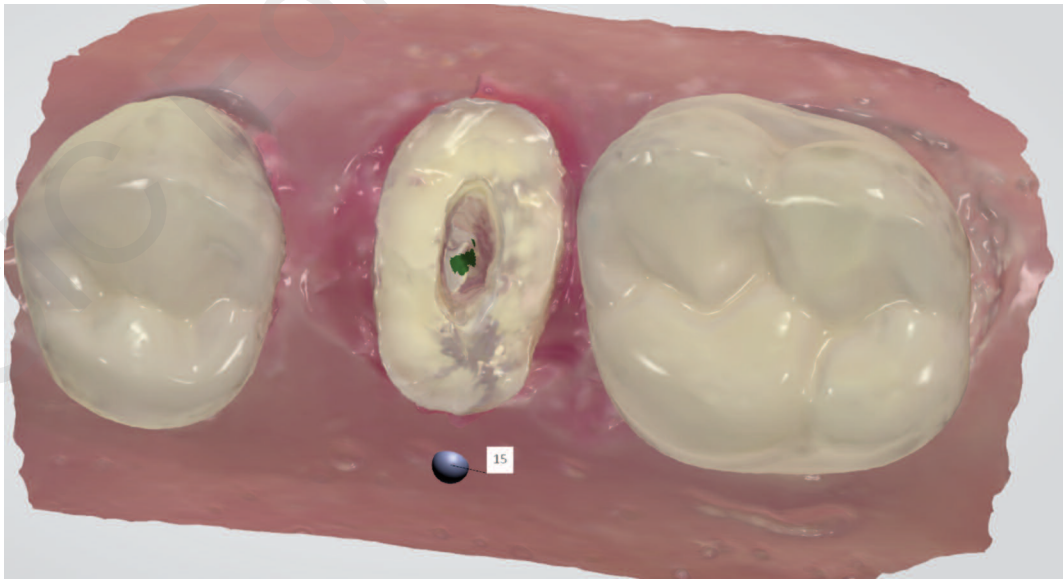

Figure 2
Occlusal view of a digital impression.

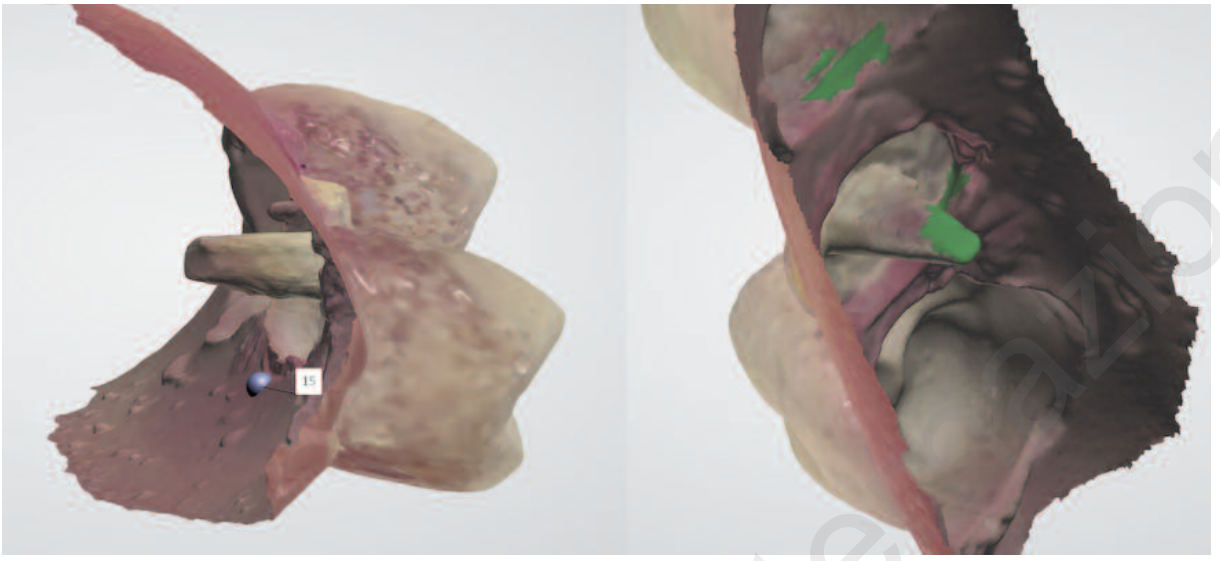

Figure 3
Digital impression internal view.

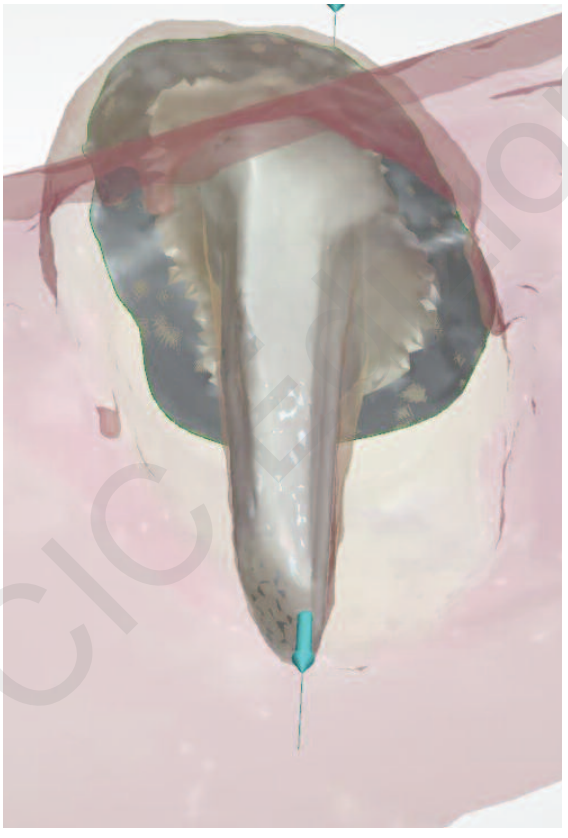

Figure 4
CAD processing of the post-space.

Figure 5
Pink acrylic resin model with a positioned sample, the individual tray and the traditional silicon impression.

Results

The data expressed in Table 1 highlight the length discrepancy of the post-space reading between the digital and traditional technique. A shorter reading depth was noticed in all the samples for the digital technique compared to the traditional one. The mean depth discrepancy expressed in percentages (19.58%) indicates that the digital impression with current technologies

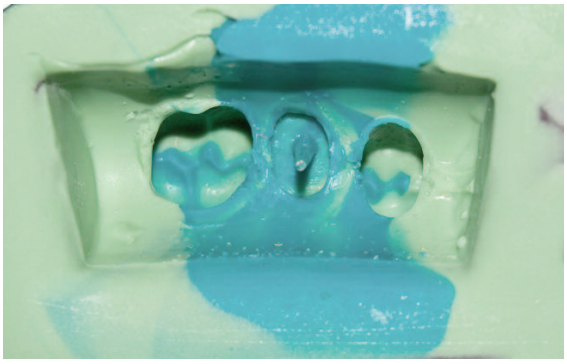

Figure 6
Detail of the traditional silicon impression with calcinable plastic post-space.

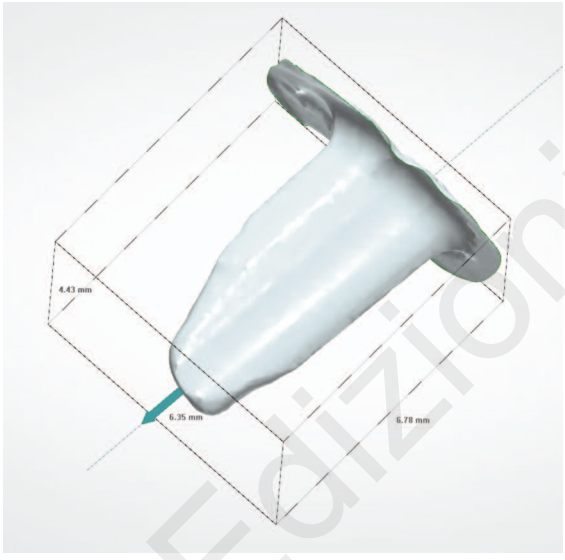

Figure 7
Measurement with a digital grid of the post-space scanned in digital technique.

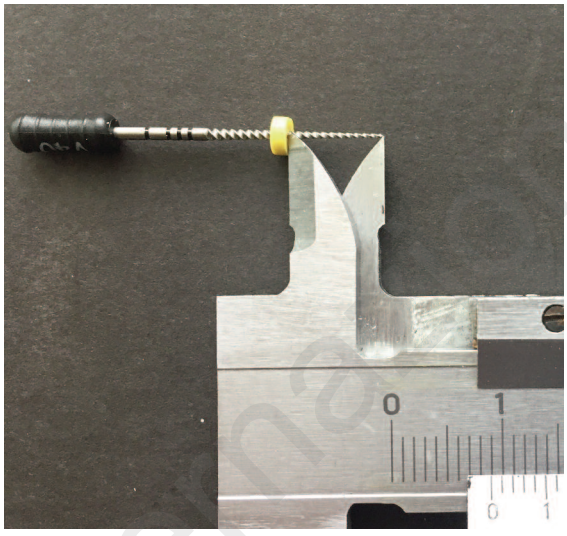

Figure 8
Measurement with a gauge of the post-space length obtained through the traditional technique.

Figure 9
Measurement of the diameter and area of the post-space entrance.

fails to impress clearly the post-space. Standard deviation of the data expressed in percentage of Table 1 is 13.89. This data suggests that the values were not similar to each other, but this is probably due to the low number of samples.
In two cases the digital technique has achieved less than 10% difference compared to the traditional technique, but there have been also cases in which the variation in depth has reached almost 40%.
From the results of the analysis of the root canal entrances (Table 2), it is possible to hypothesize

Table 1 - Comparison between the depths of the post-spaces obtained through the traditional and digital technique with the respective discrepancies expressed in percentages.

DEPTH IN MILLIMETERS OF THE POST-SPACES IN:		
	DIGITAL TECHNIQUE	TRADITIONAL TECHNIQUE
SAMPLE 1	5.71 (37.94%)	9.2
SAMPLE 2	9.22 (5.92%)	9.8
SAMPLE 3	8.62 (11.14%)	9.7
SAMPLE 4	6.78 (22.96%)	8.8
SAMPLE 5	6.55 (33.17%)	9.8
SAMPLE 6	8.05 (6.40%)	8.6

Table 2 - Larger and smaller diameter measurement for each sample with the calculation of the post-space entrance areas through the Tool 3.0 software.

MEASUREMENTS OF THE CANAL ENTRANCES:		
	DIAMETERS (mm)	SURFACES (mm^2)
SAMPLE 1	2.87 - 1.8	4.16
SAMPLE 2	4.3 - 2.5	7.56
SAMPLE 3	3.3 - 1.96	4.78
SAMPLE 4	4.21 - 2.02	7.01
SAMPLE 5	3.34 - 2.5	7.20
SAMPLE 6	3.93 -3.23	8.32

that the depth in digital technique, besides being influenced by the IOS hardware and software, is influenced by the amplitude of the surface of the post-spaces entrances.
The samples that showed the minor discrepancy between the two techniques expressed the widest post-space entrance.

Discussion

Several articles have proposed in the literature the use of the IOS and CAD-CAM technology to produce endodontic posts (24). Dedicated tools, called scan-posts, are used to detect the post-

space through the use of an IOS. Anyway this kind of technique, even though makes it easier to detect the depth of the post-space, is not able to record properly the root channel anatomy.

Considering the better features of an anatomic endodontic post, such as the root dentin preservation (8, 20, 29-33), reduced cement layer (34-37), minor bubbles formation (38), increased post retention (7, 8, 39, 40), and fracture resistance (41, 42), in this study the possibility of producing an anatomic endodontic post through the use of an IOS has been investigated. To the best of our knowledge no studies have yet investigated the IOS capability to detect the post-space for the production of anatomic posts.

In the present paper, the digital impression showed lower capability to read the post-space compared to the traditional impression. Anyway, similar results between the two techniques have been obtained for post-spaces expressing a wide entrance. That is probably due to the increased amount of IOS light able to get into the post-space when a greater entrance is expressed. One major limitation of the present study was the low sample number. Besides an *in vitro* study design does not take into consideration all the variables of the mouth environment such as oral fluids and the IOS motion limitations. Further studies on a greater sample and with different IOS systems should analyze the possibility of recording the post-space through a digital impression in order to produce an anatomic post.

Conclusions

In this *in vitro* study, the application of the IOS for the post-space reading in order to deliver an anatomic post has been proven to be still not reliable, as there are still depth reading limitations for the narrow root channels. In fact, in this type of channels it is difficult to reach with the light beam of the IOS the deepest areas of the post-space, with a consequent incomplete post-space reading. Further improvements in the IOS hardware and software are necessary to make the digital impression able to read properly the post-space independently from the root channel anatomy.

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