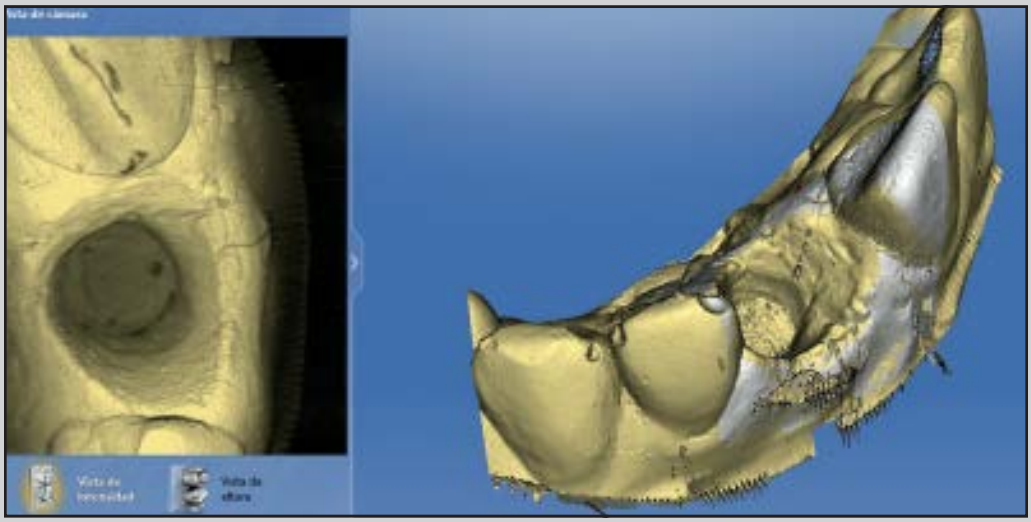

Comparison of Direct and Indirect Techniques to Develop Customized Implant Impression Copings: A Pilot Study

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The aim of this pilot study was to compare a direct and an indirect technique for fabricating customized impression copings. The accuracy of these techniques to capture the tissue contours that have been developed using implant-supported fixed interim restorations (ISFIRs) in single implants for their esthetic value were evaluated. Five patients presenting with maxillary central incisor ISFIRs were enrolled in the study. Customized impression copings were fabricated using a direct and an indirect technique. Specimens of experimental (direct and indirect technique) and control groups (ISFIR) were compared in terms of linear measurements on their buccolingual (BL) and mesiodistal (MD) dimensions at three different levels: platform, middle, and gingival margin. Statistically significant differences were detected between the control group and the direct technique specimens on both the gingival margin and middle levels (P < .05). Between the direct and indirect techniques, statistically significant differences were found in their MD and BL dimensions at the gingival margin level (G-MD, G-BL) and the buccolingual dimension at the middle level (M-BL) (P < .05). The indirect technique used for the fabrication of customized implant impression copings seems to be more accurate in capturing the profile of the ISFIR at all three levels (platform, middle, and gingival margin). The direct technique is accurate only at the platform level. (Int J Periodontics Restorative Dent 2015;35:525–531. doi: 10.11607/prd.2118)

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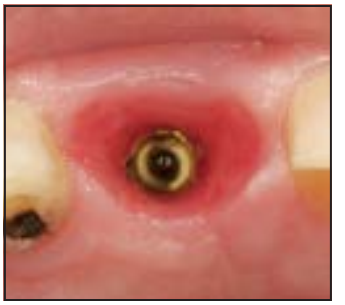
An implant-supported fixed interim restoration (ISFIR) is a good diagnostic tool and communication device that allows the introduction of progressive occlusal loading while simultaneously sculpting and maintaining harmonious soft tissue profiles.[1–10]

Several methods for capturing and transferring the contours of peri-implant tissues developed by using an ISFIR have been described and documented in the literature.[11–15] One of these techniques was introduced by Hinds[16] in 1997. This approach entailed registering the tissue portion of the ISFIR in a mold with polyvinyl siloxane (PVS) bite registration material and using this imprint to fabricate a custom impression coping that would recreate the captured contours of the ISFIR. This procedure takes place outside the patient's mouth, therefore the authors have termed it the "indirect technique" (IT).

In 2002, Polack[17] published a simple method in which an individualized impression coping is fabricated directly in the patient's mouth after removing the ISFIR, replacing it with a stock impression coping, and coating it with a flowable composite that enables the capture and transfer of peri-implant soft tissues onto the master cast. This technique is termed by the authors as the "direct technique" (DT).

Fig 1a *Customized impression copings.*



Figs 1b and 1c *Implant-supported fixed interim restoration and its peri-implant tissue.*

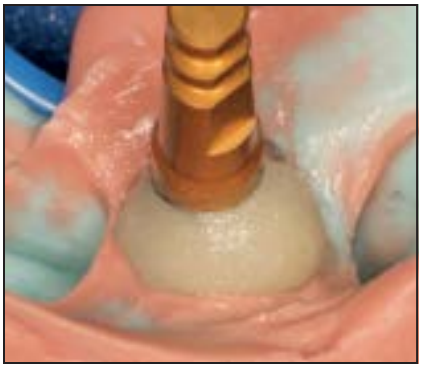


Fig 1d (left) *Customized impression coping indirect technique.*

Fig 1e (right) *Customized impression coping direct technique.*

The purpose of this study was to compare a direct and an indirect technique for fabricating customized impression copings in their accuracy to capture the esthetic value of tissue contours that have been developed by the use of ISFIRs in single implants.

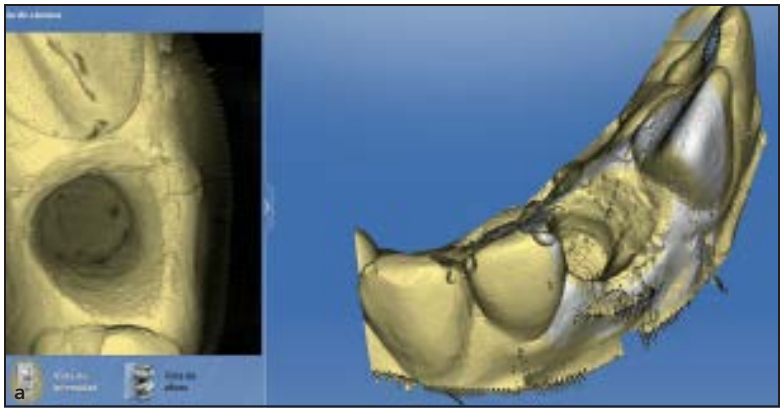
Method and materials

Patient selection

Five systemically healthy individuals ranging from 38 to 74 years old with no contraindications for dental therapy were enrolled in this study. All patients consented to proceed with restorative procedures including the fabrication of two customized impression copings (Fig 1a) to facilitate the fabrication of the final implant-supported prosthesis. Each individual had a screw-retained ISFIR on a maxillary central incisor which had been fabricated at the time of implant placement (Figs 1b and 1c). Individual endosteal implants had been placed simultaneously after tooth removal at approximately 3 mm apical to the zenith of the buccal gingival margin and had not had any complications during their healing period, which ranged from 90 to 120 days.

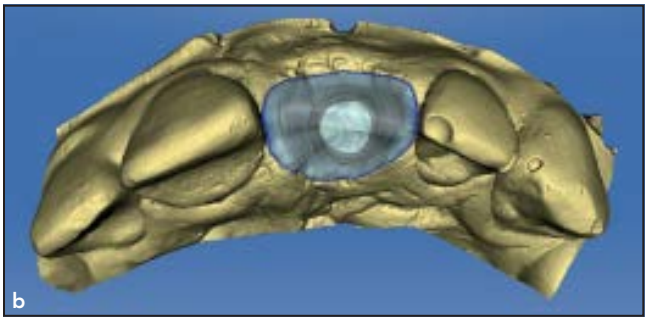
Indirect technique (IT) procedure

A stone-based jig was fabricated using dental stone type III (Quickstone, Whip Mix) containing an implant analog buried up to its platform. The stone surface was indexed with two notches for repositioning purposes. The ISFIR was removed and screwed onto the analog. To minimize soft tissue collapse around the dental implant, a stock healing abutment was placed on the implant at the time of ISFIR retrieval. PVS material (Exaflex, GC America) was injected around the cervical two thirds of the ISFIR.



Figs 2a and 2b *Virtual cast.*

Fig 2c *Computer-aided design of specimens.*



Once the impression material was set, the ISFIR was removed and an impression coping was placed on the analog. A flowable resin composite (Tetric-N-Flow, Ivoclar, Vivadent) was injected into the PVS mold and immediately light cured for 40 seconds. The customized impression coping was then removed and placed into the dental implant after removing the healing abutment. A periapical radiograph was taken to verify complete seating of the impression coping onto the implant platform. An open tray impression was made with PVS material. Once the impression material was set, the impression was removed and the ISFIR was placed back and secured into the dental implant. An all-stone master cast was immediately poured with die stone type IV (Silky Rock, Whip Mix). One clinician collected all impressions (Fig 1d).

Direct technique (DT) procedure

Immediately after removal of ISFIR, an impression coping was seated onto the dental implant. Flowable resin composite was injected and light cured for 40 seconds. A periapical radiograph was then taken to verify complete seating of the impression coping onto the implant platform. Impression and master cast fabrication followed the same steps described for the IT. One clinician collected all impressions (Fig 1e).

Specimen fabrication

The casts were optically scanned with a three-dimensional (3D) camera (Cerec Bluecam, Sirona Dental Systems) (Fig 2a and 2b). The data set acquired was then composed into one digital image encompassing the anatomic segments from the adjacent central to the lateral

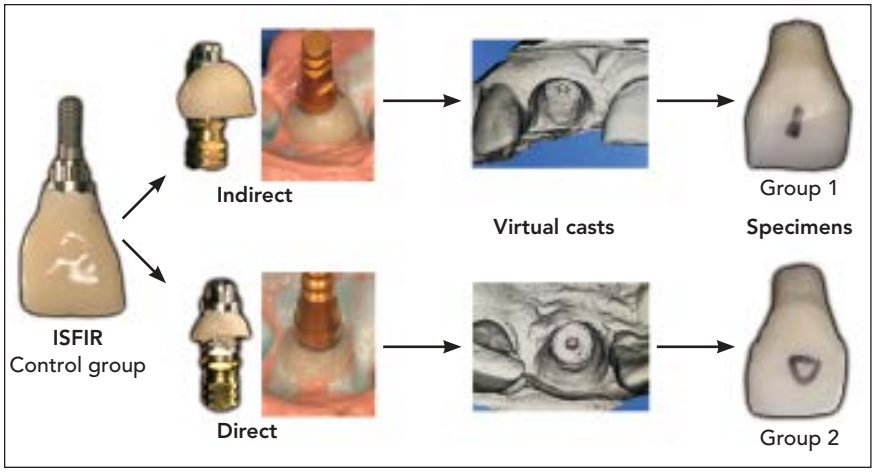


Fig 3 *Diagram of control and experimental group distribution.*

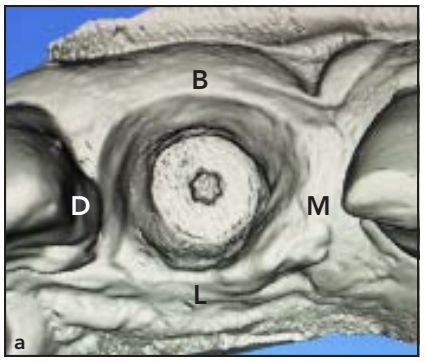
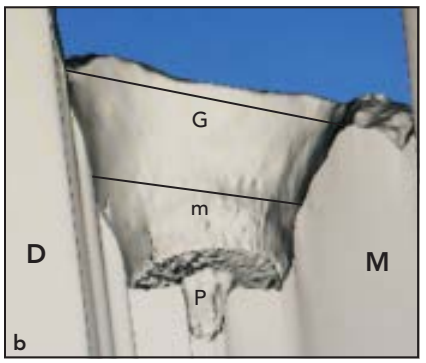
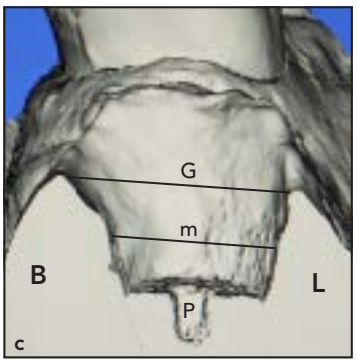


Fig 4a *Occlusal view virtual cast.*

Fig 4b *Frontal view of emergence profile.*

Fig 4c *Sagittal view of emergence profile. B = buccal; L = lingual; M = mesial; D = distal; G = gingival margin; P = platform; m = middle.*





incisors with computer-aided design/computer-assisted manufacturer software (Cerec version 4.2, Sirona Dental Systems). 3D specimens were designed using the Cerec software (Fig 2c) and manufactured on the Cerec inLab unit using blocks of microfiller-reinforced polyacrylic (Vita Cad-Temp, Sirona Dental Systems) (Fig 3).

Measurements

All measurements were taken with a digital caliper (Mitutoyo 700-126). One examiner performed all measurements; each measurement was taken three times and its average was recorded. Three linear measurements were recorded, both on their buccolingual (BL) and mesiodistal (MD) dimensions, on all specimens of the experimental and control groups. These measurements were labeled as follows (Figs 4 and 5):

- Gingival margin (G): Coinciding with soft tissue zenith (BL) and most coronal portion of papillae (MD)
- Middle (m): Equidistant to the platform and gingival margin levels
- Platform (P): Most apical area of specimen

Statistical analysis

Each site was considered a measurement unit. A paired *t* test was used to compare the measured values in the control, DT, and IT groups. Also, the paired *t* test was used to compare the arithmetic differences between the measurements of ISFIR-direct (ΔDirect) and ISFIR-indirect groups (ΔIndirect). The significance value for this study was .05.

Results

Fifteen specimens were included in this investigation, recording six linear measurements per specimen

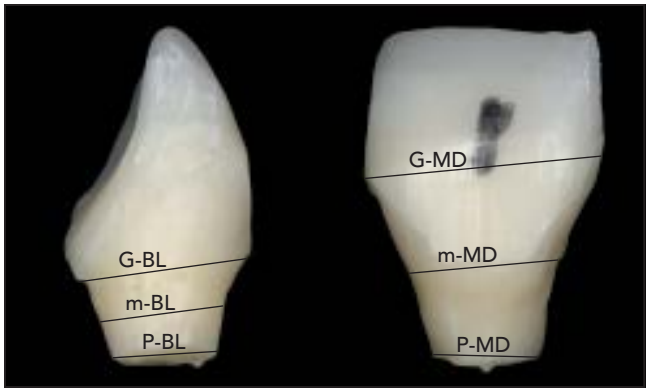


Fig 5a *Frontal and lateral view of specimen and linear measurements.*

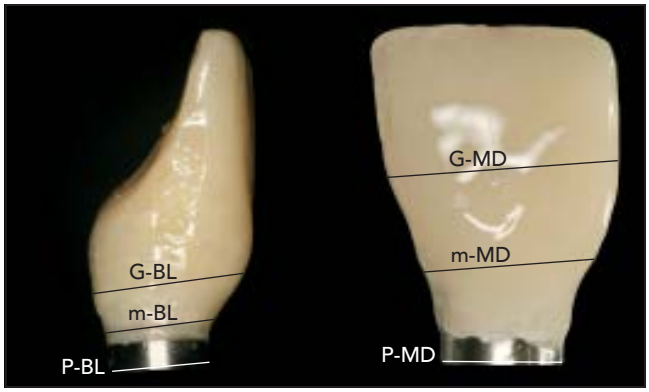


Fig 5b *Frontal and lateral view of ISFIR and linear measurements. G = gingival margin; m = middle; P = platform; BL = buccolingual; MD = mesiodistal.*

Table 1 **Mean measurements ± standard deviation of experimental indirect specimen vs control**

Parameter	Indirect (mm)	ISFIR (mm)	*P*
Gingival			
Mesiodistal	7.98 ± 0.26	8.26 ± 0.34	.211
Buccolingual	7.08 ± 0.28	7.56 ± 0.32	.129
Middle			
Mesiodistal	5.38 ± 0.14	6.02 ± 0.50	.163
Buccolingual	5.48 ± 0.20	6.08 ± 0.38	.135
Platform			
Mesiodistal	4.52 ± 0.12	4.82 ± 0.38	.203
Buccolingual	4.70 ± 0.18	4.84 ± 0.36	.65

n = 5
ISFIR = implant-supported fixed interim restoration.

Table 2 **Mean measurements ± standard deviation of experimental direct specimen vs control**

Parameter	Direct (mm)	ISFIR (mm)	*P*
Gingival			
Mesiodistal	6.72 ± 0.46	8.26 ± 0.34	.01*
Buccolingual	5.98 ± 0.20	7.56 ± 0.32	.003*
Middle			
Mesiodistal	4.78 ±0.26	6.02 ± 0.50	.048*
Buccolingual	4.78 ± 0.160	6.08 ± 0.38	.013*
Platform			
Mesiodistal	4.30 ± 0.10	4.82 ± 0.38	.065
Buccolingual	4.40 ± 0.20	4.82 ± 0.34	.149

n = 5
* Statistically significant.
ISFIR = implant-supported fixed interim restoration.

(Fig 5). These specimens were divided as follows: control group formed by the five ISFIRs; experimental group 1 consisting of five specimens obtained with the DT; and experimental group 2 made up by five specimens obtained with the IT.

No statistically significant differences were found between measurements of the control group and the IT specimen group ($P > .05$). (Table 1)

Statistically significant differences were detected between the control group and the DT specimens in both the gingival margin and middle levels ($P < .05$). No statistically significant differences were recorded in the platform level (Table 2).

When comparing ΔDT and ΔIT values, statistically significant differences were found at the gingival margin level in both the MD and BL aspects. Statistically significant differences were found in the middle level only in the BL aspect ($P < .05$) (Table 3). No statistically significant differences were observed in the remaining areas being measured.

Discussion

The emergence profile of the implant-supported restoration has a critical effect on peri-implant tissue

Table 3 Mean differences ± standard deviations between experimental groups

Parameter	ΔIndirect (mm)	ΔDirect (mm)	*P*
Gingival			
Mesiodistal	0.36 ± 0.22	1.54 ± 0.56	.01*
Buccolingual	0.48 ± 0.42	1.58 ± 0.40	.026*
Middle			
Mesiodistal	0.76 ± 0.38	1.24 ± 0.68	.58
Buccolingual	0.68 ± 0.46	1.30 ± 0.52	.011*
Platform			
Mesiodistal	0.38 ± 0.26	0.52 ± 0.28	.206
Buccolingual	0.50 ± 0.22	0.44 ± 0.36	.722

n = 5
* Statistically significant.

health, hygiene, and esthetics.[18] The contours of the interim prosthesis actively sculpt the peri-implant soft tissues, allowing the clinician to visualize, assess, and modify the existing tissue profile before making an impression to fabricate the final prosthesis. The fabrication of the subgingival contours of the final prosthesis should be guided by the existing tissue dimensions obtained during the provisionalization phase. Without an accurate dimensional transfer tool, the translation of the sculpted soft tissue will remain a challenge and could become guesswork at best. It is evident that when stock impression copings are used, because of their cylindrical shape, capturing peri-implant soft tissue profiles becomes inaccurate. If this information is not precisely transferred to the laboratory dental technician, volumetric contours will not be completely recreated and consequently the final emergence profile may differ from the profile established by the interim restoration, potentially rendering a compromised esthetic result.

In this pilot study, two impression techniques were compared using customized impression copings. To the knowledge of the authors, this is the first time these two techniques are being compared in the literature. The outcome of this investigation lays the foundation for achieving an accurate reproduction of restorative contours that avoids soft tissue distortion, such as apical migration induced by overcontouring or soft tissue collapse as a result of undercontouring. According to the literature[18] an undercontoured critical and subcritical profile could lead to a displacement of the gingival zenith with rather noticeable changes when restoring a single dental implant in the esthetic area. Considering the existence of a significant difference between both the DT and IT approach to fabricate customized impression copings, a soft tissue displacement of an average of 1 mm is observed with the DT vs the IT in both the BL and MD dimensions at the gingival margin and middle levels (Table 3). Changes of 1 mm can become noticeable when restoring a central incisor that must match as accurately as possible the apicocoronal position of the gingival zenith of its contralateral central incisor.

Once the provisional restoration is removed, before taking an impression, a progressive collapse of soft tissues is meant to occur because of the lack of rigid support. When customizing the impression coping in a direct fashion, the collapsed tissues will be ultimately captured. On the other hand, when the impression coping is fabricated indirectly, an impression is generated, which incorporates the anatomic profile of the rigid material of the provisional restoration itself. The awareness of these dimensional changes led to the choice of a fast setting material to capture soft tissue profiles. Such materials present an inherently higher contraction rate compared with some other self-curing materials. However, self-curing materials need longer setting times that could potentially have a negative effect on the accuracy of soft tissue capturing. To circumvent some of these issues, other authors have proposed making the impression directly with the ISFIR.[19,20] This approach is time consuming because the patient is not able to wear the ISFIR until the master cast is fabricated.[20]

It is the opinion of the authors that two models should be obtained when fabricating a final implant-supported restoration using a customized impression coping: *(1)* an all-stone cast model that yields a solid surface reproduction of soft tissue profiles, and *(2)* a model with

a soft tissue replica, which facilitates restorative material manipulation and adjusting procedures.

With the use of intraoral digital impression becoming mainstream, it has been proposed to capture peri-implant tissue contours with personalized scanbodies.[21] This technique limits the reproduction of the soft tissues at the platform and gingival margin levels of the implant (the profile of the entire submucosal portion cannot be captured). This validates the rationale behind the acquisition of a master cast using an impression coping fabricated with an IT, and then scanning this cast with a scanbody that will allow for an accurate replica of the supraimplant emergence profile.

This is a pilot study, and as such, one of its limitations is the sample size. Also, other variables like gingival biotype were not considered and may play a role in tissue behavior while being captured during impression making procedures.

A larger sample and comparison of different restorative materials used to capture soft tissue profiles would be beneficial for further understanding the principles described in this article. This could lead to the optimization of clinical protocols that would facilitate the capturing of sculpted tissues in an accurate and predictable manner, and ultimately translate into superior esthetic results in implant dentistry.

Conclusion

Statistically significant differences were recorded when comparing the control group (ISFIR) and the DT specimens on both the gingival margin and middle levels.

Within the limitations of this pilot study, results suggest that the IT used for fabricating customized implant impression copings seems to be more accurate in capturing the profile of the ISFIR at all three levels (platform, middle, and gingival margin). The DT provides accuracy only at the platform level.

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