

Case Report

Digital Analysis of a Novel Impression Method Named the Biological-Oriented Digital Impression Technique: A Clinical Audit

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Abstract: This report aims to clinically evaluate the feasibility of a novel biological-oriented digital impression method for teeth prepared with a vertical preparation technique. Something that makes this case unique is that the definitive impression is taken without cord displacement, reducing the invasiveness for the patient. In addition, dental technicians can reproduce the exact emergence profile of the temporary restoration used to reshape the soft tissue contours and define the accurate finish line at the established prosthetic junction, potentially avoiding the aesthetic and biological issues of the double-cord technique. The finish line and emergence profile are transferred using the temporary restoration through a simple CAD procedure performed using the same software used to take the impression. This makes the proposed biological-oriented digital impression technique (BODIT) easy to perform, avoiding adjunctive time and costs for clinicians and patients. Conclusions: Finally, patients' satisfaction could be significantly improved.

Keywords: digital impression; vertical preparation technique; biological-oriented digital impression; finish line; emergence profile



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1. Introduction

Various preparation designs and materials have been proposed for the prosthetic treatment of compromised teeth [1–3]. However, restoring a single anterior tooth has always been one of dentistry's most difficult aesthetic restorative procedures, especially for a single central incisor. The success of prosthetic rehabilitation depends on more than proper techniques and materials. The soft tissue condition and respect for some biomimetic principles are needed to obtain a lifelike aesthetic appearance [4,5]. The margin of a tooth to be rehabilitated can be prepared with a clear horizontal finish line, such as with a chamfer and straight shoulder, or shoulderless [6,7]. The latter, called vertical preparation, includes knife- or feather-edge designs and was initially proposed for periodontally compromised teeth [8,9]. This technique was proposed to create an anatomic crown with a prosthetic emergence profile that simulated the shape of the natural tooth, even in the case of periodontal disease, by moving the emergence of the anatomic crown from the cemento-enamel junction (CEJ) to a new prosthetic junction (or prosthetic CEJ) at the desired location [9,10]. There is no clear finish line but instead a boundary range of the preparation, which could be located at different gingival pocket depths, depending on the available biological width [8].

Recently, a modern vision of vertical preparations, named the biologically oriented preparation technique (BOPT), was proposed for the aesthetic rehabilitation of teeth and implants [11,12]. This approach has shown high-quality clinical and aesthetic results regarding soft tissue stability at the prosthetic/tissue interface, both at the short and the long-term follow-up [13,14]. The BOPT concept consists of a vertical, edgeless, subgingival preparation, gingivage, and interim restoration with proper customized margins; this aims to seal the abutment preparation coronally to the finish line, contributing to blood clot stabilization and preservation. The specific reshaping of the temporary restoration aims to continuously adapt the marginal periodontal tissue to the remodeled emergence profile of the crown, creating a new prosthetic junction [13]. According to the BOPT concept, an accurate impression at the newly created prosthetic junction is needed to maintain the obtained biomimetic results. In fixed prosthodontic treatment on natural teeth, the horizontal and vertical “displacement of the marginal gingiva away from a tooth” [15], before making the definitive impression, is one of the important steps that helps to maintain aesthetics and a healthy periodontium [16]. Although several methods have been proposed [17], the double-cord impression technique is still the gold standard, even when a digital impression is taken [18]. The benefits of this technique are the vertical and horizontal soft tissue displacement at the preparation’s finish line and its ability to control hemorrhage. On the other hand, the invasion of the sulcus with cords and chemical hemostatic agents could be dangerous from an aesthetic point of view. The vertical displacement exposes the unprepared portion of the tooth, apical to the finish line. In contrast, the horizontal displacement moves the marginal tissues away, so an adequate volume of impression material can be taken around the prepared tooth. However, the BOPT concept is based on establishing a new prosthetic junction on a tooth surface prepared with a clear finish line. The prosthetic finish line and the sculpted soft tissue contours should match the customized temporary crowns’ profile. Therefore, the ideal scenario is to transfer and reproduce it into the final prosthetic restoration. Even with recent digital improvements, an accurate impression can be taken in a faster and more simple way than analogue approaches [19–22]. Moreover, further strategies can be developed through digital transformation. This proof-of-concept report aims to evaluate the feasibility of a novel biological-oriented digital impression technique for teeth prepared with a vertical preparation in a clinical audit. Using this novel approach, the marginal soft tissue displacement may not be needed, as the whole temporary restoration can be scanned from its margin line. Using this technique, dental technicians can reproduce the exact emergence profile of the temporary restoration used to reshape the soft tissue contours and define the accurate finish line at the established prosthetic junction, potentially avoiding the aesthetic and biological issues of the double-cord technique.

2. Case Presentation

A 30-year-old woman without any medical problems was referred to a private dental clinic for the prosthetic rehabilitation of her upper left central incisor, which had been affected by a horizontal crown fracture due to a traumatic dental injury (Figure 1). After clinical and radiological examination, the proposed treatment plan was endodontic therapy, fiber-reinforced composite post, interim and metal-free restorations. Before starting any procedure, the patient signed the informed consent.

The 2013 Helsinki Declaration and the Good Medical Practice principles were also adhered to. Medical data were anonymized so that patients could not be identified. After the endodontic therapy and the related restorative procedures (Figure 1), the tooth was prepared according to the BOPT concept [11]. A few weeks after treatment, no more symptoms were present. Radiographically, no reductions in the size of the apical lesion were found. However, further radiographic and clinical controls were needed. Alternatively, a surgical intervention could have been used. After tooth preparation, an interim acrylic resin restoration fabricated by a dental laboratory was relined and adapted on the prepared tooth, as described by Ignazio Loi and Antonello di Felice [11]. In brief, the interim restoration was first rebased. Then, the area between the sulcus and the gingival margin

was relined using photo polymerizable flowable composite resin, allowing the borders of the interim restoration to seal and support the gingival margins circumferentially. Using the provisional restorations, a CEJ was created with the new emergence profile, also enabling the stabilization of the blood clot formed in the gingival sulcus during the gingivage. The interim restoration was cemented using temporary dental cement (Temp-Bond Clear, Kerr Dental, Kloten, Switzerland). After four weeks of soft tissue maturation and stabilization, the border of the interim restoration was reshaped by over-contouring or under-contouring the prosthesis, finally enabling the marginal soft tissue remodeling. This procedure was repeated every four weeks, up to four months, according to the final aesthetic results to be obtained (Figure 2).



Figure 1. Pre-operative orthopantomography and periapical radiograph.

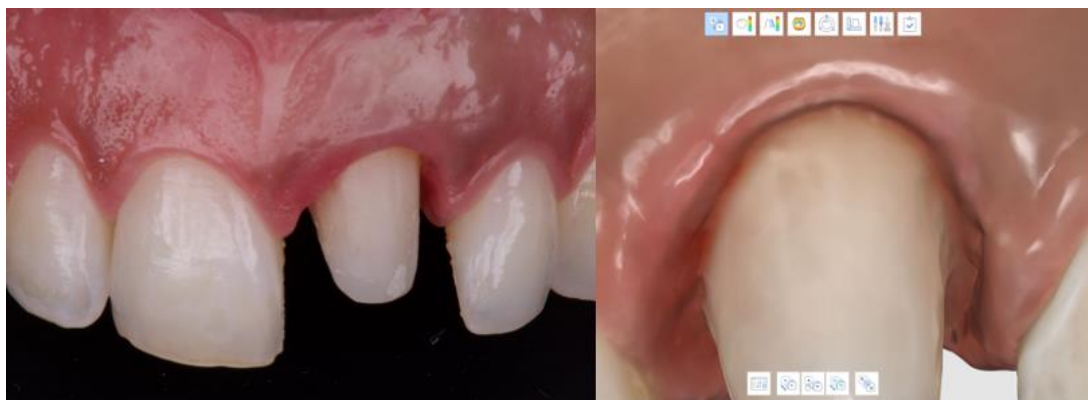
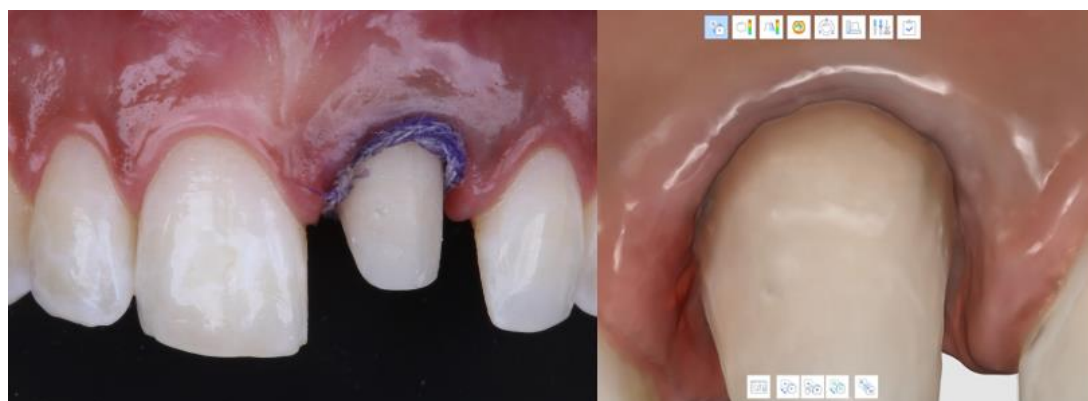


Figure 2. Temporary restoration.

Finally, after an overall healing period of six months, definitive impressions were taken according to the novel concept of BODIT. All the digital impressions were taken without anesthesia, as different stages in the same prosthetic section, and automatically aligned with each other (Medit Link V.3.0.6 for macOS, Medit Corp., Seoul, Republic of Korea). All impressions, except one, were taken using an intra-oral scanner (Medit i700, Medit Corp., Seoul, Republic of Korea). The impression of the interim restoration was taken using a sticky wax mounted on the holder. Instead, the analogue impression was taken using polyether material (Impregum, 3M Italia Srl, Pioletto, MI, Italy) and used as a control. The step-by-step procedures used are reported in Table 1 and Figures 3–6.

Table 1. Different impression and scan stages.

Impression	Strategy	Scan stage (Medit Link, Medit Corp.)
Digital impression of the prepared dental abutment, without cords.	Taken immediately after temporary restoration removal and abutment cleaning, to transfer the information of the prepared dental abutment to the dental lab.	Pre-operative maxilla scan, using the high-resolution scan mode for scan areas that required finer information.
Digital impression with the interim restoration in place.	Taken after the previous impression, to transfer the macroscopic information of the interim restoration to the dental lab (size and shape).	Maxilla scan.
Digital impression of the interim restoration outside the patient month.	Taken after the previous impression, to transfer the customized finish line and emergence profile of the adapted interim restoration.	Scanbody scan, with high-resolution scan mode.
Digital impression of the antagonist arch	Taken after the previous impression with the mandible in maximal intercuspation.	Mandible scan.
Analog impression of the prepared dental abutment, with cords.	Taken according to the double-cord technique, after the second cord removal, and used as control.	One-step analog impression with medium and light material.
Digital impression of the prepared dental abutment, with cords.	Taken according to the double-cord technique, after the second cord removal, and used to evaluate the amount of soft tissue displacement.	Additional data.
Digital bite registration	To obtain the occlusal alignment of the arches in maximal intercuspation.	Occlusion scan.

**Figure 3.** Digital impression without cord.**Figure 4.** Digital impression with retraction cords (double-cord method).

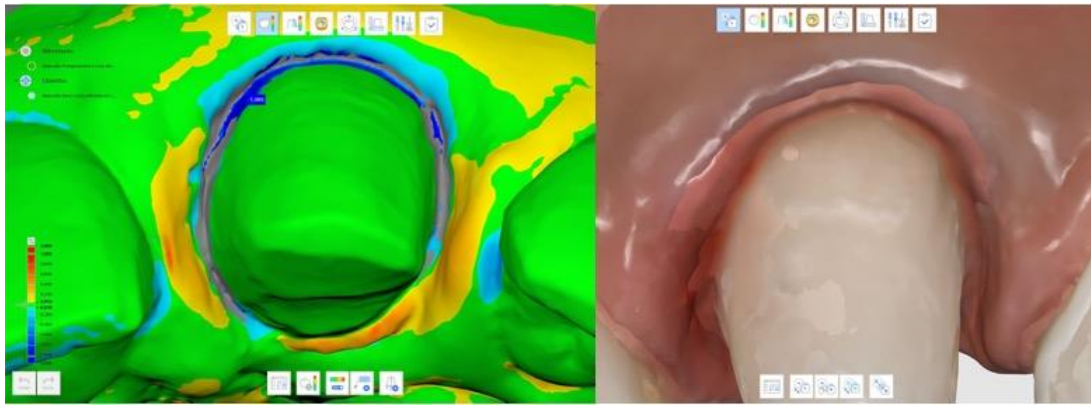


Figure 5. Digital impression with retraction cords (double-cord method).

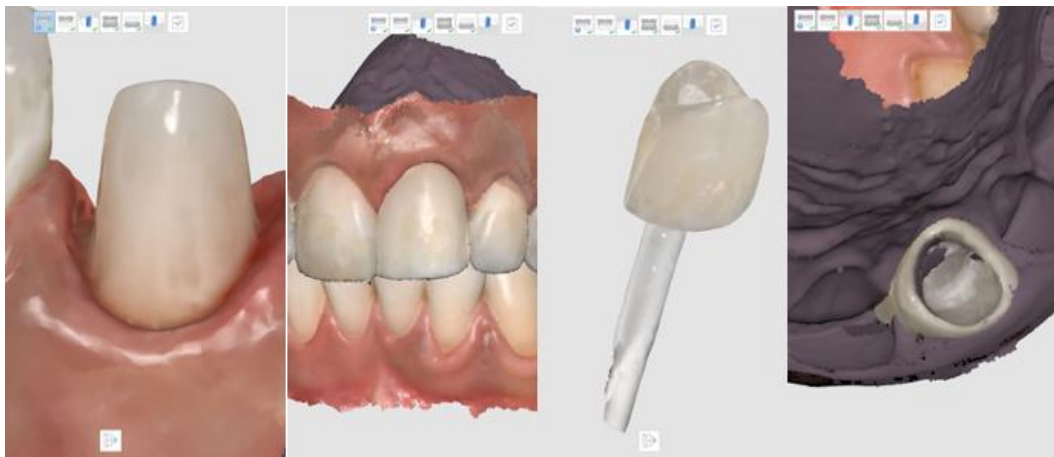


Figure 6. The operative sequence of the digital impressions taken according to the BODIT. From left to right: impression of the dental abutment in HR without any cords; impression of the temporary restoration in place; chairside impression of the temporary restoration using a sticky wax mounted on the holder; and matching of the previous impressions that show the finish line and the emergence profile of the temporary restoration.

The computer-aided design (CAD) of the final restoration was started with a Boolean of subtraction between the pre-operative maxilla scan and the Scanbody scan (Medit Design, Medit Corp.). This operation enables the reshaping of the soft tissue margins according to the finish line and the emergence profile of the temporary restoration (Figures 7–9). Afterwards, the clinic can export the impressions to the dental lab, with the finish line already detected. Then, the definitive crown was designed, copying the temporary restoration and mimicking the contralateral tooth (ChairsideCAD 3.0 Galway, exocad GmbH, Darmstadt, Germany).

The restoration was then printed in casting resin and finalized in lithium disilicate through heat press forming. Finally, feldspathic ceramic was layered to improve the aesthetic results. After an accurate try-in of the definitive crown and the patient's acceptance, the restoration was temporarily cemented for two weeks (Temp-Bond Clear, Kerr Dental). After this period, no complications occurred and the patient's satisfaction remained high, so the restoration was definitively cemented using Automix Resin Modified Glass Ionomer Cement (RelyX Luting Plus, 3M Italia Srl). After one week, the patient was seen for occlusal and cementation control, and then seen every six months for hygiene maintenance and occlusal controls (Figures 10 and 11).

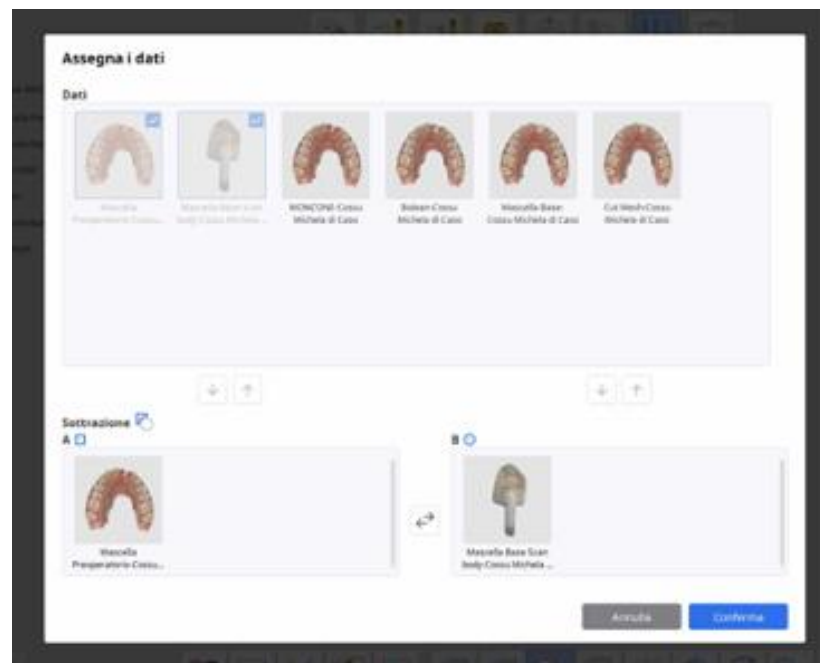


Figure 7. Set of the Boolean of subtraction between the pre-operative maxilla scan and the Scanbody scan (temporary restoration on a sticky wax mounted on the holder; Medit Design, Medit corp.).

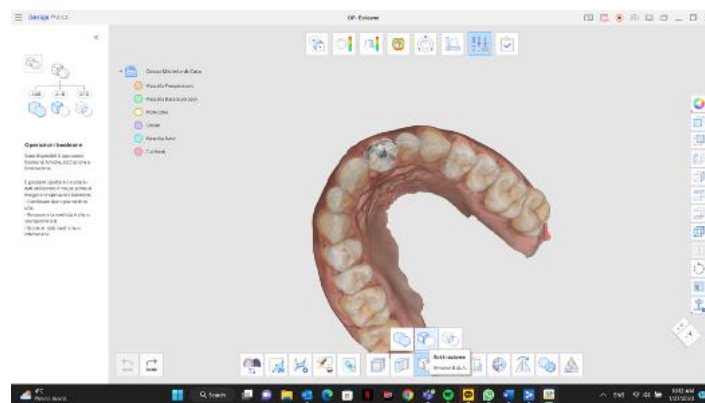


Figure 8. Matching between the pre-operative maxilla and Scanbody scans (Medit Design, Medit corp.).

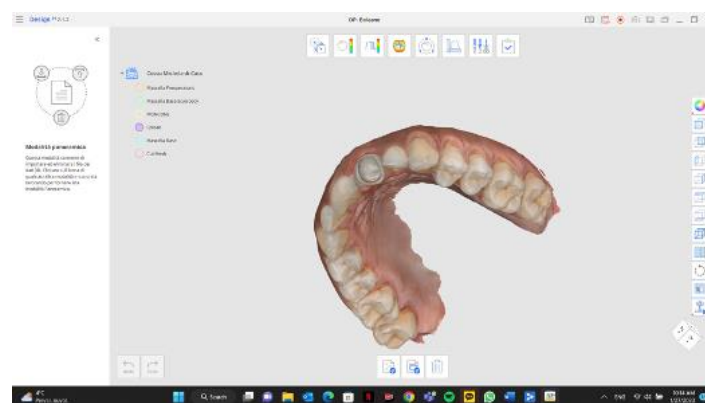


Figure 9. Boolean of subtraction: final result (Medit Design, Medit corp.).



Figure 10. Definitive restoration.



Figure 11. Emotional picture and periapical radiograph on the right.

3. Discussion

The proposed biological-oriented impression technique aims to easily and quickly transfer, to the dental lab, the accurate information of the finish line and the emergence profile of the interim restoration when applied on a tooth prepared according to the BOPT concept [11]. The dental technician, or the same dentist in a chair-side workflow, can easily detect the finish line at the prosthetic CEJ, as well as the emergence profile of the interim restoration. In the present report, only two software were used. The first software was used to take the impression and detect the finish line (Medit Link V.3.0.6 for macOS, Medit corp.), and then a CAD software was used to finalize the restoration (ChairsideCAD 3.0 Galway, exocad GmbH). In addition, according to the presented technique, entitled the biological-oriented digital impression technique, no retraction cords are needed due to there being no marginal soft tissue displacement. This technique fully respects the biologic width dimensions by avoiding the invasion of the sulcus and the epithelial attachment. According to the BOPT concept, a novel prosthetic CEJ is established. The process begins after dental abutment preparation and gingivage, with fibroblast stimulation and migration to the sulcus. The biological-oriented digital impression technique, or BODIT, represents an innovation in dentistry, merging biological understanding with digital technology to improve dental impressions and prosthetic fitting. Creating a comprehensive 3D representation of the oral cavity enhances the treatment planning and execution process. However, its adoption might be challenged by the high costs and accessibility issues associated with digital impression systems [11,21,22]. Considering that the initial investment could lead to long-term benefits is essential. The increased accuracy could reduce the need for costly

prosthetic adjustments and remakes. In addition to the financial aspect, mastering BODIT requires a degree of training for dental professionals. This learning curve is intended to supplement their expertise over time. Notably, BODIT improves the patient experience by being less messy and more comfortable than traditional methods. This increased comfort can enhance patient satisfaction, becoming a unique selling point for dental practices despite the initial investment and training requirements. While BODIT has the immense potential to revolutionize dental impressions, its adoption hinges on cost, accessibility, and training. Therefore, a clinical audit should assess its effectiveness and feasibility in everyday practice [22,23]. Accurate interim restoration is mandatory to promote soft tissue healing and to guide marginal soft tissue remodeling. Key aspects of the clinical success of the presented technique are also the absence of soft tissue inflammation. The interim restoration must be well-finished and polished. Today, this procedure is still operator-dependent. The authors believe that in the near future, a set of interim restorations can be produced in advance, according to the final shape to be obtained. Moreover, the same proposed technique can be applied to implant-supported and multiple restorations. Although high patient satisfaction was obtained in the present clinical audit, and the satisfaction of the dental team was high, further research is needed to establish the technique well. The biological-oriented digital impression technique (BODIT) represents a paradigm shift in dentistry, integrating biological understanding and cutting-edge digital technology to enhance the quality of dental impressions and prosthetic fitting. Our report confirmed that BODIT facilitates the generation of comprehensive and highly accurate 3D representations of the oral cavity, substantially improving treatment planning and execution. This advanced representation offers the potential for reducing the rate of prosthetic remakes and adjustments, leading to significant time and cost savings in the long run [24,25]. However, the financial investment associated with acquiring and maintaining digital impression systems and the training needed to achieve proficiency in using these systems require a lot of work. These factors could impact the widespread adoption of BODIT, particularly in low-resource settings.

Limitations

The limitation of the presented technique is that the fit of the temporary restoration must be precise and well-polished. However, this should be a requisite in any dental procedure. Another limitation could be that the chair-side scan of the temporary restoration might be not easy, particularly at the beginning. For the latter, a learning curve is needed. Further research should be conducted to strongly evaluate this technique in both single and multi-unit restorations.

4. Conclusions

An important finding from our report was the proposed technique's ability to enhance the patient experience, marked by less discomfort and a more streamlined process than traditional impression methods. While often overlooked, this aspect could serve as a unique selling point for dental practices and should be considered. Despite the challenges, the potential benefits of BODIT are undeniable. Future research should focus on making digital impression technologies more accessible and affordable. Further, additional studies are warranted to explore educational strategies for the faster and more efficient training of dental professionals in using these systems. In summary, while BODIT holds substantial promise to revolutionize dental impressions, its adoption and integration into regular practice will depend on addressing the challenges of cost, accessibility, and training. As such, our findings underscore the importance of a comprehensive clinical audit that evaluates the efficacy of BODIT and its feasibility and acceptability in the complex landscape of everyday dental practice.

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