IDentistry

INTERNATIONAL DENTISTRY - AFRICAN EDITION

VOL. 11 NO. 4

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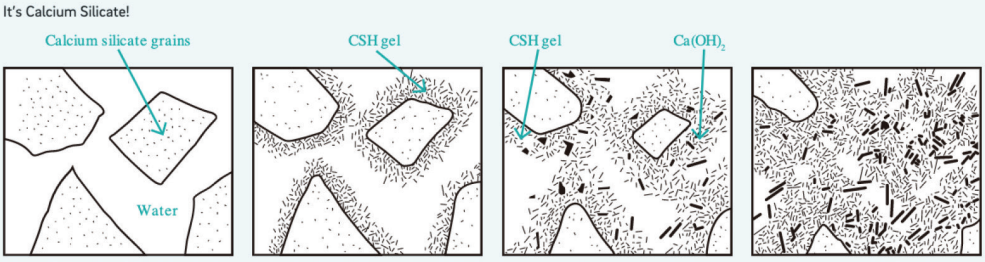

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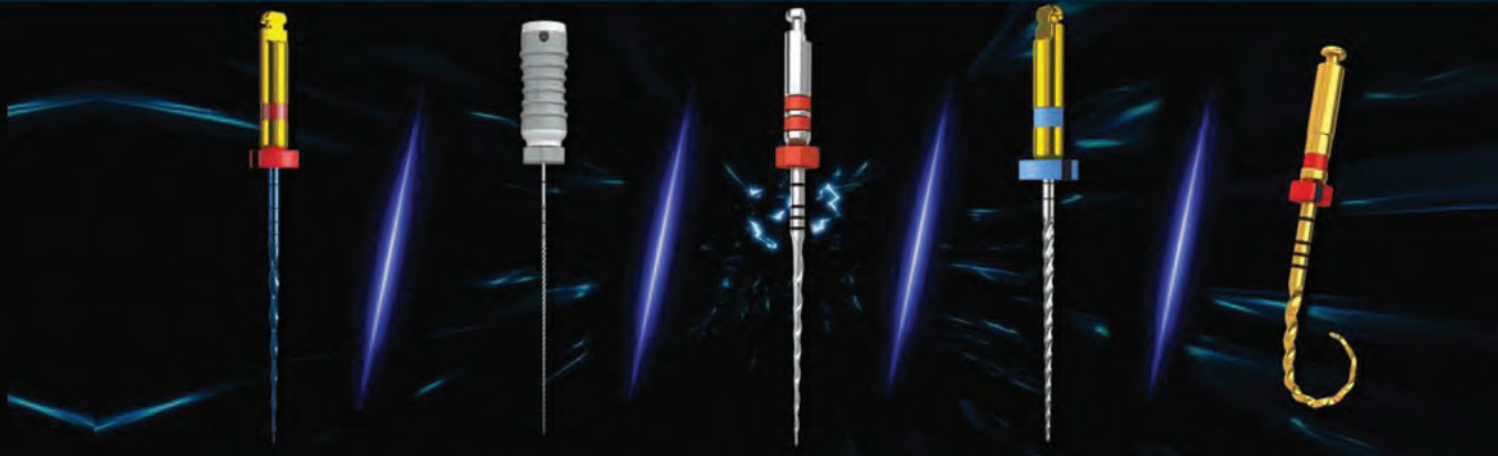

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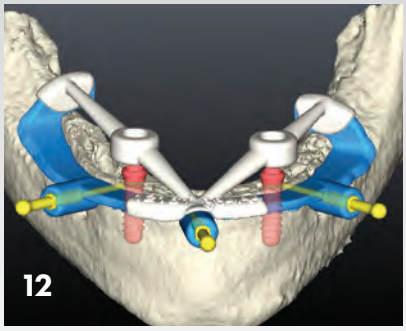

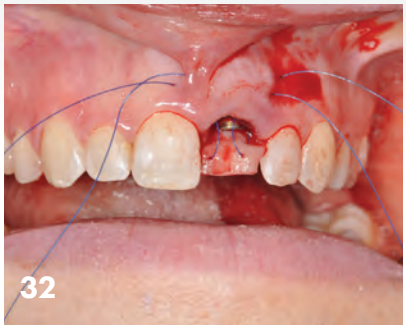

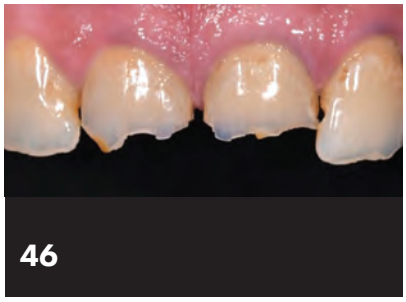

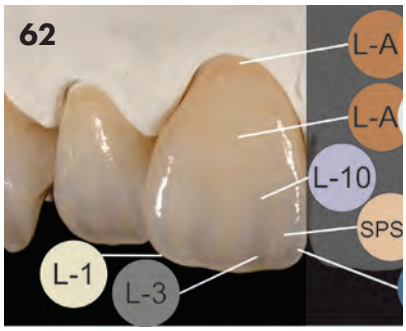

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Dental Training - could the Private Sector make a difference?

Professor Andre W van Zyl
MChD (Oral Medicine & Periodontics)

A few years ago I was asked to give a lecture on how I saw the future of dental training in South Africa. I was still in full time academics. What I said then, is probably truer today than ever. I was crucified by the establishment at the time, for daring to criticise the training at our dental schools.

At the time I saw that cutting edge technology was used widely in the private sector, but lack of funding meant that we were falling behind in the training hospitals. This was seen across almost all disciplines. Five years later and I think training institutions are under more strain today and budget constraints will increase in the years to come.

The only solution that I thought would be sustainable then is what I still believe now - to involve the private sector in a mentorship capacity, almost as a finishing school. This could be achieved either through student driven contact with the private sector (which I think would benefit only a few), or as a concerted effort by the academic institutions to involve all role players in the training of students.

In the field of periodontology, I could achieve much more in a week with 2 students in my practice than they would learn from me in fragmented sessions over a year at varsity. I think I have enough experience to justify that statement and am sure my colleagues in other disciplines would be able to say much the same.

I believe that there is much goodwill out there by dentists towards their alma maters. I think it is time to test that goodwill. It needs just one champion to drive the process and it could be achieved within the final two years of training.

At the end of the day it is the responsibility of training institutions to deliver competent clinicians for the private sector as well. What better place to hone some of those skills than in top private practices?

Warm regards

Andre

International Dentistry
INTERNATIONAL DENTISTRY - AFRICAN EDITION

Vol. 11 No. 4, August/September 2021
ISSN 2226-1567

International Dentistry African Edition
is published by Modern Dentistry Media CC,
PO Box 76021 Wendywood 2144 South Africa
Tel: +27 11 702-3195
e-mail: dentsa@iafrica.com
www.moderndentistrymedia.com

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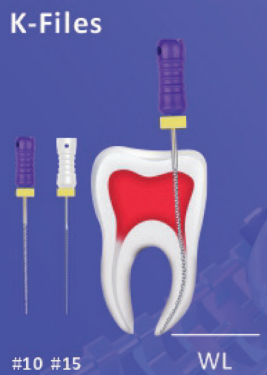

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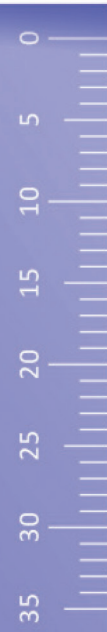

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Masterclass in Clinical Practice

Implant Dentistry
with
Prof Andre W van Zyl[1]

Removing a fractured implant screw

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2. Tesmer M, Wallet S, Koutouzis T, Lundgren T. Bacterial colonization of the dental implant fixture-abutment interface: an in vitro study. J Periodontol. 2009;80(12):1991-7.

[1] Andre W. van Zyl
MChD (Oral Medicine & Periodontics)

I am often sent patients with the request to remove fractured screws within implants. As implants age and metal fatigue sets in, this will become a routine procedure that many clinicians will be faced with. If the screw is not removed successfully, or if the screw thread within the implant is damaged in an effort to remove it, it may lead to the loss of the implant. This has massive cost implications for the patient and may involve many procedures if the implant is to be removed and replaced with a new one. It is therefore an extremely important procedure, yet a very simple one in most cases. There are some important do's and don'ts in this procedure.

1st Tip: Never use a drill at any time in the process of trying to remove the broken off screw. This will most definitely damage the screw threads within the implant, rendering the implant useless. To tap new thread inside an implant is in my humble opinion not a viable option for most.

2nd Tip: Once the screw head fractures off, the screw is no longer under tension, and should be loose within the implant. This implies that it should be very easy to turn the screw out, provided a method can be found to turn the screw anti-clockwise. No force is therefore necessary, rather a light touch used correctly.

Clinical procedure:

In my experience the ultrasonic scaler works best for removing broken off screws. Almost all practices will have an ultrasonic scaler, so it should be possible for most clinicians to use this technique.

In order to use the ultrasonic to remove a broken off screw, one has to understand the action of the scaler tip. Regardless of the type of scaler, it has been found that most use the same action of a longitudinal elliptical nature.[1] This forward and backward movement if used correctly will spin the screw anti-clockwise and so remove the screw. One has to be patient and not touch any exposed threads inside the implant as this will damage the threads and prevent placement of a new abutment/screw.

The idea is to touch the tip gently on the screw and to induce a rotational force on the screw by moving the tip as shown in Figure 1.

It follows that this rotational force can be inward or outward, depending on how and where the tip touches the screw shaft. By touching it gently to the screw, and playing with the tip in an anti-clockwise motion, the screw will at some stage tend to rotate outward. Figure 1 shows the correct application of the tip as indicated by the arrow.

This may cause a sudden movement, expelling the screw fragment completely, or it may move it slightly (see Figures 2a and b), enabling the clinician to use a tweezer or instrument like a probe to further rotate it outwards. After each application one should carefully inspect the screw for movement, as it may just as quickly turn clockwise again.

3rd Tip: To prevent the screw from being aspirated, precautions should be taken to catch the screw in a gauze placed posterior around implant to protect throat area or alternatively using high volume suction to catch it as it comes out.

The smallest diameter scaling tip should be used (Figure 3) so as to engage the screw only, without damaging the threads adjacent. A larger diameter tip may damage the implant. The tip shown is a

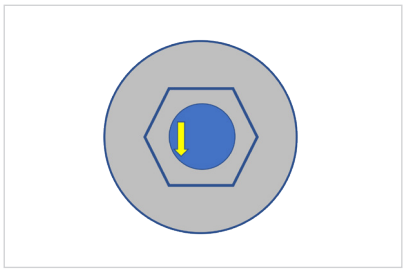

Figure 1: Diagrammatic illustration of correct application of scaling tip on screw (shown as blue circle) in an external hex implant

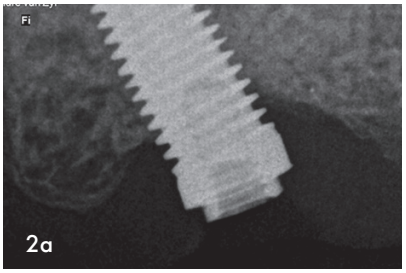

Figure 2a: Radiograph showing broken off screw deep in implant

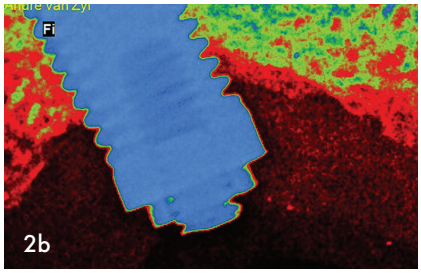

Figure 2b: Radiograph showing screw just emerging above implant after applying a light ultrasonic force as described

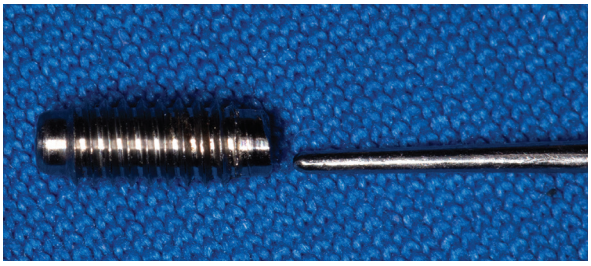

Figure 3: Small diameter scaling tip shown against a broken off standard size implant abutment screw.

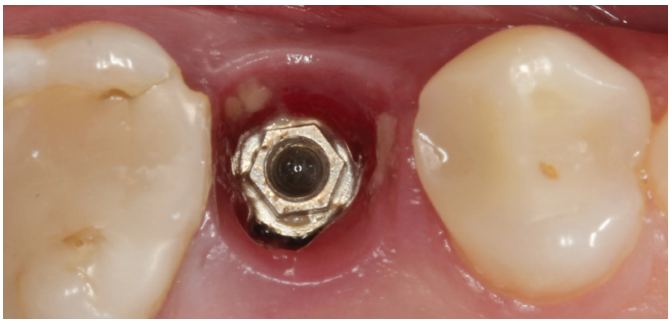

Figure 4: External hex implant showing clear visual access to screw hole

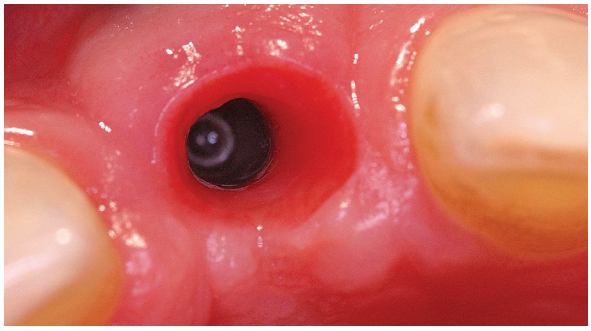

Figure 5: View of a cone-in-cone connection obscuring the implant platform and showing cone only

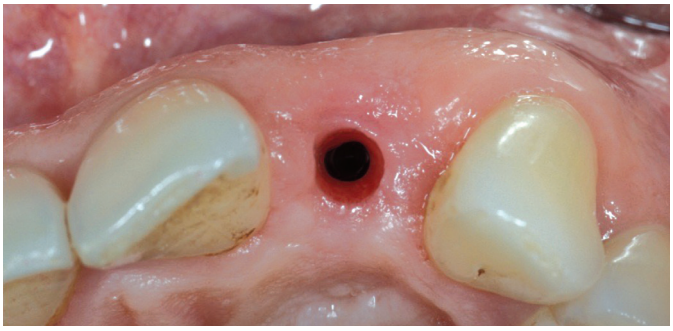

Figure 6. Figure 6: Narrow diameter abutment and a cone in cone abutment connection with almost no visual or physical access to screw hole (Image courtesy Prof. Paul Weigl, Frankfurt)

NSK® P-20S. If a rotation is sensed but the screw does not turn enough, the tip may be used in a complete rotational manner to help turn the screw out. Keep the tip in light contact with the screw while guiding the tip in anticlockwise circle movements.

Over the past 12 years many implant designers have changed to a cone-in cone implant abutment connection. Should a screw fracture in such implant designs, the challenge is to remove the screw without touching the cone inside the implant as the cone is important in providing a bacterial seal. Scratching the cone with the ultrasonic scaler may cause loss of the bacterial seal leading to bacterial accumulation within the implant.[2]

When examining a butt-joint external hex implant, the screw hole is visible and soft tissue will not obscure the implant platform (Figure 4). However, when a cone-in cone connection is examined, the implant cone is visible, but the implant platform is obscured by soft tissue and bone (Figure 5). This makes it very difficult to view the screw and to engage the screw without damaging the cone interface. The smaller the cone angle (Also called the Morse taper), the more difficult the access will be. In addition, if a narrow diameter abutment was used, it may be impossible to see and access the broken off screw (Figure 6) and it may need a surgical exposure to obtain access to the implant platform and screw.

Conclusion

Removing a broken off screw can be a rewarding experience for clinician and patient if it is successful, but can be a practice breaker if it becomes a drawn out procedure ending in the loss of the implant. It is well worth it to book these procedures as the last of the day, so as to have enough time and not rush it. Have a healing abutment or abutment on hand to place once the screw is removed to maintain the gingival opening.

The procedure is shown in the video clip.
Click on the QR code to view

Masterclass in Clinical Practice

Endodontics

with

Dr Martin Vorster[1]
Prof Peet van der Vyver[2]

Non-vital bleaching for discoloured endodontically treated teeth

[1] Martin Vorster,
BChD (Pret); PGDipDent (Endo); MSc (Odont)

[2] Peet van der Vyver,
BChD (Pret); Dip. Odont (Aest Dent);
Dip.Odont (Endo); MSc Odont (Endo), PhD (Endo)

Introduction

Tooth discolouration has varying etiological factors and differs in its severity, location and clinical appearance. Tooth discoloration can be defined as being either of intrinsic or extrinsic origin or even a combination of both factors.

Trauma, aging, pulpal necrosis, resorption, intrapulpal bleeding as well as endodontic and restorative procedures and its associated materials are some of the leading causes of local post-operative intrinsic staining.

Not only does tooth discoloration present an aesthetic concern to the patient, but it also poses a clinical challenge to the dental practitioner. Different bleaching materials and effective treatment modalities to address tooth discolouration are well described in literature.

Non-vital walking bleaching is one such treatment option considered an effective non-invasive endodontic treatment to lighten discoloured non-vital teeth as a result of intrinsic staining. This is achieved by the placement of chemical oxidising agents within the coronal aspect of the tooth.

In this series of "Masterclass in clinical practice" the authors will demonstrate the walking bleaching technique using 35% hydrogen peroxide gel, in combination with vital bleaching, in a discoloured anterior tooth, post endodontic treatment.

Preliminary treatment

• Pre-operative and post-operative clinical photographs to show the patient the results obtained at the end of the treatment is a useful tool to assess the outcome of the treatment (Figures 1 and 2).

• A good quality pre-operative periapical radiograph or CBCT scan is required to evaluate the standard of the endodontic treatment and obturation quality prior to the non-vital bleaching procedure.

Preparation of access cavity and cervical seal

• Apply a rubber dam to protect the adjacent structures.

• Gutta percha in root canal should be reduced 1–2mm below the CEJ (Figure 3a). This can be determined by using a periodontal probe placed in the pulp cavity, while reproducing the corresponding external probing to the CEJ.

• Prepare access cavity and include the mesial and distal pulp horns as they often contain necrotic pulpal remnants which can cause further discoloration.

• Air-polishing with bicarbonate soda powder (Figure 3b) can be useful to remove remnants of restorative and root-filling materials.

• Place a 2-mm layer of glass-ionomer cement (eg. Vitrebond, 3M ESPE) (Figures 3 c-d) up to the level of the CEJ to avoid leakage of bleaching agents into the periodontium.

• Additional conditioning of the dentine surface of the access cavity with 37% orthophosphoric acid (Figure 3e) is suggested to remove the smear layer and to open the dentinal tubules. This promotes enhanced penetration of the bleaching agent deep into the tubules and increases its effectiveness.

Application of bleach and temporary seal of access cavity

• Prior to the application of the bleaching gel, take a scissor and cut small Peli Tim sponges no.1 (Voco) into thin wafers (Figure 4 a-c).

• Dispense some bleaching material (eg. Opalesence Endo,

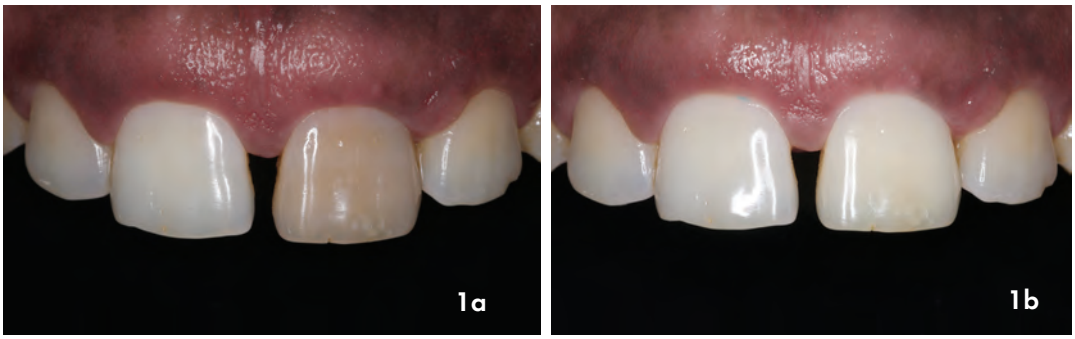

Figure 1: (a)Preoperative view of patient that presented with a discoloured root canal treated maxillary left central incisor; (b)post-operative view after non-vital bleaching.

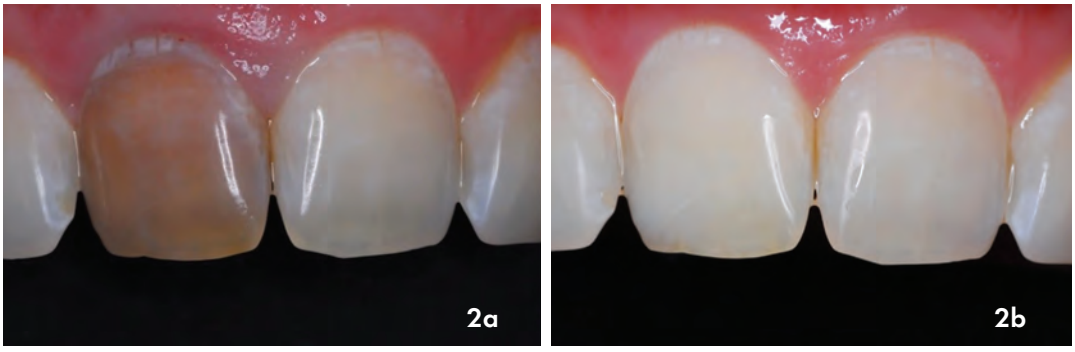

Figure 2: (a)Preoperative view of patient that presented with a discoloured root canal treated maxillary right central incisor; (b)post-operative view after non-vital bleaching.

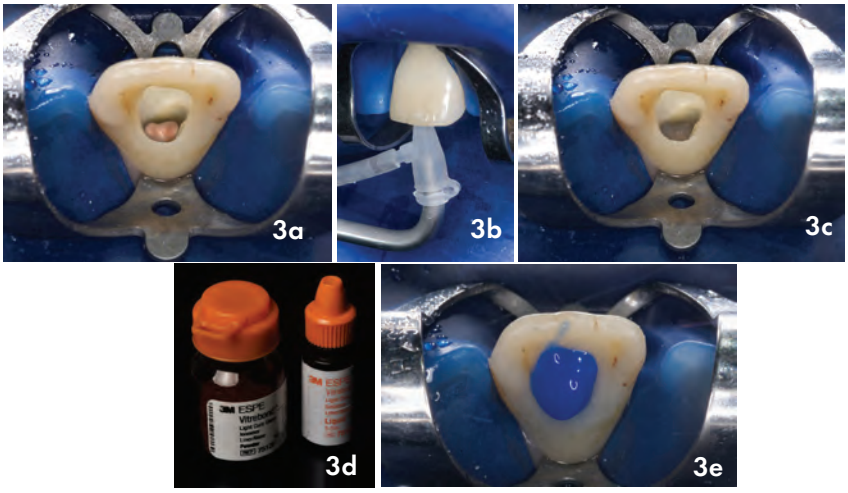

Figure 3: (a) Gutta percha reduced 1–2mm below the CEJ; (b) Air-polishing with bicarbonate soda powder in AquaCare unit (Velopex) to remove remnants of restorative and root-filling materials; (c) A 2-mm layer of glass-ionomer cement (eg. Vitrebond, 3M ESPE) placed to the level of the CEJ; (d) Vitrebond (3M ESPE); (e) Additional conditioning of the dentine surface of the access cavity with 37% orthophosphoric acid.

35% hydrogen peroxide gel, Ultradent) on the facial aspect of the access cavity (Figure 5 a-b)

• Cover the bleaching gel with a sectioned Pele Tim sponges (Figure 5c). Some of the bleach will be absorbed into the porous sponge material.

• Ensure that the bleach does not push up to the access cavity margins and leave enough space for placement of a temporary material in the access cavity. The walking bleach technique requires a sound seal around the access cavity to ensure its effectiveness and to avoid leakage of the bleaching agent into the oral cavity. This step is key to the success of the procedure and for the rate at which the bleaching takes place. With adequate seal the teeth generally bleach within 24-72 hours.

• The authors recommend to use a capsulated glass-ionomer material (eg. Ketac Molar, 3M ESPE)(Figure 5d-e) to allow for easy dispensing over the saturated Pele Tim sponges. This will ensure limited pressure on the sponge and no contamination on the access cavity margins. After the material has set it is trimmed with a round diamond bur.

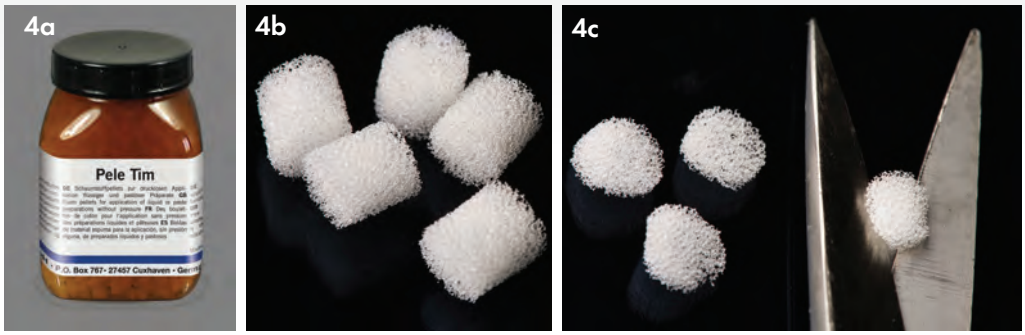

Figure 4; (a)Bottle of Pele Tim sponges; (b) High magnification view of the Pel Tim sponges; (c) Sponges cut into thin wafers with a scissors

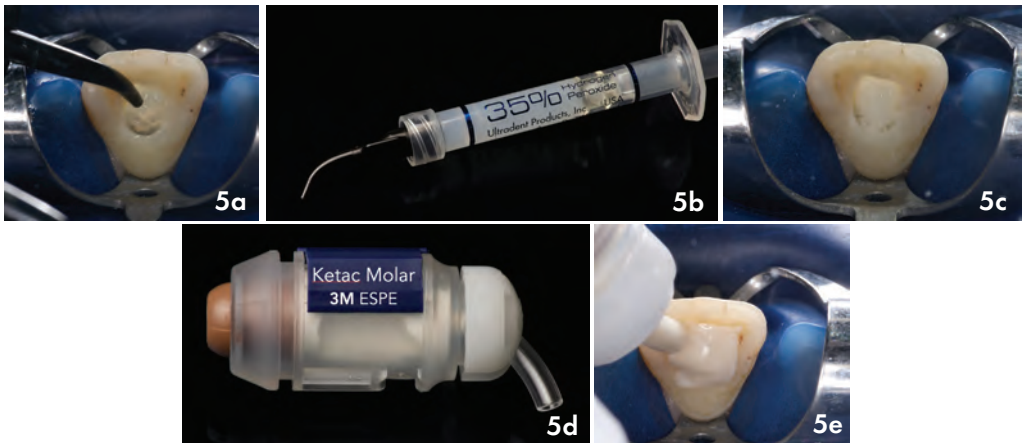

Figure 5:(a and b) OpalEndo, 35% hydrogen peroxide gel (Ultradent) is dispensed onto the facial aspect of the access cavity; (c) Bleaching gel is covered with a sectioned Pele Tim sponges; (d and e) Capsulated glass-ionomer material, Ketac Molar (3M ESPE) is dispensed over the saturated Pele Tim sponges

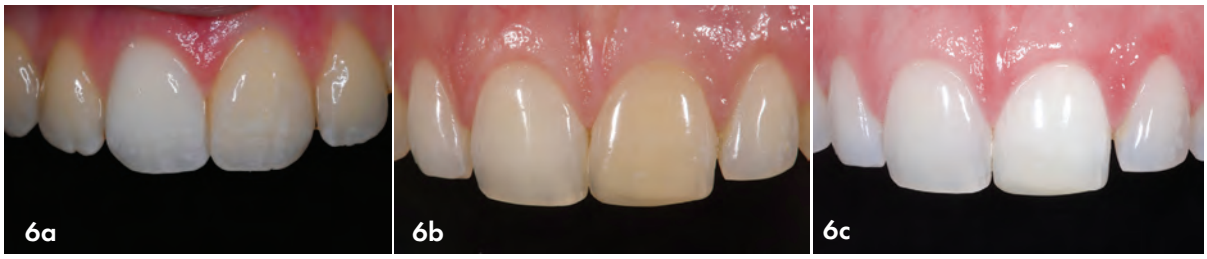

Figure 6:(a) Postoperative view of patient that presented with a discoloured root canal treated maxillary right central incisor that was over bleached; (b) Preoperative view of patient that presented with a discoloured root canal treated maxillary left central incisor; (b)Post-operative view after "over bleaching" of the maxillary left central incisor followed by vital bleaching of the surrounding teeth to achieve a more aesthetic result.

• Patients should be instructed to evaluate the tooth colour on a two hourly basis and return when the bleaching is acceptable to avoid "over-bleaching"(Figure 6a). In the event of "over bleaching" it would be advised to do vital bleaching on the surrounding teeth in order to achieve an acceptable aesthetic outcome (Figure 6b-c).

Conclusion

In conclusion, non-vital bleaching is a safe, effective and non-invasive treatment option to restore the colour and aesthetics of endodontically treated teeth. Aftercare and regular follow-up visits however remain important to ensure the longevity of non-vital bleaching procedures.

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Current state of CAD/CAM technology in implant dentistry

Dean Morton[1], Waldemar Polido[2], Wei-Shao Lin[3]

Abstract

Complete or partial digital workflow utilizing computer-aided design and computer-aided manufacturing (CAD/CAM) technology provides dental clinicians with ample options to treat their patients in a more effective way in daily practice. Dental clinicians and technicians need to recognize the limitations and proper indications of currently available technologies to accomplish optimal clinical care outcomes for patients. This article aims to narratively review various current CAD/CAM technologies (such as digital data collection, the development in CAD software programs and manufacturing platforms) in implant dentistry and discuss their advantages and limitations.

Keywords: CAD/CAM, digital, prosthesis, dental implant

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Introduction

A comprehensive digital workflow process for treatment including dental implants begins with data collection. Digital data collection may include 3-dimensional (3D) object scanning and obtaining a digital volume (CBCT). Together, the components of data collection allow for comprehensive treatment planning in which implant therapy is thought of as a singular entity and part of a total plan for the patient (Gallucci et al. 2019, Morton et al. 2019). Although the concept of comprehensive planning and treatment is embraced, this article will focus on those segments of the workflow traditionally considered to be of a restorative nature. Subsequent to data collection, the primary focus will therefore be computer-aided design and computer-aided manufacturing (CAD/CAM) of prostheses and associated processes.

CAD/CAM technology has found increasing popularity in dentistry. These processes can be seen as gradually replacing conventional fabrication methods, inclusive of implant-supported/retained prostheses. Available evidence supports incorporation of CAD/CAM protocols for single crown implant-supported crowns (Pjetursson et al. 2019), although the evidence for use of these procedures for fixed partial procedures is less compelling (Sailer et al. 2019). Research consistently demonstrates the precision and accuracy of CAD/CAM implant prostheses to be at least comparable and often improved when compared to the traditional lost-wax/casting technique. The advantages of CAD/CAM fabrication technology can be amplified for multi-unit implant prostheses and complete arch implant prostheses (Katsoulis et al. 2014).

3D object scanning can be undertaken with either a laboratory-based or intraoral scanner (Joda et al. 2017). Intraoral scanning offers clinical advantages including real-time evaluation of the impression and associated procedures (Figs 1–2). Intraoral

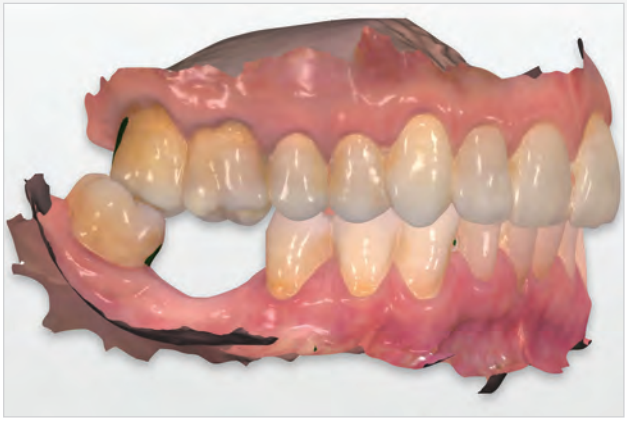


Fig. 1: An intraoral scan can be used for the preoperative diagnosis and treatment planning of static computer-aided implant surgery (sCAIS)

Fig. 2: When combined with a scan body, an intraoral scan can record the position and the timing of dental implants for the subsequent prosthesis fabrication

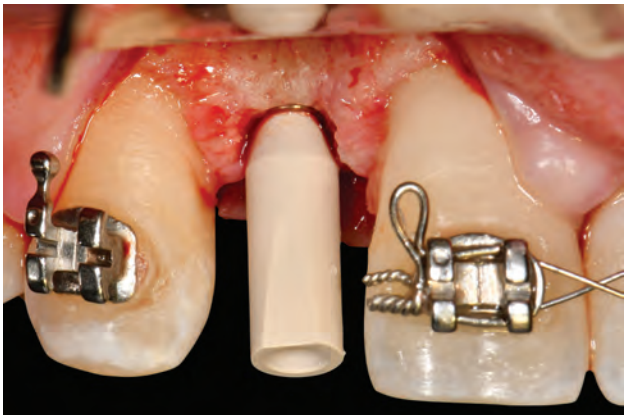


Fig. 3: An intraoral scan is more hygienic when an impression is desired during surgery. It may be of clinical convenience and ease if a patient is undergoing orthodontic treatment and is fitted with orthodontic brackets

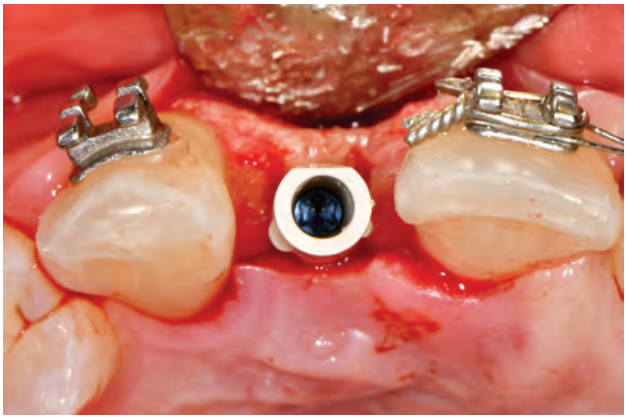


Fig. 4: The bevel near occlusal third on a scan body is a critical design for the CAD/CAM software to register the implant position and timing. The scan body should be positioned in a way that the bevel on the scan body facing area is easily accessible for intraoral scanning (generally speaking, towards the facial surface)

optical scanning offers flexibility and is compatible with in-office CAD/CAM systems and well as local and centralized laboratory options. Intraoral optical scanning may prove to be more hygienic in the transfer of information to the laboratory partners as there are no cast or analog components (Figs 3–4). There remains, however, a lack of high-quality evidence to support selection guidelines when considering conventional versus digital implant impression techniques. Available articles (mostly in-vitro laboratory studies) demonstrate however that digital impression options (intraoral and laboratory-based) offer a valid alternative for single and multi-unit implant prostheses. In particular, existing information supports improved patient perception and higher satisfaction with intraoral optical scanning (Wismeijer et al. 2014). Clinicians should be aware, however, that the distance between the implants (edentulous span), implant placement depth, implant angulation, operator experience, different intra-oral scanner systems and scan strategy may all affect the overall accuracy of intraoral scanning (Rutkūnas et al. 2017) (Figs 5–6).

Optical impressions or scans (intraoral or laboratory-based) can be used by both dental laboratory technicians and clinicians for the design and fabrication of prostheses using CAD/CAM options (Figs 7–9). For clinicians who

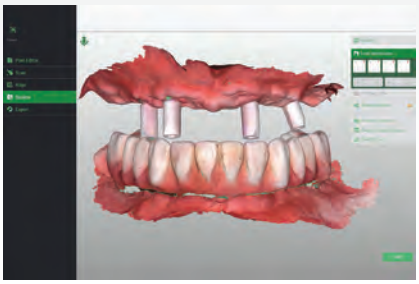


Fig. 5: The distance between implants (edentulous space) often affects the overall accuracy of intraoral scans greatly

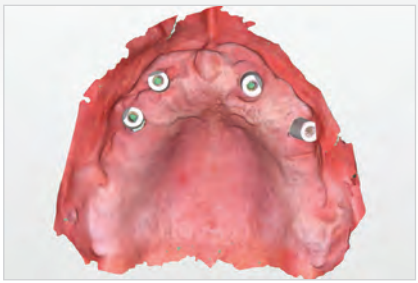


Fig. 6: Scanning the edentulous patient can pose a clinical challenge to capturing an accurate soft tissue extension, the maxillomandibular relationship, and inter-implant relationships

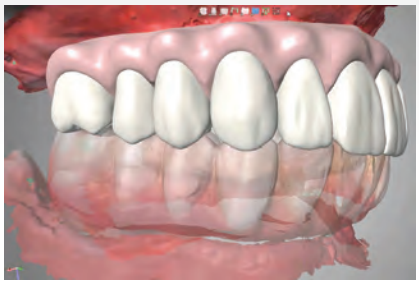


Fig. 7: The intraoral scan was sent to the dental laboratory for the design and fabrication of a CAD/CAM interim PMMA hybrid prosthesis

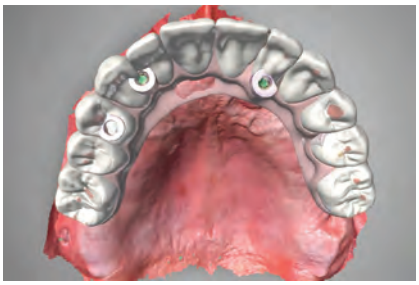


Fig. 8: Occlusal view of CAD/CAM interim PMMA hybrid prosthesis

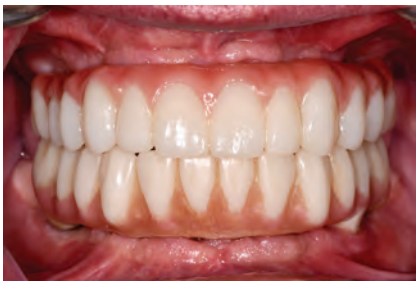


Fig. 9: The maxillary prosthesis was milled with a tooth-colored PMMA CAD/CAM block and layered with soft-tissue-colored laboratory composite resin

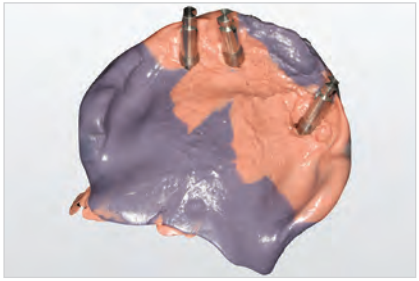


Fig. 10: When the registration of soft tissue's dynamic/functional movement is indicated for an implant-retained prosthesis, a traditional analog impression can be made to obtain proper soft tissue extension

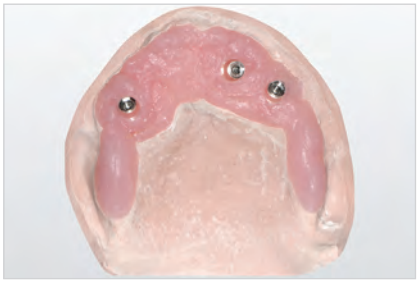


Fig. 11: A dental stone cast can be digitalized with a laboratory scanner for the subsequent CAD/CAM prosthesis fabrication

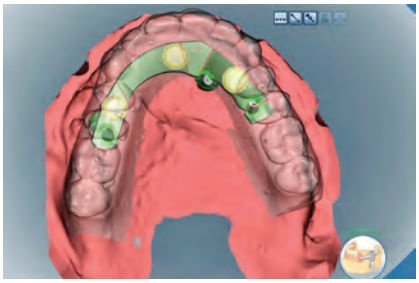


Fig. 12: Representation of scanned dental cast, and the design of CAD/CAM bar on 3 dental implants

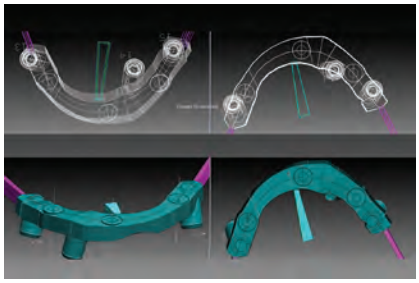
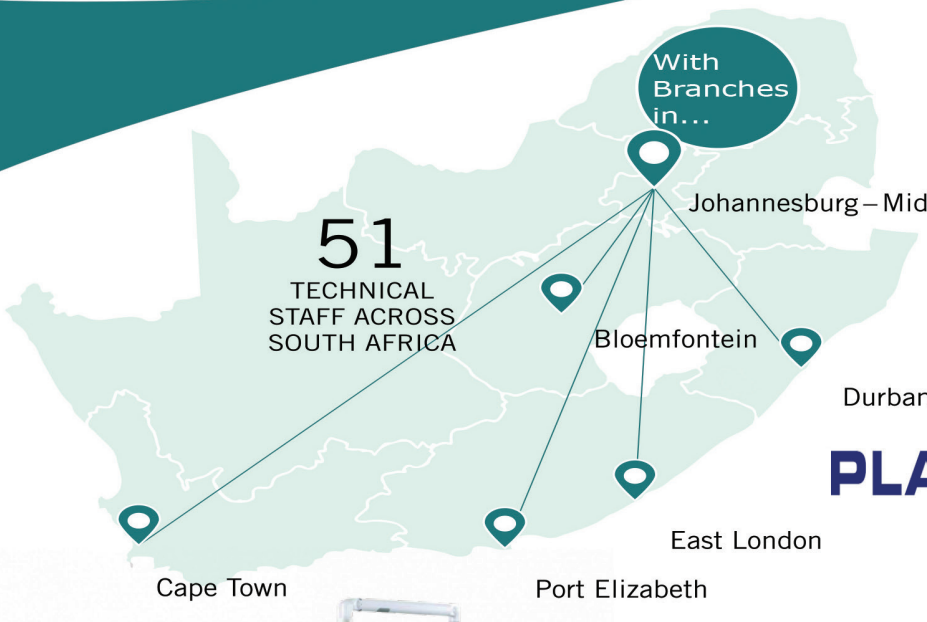


Fig. 13: Computer validation of the design of CAD/CAM bar

choose conventional impression methods or have limited access to an intra-oral optical scanner, or under certain clinical conditions, a conventional impression can be made (Fig. 10). The resulting cast can be digitalized using a laboratory scanner (Figs 11–12). This is a representation of a partial digital restorative workflow whereby CAD/CAM technology can be applied for prosthesis design and fabrication, possibly improving precision and reducing human production errors when compared to a complete conventional analog technique (Fig. 13) (Kapos et al. 2014).

Extraoral facial soft tissue scanning is a more recent option being marketed as part of a complete digital workflow



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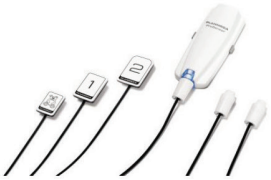

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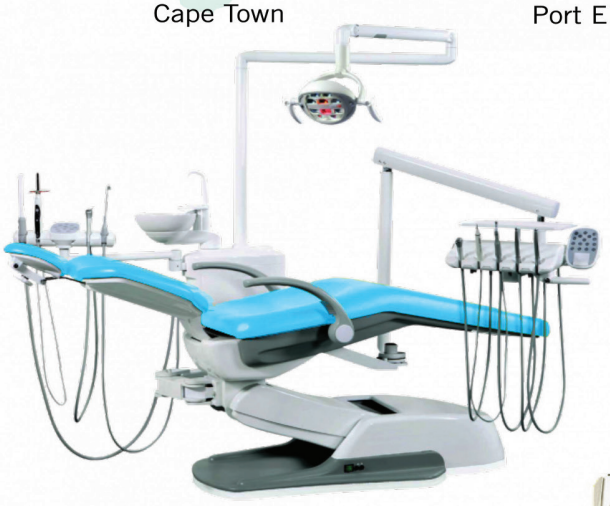

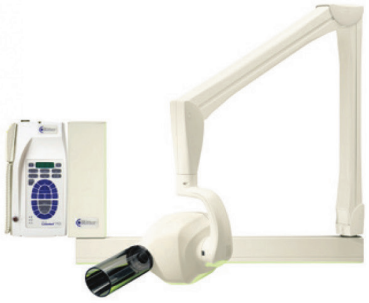

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Fig. 14: Different economic extraoral facial soft tissue surface scanners are now commercially available

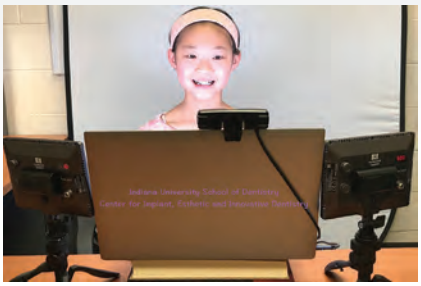

Fig. 15: Ample lighting is desired while obtaining facial scans, and additional photography lighting equipment can be purchased to improve the overall quality of facial scans

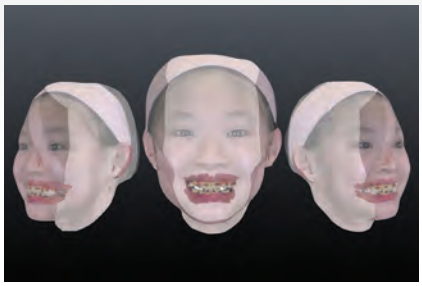

Fig. 16: A 3D virtual patient can be obtained with the superimposition of extraoral facial and intraoral dental scans

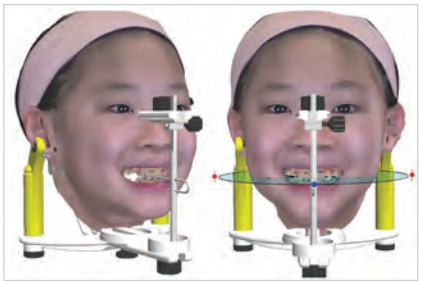

Fig. 17: Using the facial anatomic landmarks, a virtual articulator may be used to simulate/estimate the patient's dynamic occlusal contacts

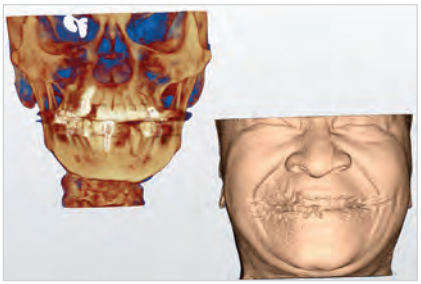

Fig. 18: Although CBCT allows the 3D imaging of the craniofacial hard tissue, it only has a limited field of view and contrast resolution for facial soft tissue

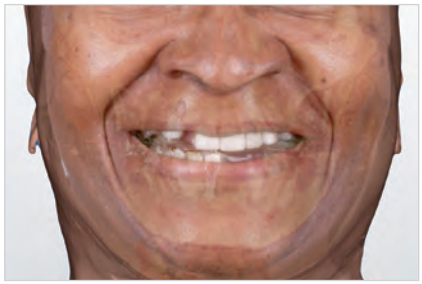

Fig. 19: The craniofacial hard tissue reconstructed from CBCT volumetric data can be superimposed with digital photographs to create a 3D virtual patient with photorealistic appearance

Fig. 20: A digital diagnostic tooth arrangement can be superimposed to the virtual patient to simulate soft tissue profile changes and obtain the patient's approval

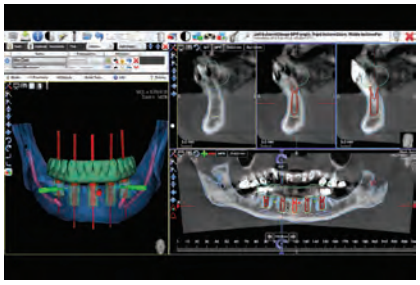

Fig. 21: The approved diagnostic tooth arrangement can be used for prosthetically-driven sCAIS planning

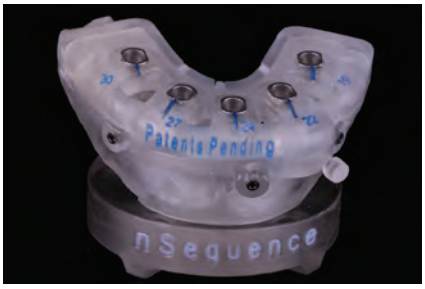

Fig. 22: CAD/CAM surgical templates for planned sCAIS

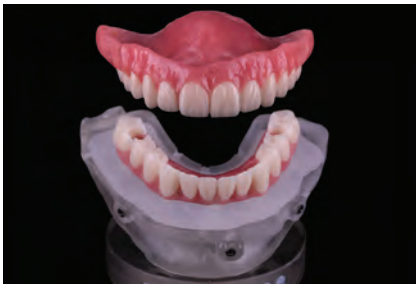

Fig. 23: CAD/CAM interim prostheses for planned immediate provisionalization

process (Figs 14–15). The overall esthetic treatment outcome is a decisive factor for the patient's emotional acceptance of both tooth loss and treatment. In order to optimize clinical outcomes, clinicians seek harmony between dental and facial esthetics. Emerging technologies allow clinicians to capture the 3D surface texture of a patient's extraoral facial soft tissue, including laser and optical-based surface scanners

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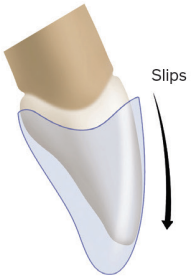

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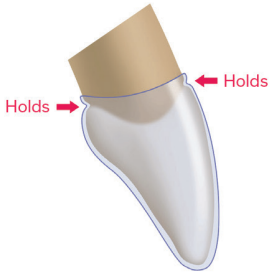

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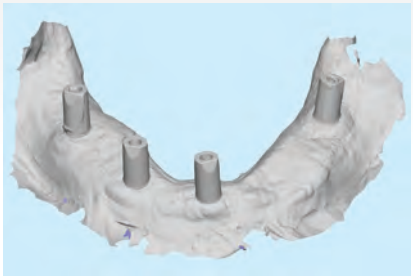


Fig. 24: Example STL file representing a mandibular intraoral scan of 4 dental implant scan bodies

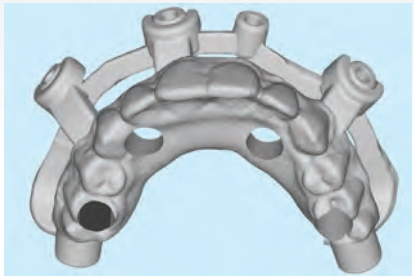


Fig. 25: Example STL file representing a surgical template and complete dental prosthesis for sCAIS

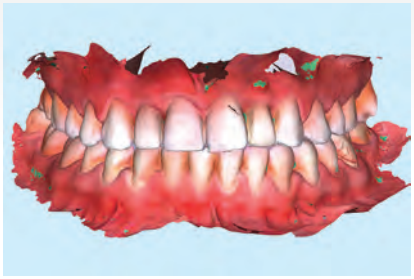


Fig. 26: Example PLY file representing a postoperative intraoral scan

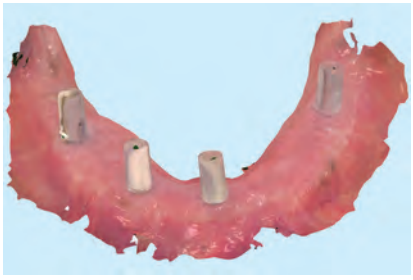


Fig. 27: Example proprietary file representing a mandibular intraoral scan of 4 dental implant scan bodies. The STL file in Fig. 24 was converted from this proprietary file format, and the surface texture and color cannot be preserved after conversion

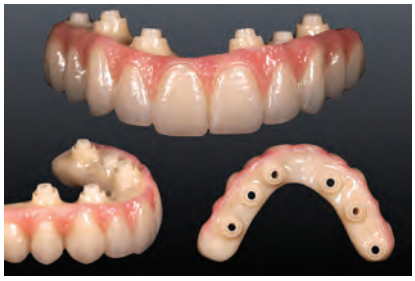


Fig. 28: Milled PMMA can be used as a prototype prothesis testing the functional and esthetic outcomes prior to the fabrication of definitive zirconia prosthesis

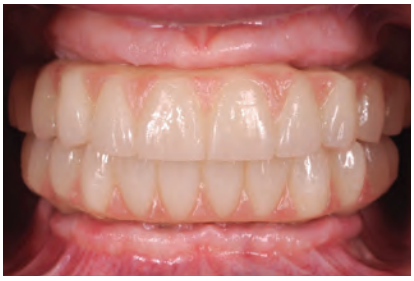


Fig. 29: After 1 to 2 months of intraoral function, the prototype prostheses may demonstrate occlusal changes resulting from patient's dynamic occlusion. The prototype prostheses can be sent back to the dental technician to be used as a reference when designing the definitive prostheses

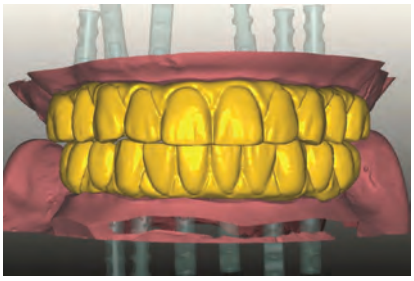


Fig. 30: Design of definitive zirconia prostheses

Fig. 31: Milled definitive zirconia prostheses prior to coloring and sintering

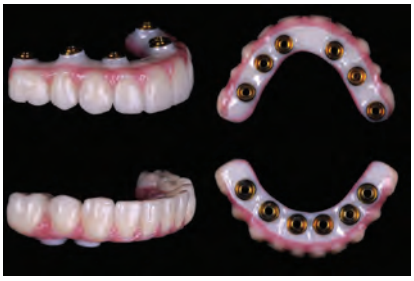


Fig. 32: Milled definitive zirconia prostheses ready for delivery

(Kau 2011) (Figs 16–17). In addition to surface scanners, 3D volumetric data obtained from a cone beam computed tomography (CBCT) can be superimposed (merged or registered) with digital photographs to create a 3D virtual patient with a photorealistic appearance. When combined with a laboratory or intraoral optical scan, a complete 3D virtual patient with photorealistic appearance can facilitate patient education and communication, diagnosis and treatment planning process for the static computer-aided implant surgery (sCAIS), as well as the design and manufacturing of CAD/CAM prostheses (Figs 18–23). Currently, the accuracy of digital data superimposition is a limiting factor when composing an accurate 3D virtual patient. Consistent anatomic landmarks need to be present in all digital files (inclusive of the intraoral optical scanner, facial scanner, CBCT imaging scanner, and dental laboratory scanner) to facilitate accurate superimposition (Kuric et al. 2018). A goal in the development of future technology is the

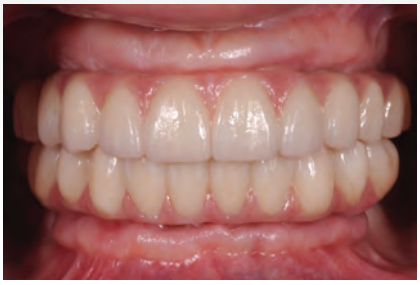


Fig. 33: Intraoral view of seated milled maxillary and mandibular definitive zirconia prostheses

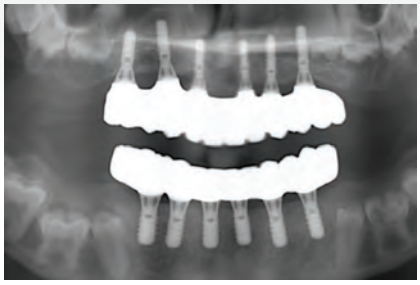


Fig. 34: Post-operative panoramic radiograph

Fig. 35: 3D printed interim implant crown with a desktop DLP printer

Fig. 36: 3D printed surgical template with a desktop SLA printer

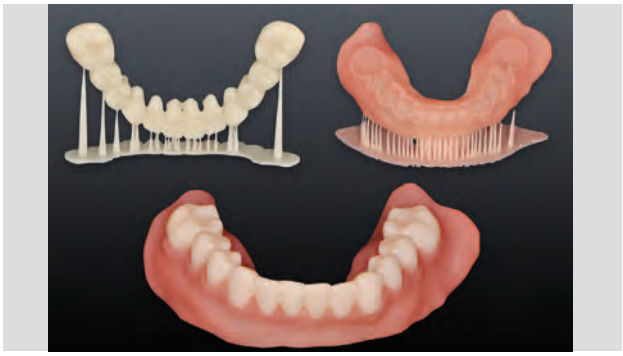


Fig. 37: 3D printed interim denture with a desktop DLP printer. Although desktop SLA or DLP printers are convenient for in-office production, one major limitation is that only one material (in color or stiffness) can be used in a single print job. When different materials are desired (such as pink and white resin in this instance), two separate prints and post-printing assembly are needed

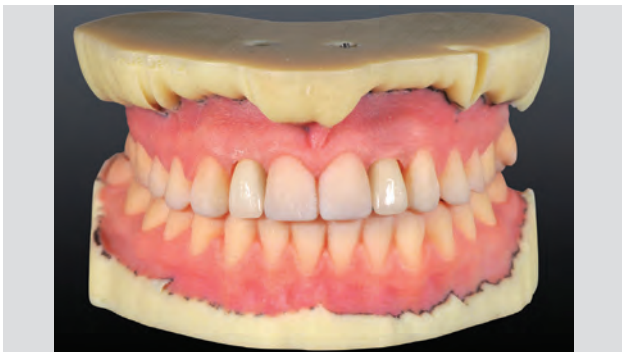


Fig. 38: Industrial 3D printer can operate different materials in the same print and produce objects with different colors, textures, gradients, transparencies and durometers in a single print operation. These dental casts were printed with a PolyJet printer (J750; Stratasys Ltd)

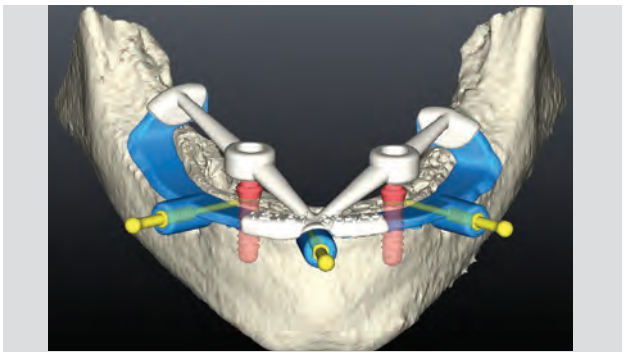


Fig. 39: Design of CAD/CAM bone reduction and surgical template for sCAIS

creation of a 4-dimensional (4D) virtual patient inclusive of the patient's dynamic motions. At present no commercially available digital system is able to compose such a 4D dental patient.

Most contemporary CAD/CAM systems have moved toward what is termed open architecture. Open architecture facilitates freedom of exchange of the digital data obtained from 3D scanners or computer software design programs.

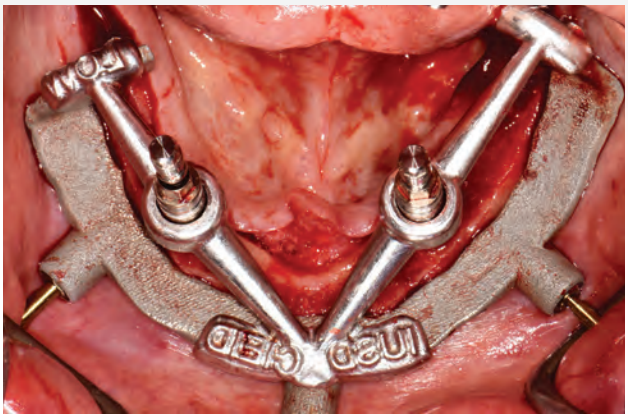


Fig. 40: The bone reduction and surgical template can be milled or printed from the cobalt-chromium (Co-Cr) or titanium alloy. Although the production cost with these materials could be higher, they offer superior mechanical strength and accuracy, which may in turn reduce the intra-operative complications, such as fracture of templates, insufficient mouth opening leading to insufficient operation access, and aggressive flap design needed to accommodate the bulky resin templates

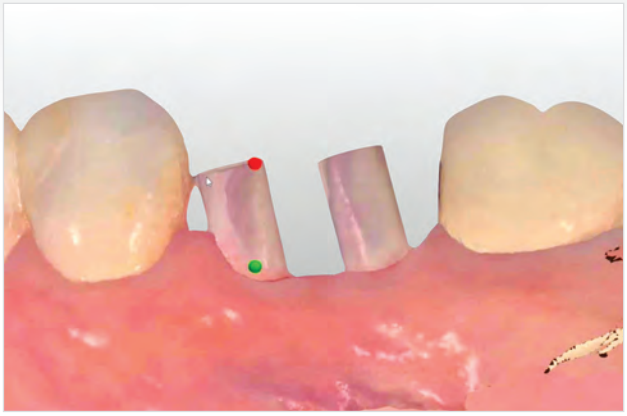


Fig. 41: A complete digital restorative workflow starts with an intraoral scan capturing implants' position and timing with scan bodies

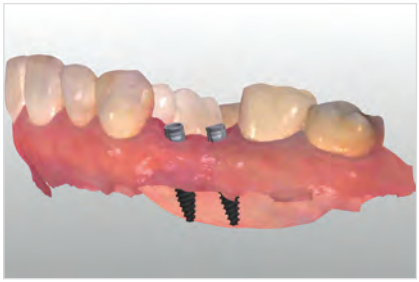


Fig. 42: Virtual titanium base abutments were placed onto the implants

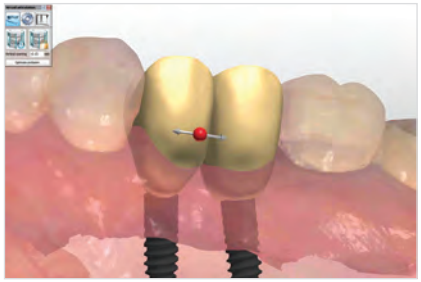


Fig. 43: Virtual design of CAD/CAM monolithic zirconia implant crowns

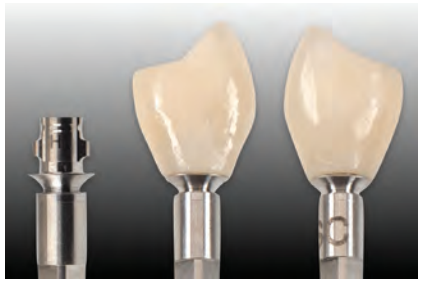
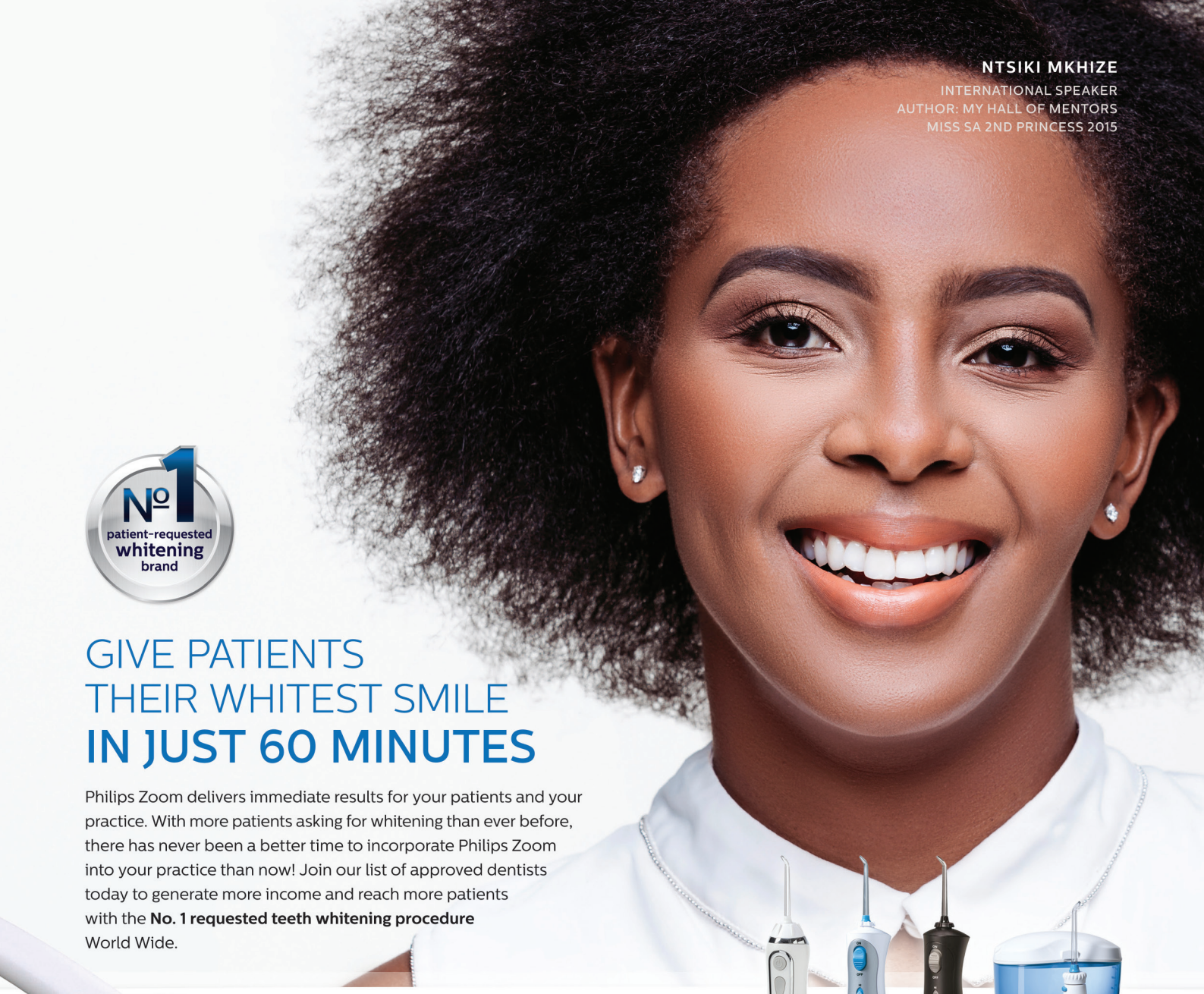


Fig. 44: Milled zirconia crowns can be completed with surface finishing, polishing and characterization. Resin luting agent is used to lute the zirconia crowns and the titanium base abutments together prior to insertion

The data can then be effectively used for the subsequent prosthesis fabrication with a range of manufacturing devices. In contrast, a CAD/CAM system with closed architecture limits the digital data acquisition process and prosthesis design and manufacturing to one integrated system with no interchangeability. Open architecture increases flexibility and allows integration of information by appropriate CAD software programs, so enabling the composition of a virtual dental patient for the treatment planning or prosthesis design. Another important advantage of an open architecture is the increased opportunity for clinicians and dental technicians to access a wide variety of manufacturing technology and restorative materials without constraint (van Noort 2012).

Digital information can be transferred between CAD software programs and manufacturing platforms more effectively when digital file formats are standardized and consistent. There are more than 140 different recognized file formats, with Standard Tessellation Language (STL) being the most commonly used. The STL format, although widely used, is limited to the surface geometry of a 3D object, without any representation of color or texture (Grant et al. 2016) (Figs 24–25). In cases where surface color or texture are relevant,



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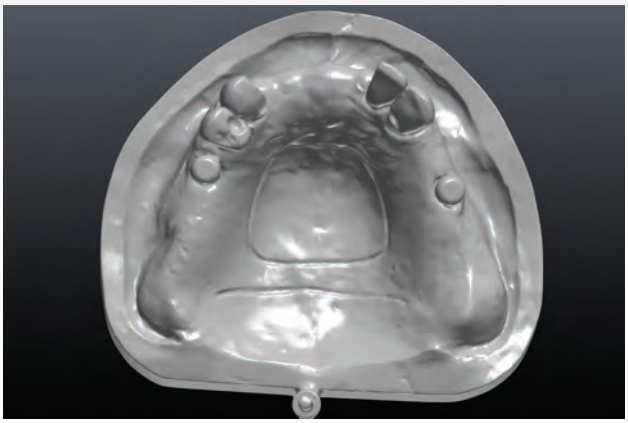

Fig. 45: When dynamic soft tissue movement is critical to a removable implant-retained prosthesis, a traditional impression should be made for optimal clinical outcomes. An analog cast can be digitalized in the dental laboratory with a laboratory scanner

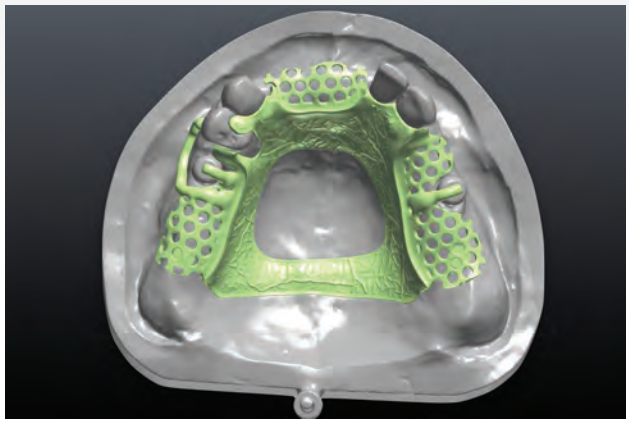

Fig. 46: Continuation of digital prosthesis design after analog cast digitalization

Fig. 47: Printed cobalt-chromium (Co-Cr) framework for removable dental prothesis

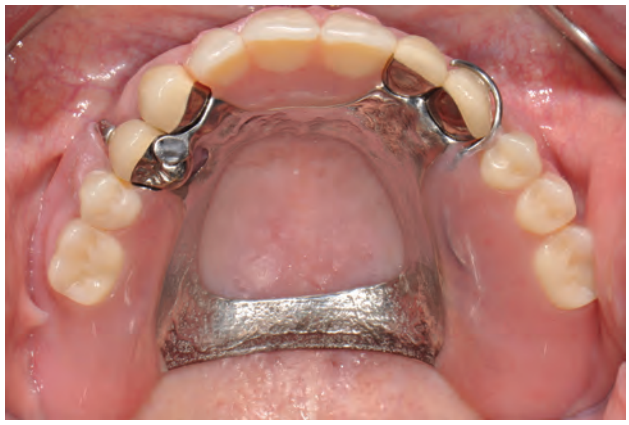

Fig. 48: Intraoral view of CAD/CAM implant-retained removable partial dental prosthesis

the OBJ (an open file format developed by Wavefront Technologies) or PLY (Polygon File Format or Stanford Triangle Format) file formats can be utilized to retain this information (Davies et al. 2017) (Fig. 26). OBJ or PLY files are therefore utilized to store extraoral facial information, preserving the 3D texture and color information of a patient's facial expression (Morton et al. 2019) (Fig. 16). A closed CAD/CAM system may utilize a proprietary digital file format that is not recognized by all software options, and although conversion of the file formats is possible, it may lead to data loss (Fig. 27).

Noteworthy developments in the field of CAD/CAM include additive manufacturing technologies. Previously, CAD/CAM technology was dominated by subtractive manufacturing methods, such as computer numerically controlled machining, electrical discharge machining, electrochemical machining, electron beam machining, photochemical machining, and ultrasonic machining. Dental ceramic protheses and metal bar/frameworks are often milled from lithium disilicate, zirconia, titanium alloy or cobalt-chromium alloy (Figs 28–34). Although subtractive manufacturing has achieved a high degree of sophistication, it is not without limitations. It can be a wasteful process and does not easily allow for mass production as only one

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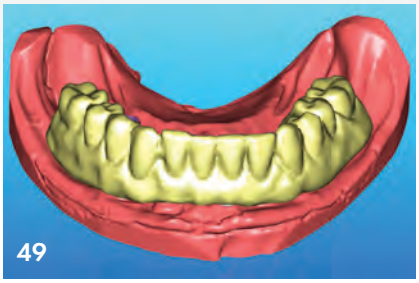

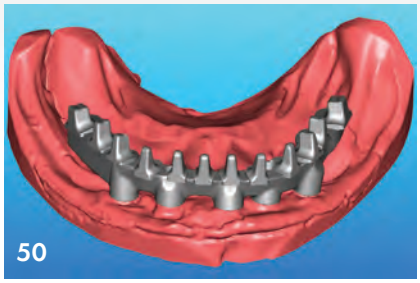

Fig. 49: When the clinician requires a clinical trial insertion, and/or the dental technician needs the articu-lated analog casts to re-position the manufactured framework or prosthesis for the subsequent finishing process, a partial digital workflow should be used. This figure illustrates the digitalization of a milled cast, and diagnostic tooth arrangement after obtaining the patient's approval from clinical trial insertion.

Fig. 50: Design for a CAD/CAM titanium framework on 5 dental implants.

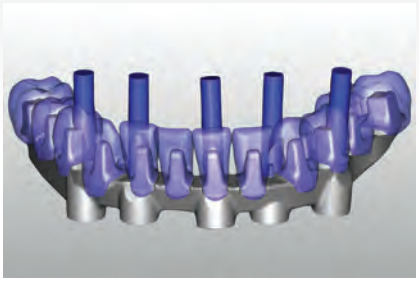

Fig. 51: Design of the CAD/CAM crowns fitting on the framework

object can be machined at a time. Additive manufacturing can create objects with fine surface details (such as undercuts and voids) and complex internal structures (van Noort 2012). Additive manufacturing is defined by the American Society for Testing and Materials (ASTM) as "the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies". This process is increasingly utilized in dentistry to manufacture 3D objects from polymers and metal alloys. Additive manufacturing is categorized by the ASTM as vat polymerization, material extrusion, material jetting, powder bed fusion and direct energy deposition. Although vat polymerization requires more extensive post-processing to remove build supports, unused material, and additional polymerization, it has become a popular CAD/CAM option in dentistry with the rise of low-cost desktop stereolithography (SLA) and direct light projection (DLP) 3D printers. Dental casts, surgical templates, custom trays, fixed dental prostheses, removable dental prostheses, or occlusal splints can now be produced in the dental office with simplicity (Figs 35–37). Although the use of the low-cost desktop 3D printers has increased in-office production of dental protheses, these options have not been scientifically validated. Industrial 3D printers may utilize different manufacturing methods such as material jetting, which allow for the use of different materials (in color or stiffness) within the same print (Fig. 38), and powder bed fusion for the printing of cobalt-chrome and titanium alloy frameworks (Katkar et al. 2018) (Figs 39–40).

Regardless of current popularity, a complete digital restorative workflow is not routinely used in dental practice. The challenges of a complete digital restorative workflow include virtually defining the functional occlusal morphology of the prosthesis, and further processing and customization of a CAD/CAM prosthesis without a physical analog cast. An analog cast is still required in most instances for inspection, adjustment and individualization of a CAD/CAM prosthesis, limiting digital workflow options to fully anatomic contour, monolithic restorations (Martinez-Rus et al. 2013). Although there is only limited evidence available, fully anatomic, monolithic implant-supported crowns fabricated with a complete digital restorative work-flow seem promising and are increasingly feasible (Morton et al. 2019). Monolithic implant prostheses are characterized by a reduced risk of surface cracking or chipping, with the possible tradeoff of lower optical (and esthetic) properties (Joda et al. 2015) (Figs 41–44).

For these reasons complex, fixed, implant-supported prostheses and removable implant-supported/retained prostheses are often designed and fabricated using a mixed analog-digital (partial digital) restorative workflow (Kachalia et al. 2010). Issues remain with the effective capture of dynamic soft tissue movement, for example, leading clinicians to use conventional impression-making along with digitalization of the analog impression or cast in the laboratory (Figs 45–46). Clinicians and dental technicians see benefits associated with a CAD/CAM fabrication process in obtaining a well-designed prosthesis contour in the digital environment, and an accurately fabricated framework or prosthesis from the subtractively or additively manufacturing technology (Figs 47–48).

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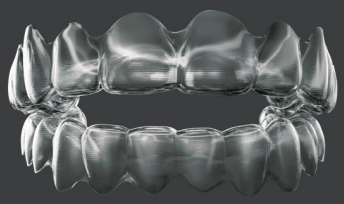

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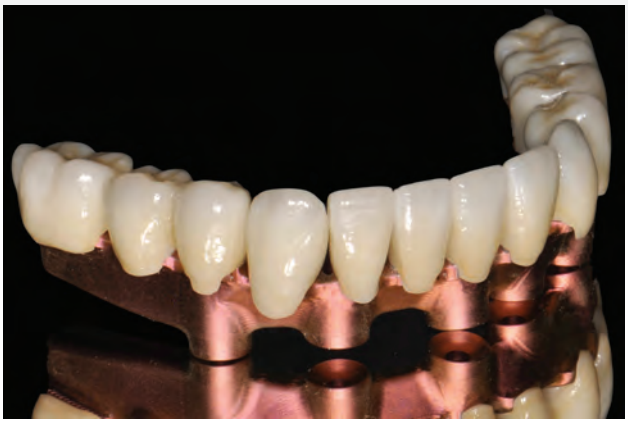

Fig. 52: CAD/CAM (milled) anodized titanium framework and zirconia crowns

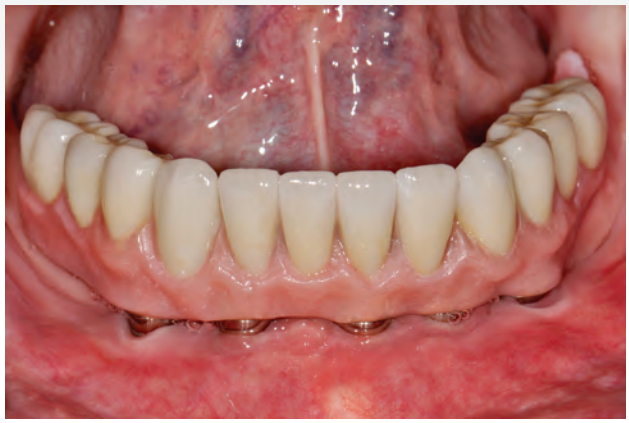

Fig. 53: Implant-supported complete fixed dental prosthesis (titanium framework and individual monolithic zirconia crowns)

articulated analog casts fabricated from stone or printed or milled to facilitate or refine the finishing process inclusive of contouring, denture tooth arrangement/processing, adding veneering material, and surface characterization. A partial digital workflow may increase overall worktime when completing the prosthesis but remains a necessary phase in most cases in order to achieve satisfactory functional and esthetic outcomes for implant-supported/retained prostheses (Joda et al. 2017) (Figs 49–53).

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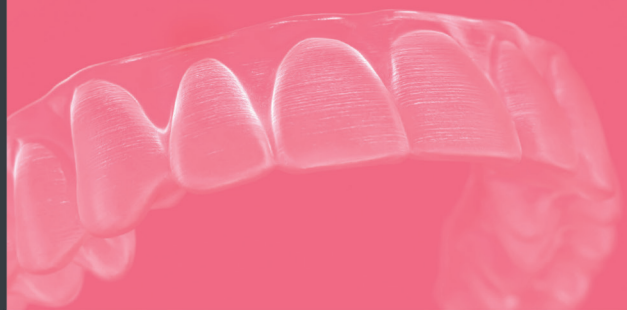

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Immediate placement and immediate restoration in the aesthetic zone: A review of the literature and case report

Peter Doherty[1]

Introduction

The immediately placed and immediately restored dental implant has many advantages to offer us as clinicians and our patients: reduced total treatment times, less surgical procedures, preservation of the gingival architecture, less appointments, high patient satisfaction, and it also avoids the psychological impact of wearing a removable temporary prosthesis. Immediate placement is also nothing new, the concept of placing implants into fresh extraction sockets was first reported by Schulte and Heimke (1976). We have learned a lot in the intervening period about the procedure, however it remains clinically challenging and has the potential for significant aesthetic problems if inappropriately selected, and therefore requires some clear guidelines to operate within.

Literature review

The timing between tooth extraction and implant placement has been categorised into four different protocols by the International Team for Implantology (ITI) (Chen and Buser, 2008). Type 1 placement is the immediate implant, where the implant is placed into the socket at the time of tooth extraction. In Type 2 placement (early placement with soft tissue healing) the implant is placed 4-8 weeks after extraction. The soft tissues have healed, but there is little bony healing. Type 3 placement (early placement with partial bone healing) occurs at 12-16 weeks. The soft tissues have healed and there is significant bony healing.

The main reasons for selection of Type 2 and 3 placements are to ensure an absence of pathology at the time of placement, and also increase the availability of soft tissues when a bone augmentation procedure is planned.

It has been shown that Type 1 placement has a greater variability of outcomes and is

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associated with a greater risk of midfacial recession >1mm than Type 2 and Type 3 placement (Chen and Buser, 2014). Type 1 placement has also been shown to have survival rates equal to type 4 (fully healed) placement, even in teeth with associated pathology (Hammerle et al, 2004).

Planning immediate placement and immediate restoration cases require consideration of six vital areas:

1. The bone apical to the tooth
2. The buccal plate
3. The position of the gingival margin
4. The gingival biotype
5. The design of the implant
6. The jump gap.

The bone apical to the tooth

3-5mm of bone is required apical to the tooth to ensure sufficient implant stability at the time of placement. Immediate implants gain their primary stability from this apical bone, and from the palatal and lateral walls of the socket. The buccal plate must not be engaged to provide primary stability as this will often resorb leaving the implant facially positioned and at risk of an aesthetically compromised result. In addition to sufficient bone volume, the apical bone must be of sufficient density which is determined pre operatively with a CBCT (figures 2-4).

The buccal plate

The thickness of the buccal plate must be assessed with CBCT prior to immediate implant placement. If the buccal plate is thicker than 1mm there will be minimal bone loss following extraction. However, it has been shown that if the plate is less than 1mm thick there will be a median bone loss of 7mm in height (Chappuis et al, 2015).

Furthermore, in 90% of cases we see in practice, the buccal plate of the maxillary anterior teeth is 1mm or less (Huynh-Ba et al, 2010; Braut et al, 2011). This fragile piece of bone is critical to implant aesthetics. It derives its blood supply from the periodontal ligament and the periosteum mostly, with some thicker buccal plates having an endosseous supply from the bone marrow – though this is usually absent. If the buccal plate is 1mm thick or less then placement of an implant will not preserve the bone and the buccal plate will resorb (Arujo et al, 2005). It is critical to manage this resorption, as simply extracting a maxillary anterior tooth and placing an implant will lead to a buccolingual dimensional change of 1.1mm (Grunder, 2011) and the subsequent risk of aesthetic compromise. The same study by Grunder (2011) showed that placing a subepithelial connective tissue graft at the same time as immediate placement led to a gain of 0.34mm in the buccolingual dimension.

Strategies used in immediate implantation to avoid the problems posed by the resorption of the facial plate include:

A: Smaller implant diameter
B: Palatal implant position
C: Hard tissue grafting
D: Soft tissue grafting
E: Immediate provisional restoration.

The position of the gingival margin

Gingival margin position is critical to the success of maxillary anterior implants, particularly in high smile line cases. Where there is recession present on a tooth planned for implant replacement it would be advisable to select a type 2 or type 3 placement and avoid the immediate approach.

The gingival biotype

Described as either thick or thin, thick biotypes are said to have gingival tissues which are 2mm or more in thickness, and thin biotypes to be less than 1.5mm in thickness (Claffey and Shanley, 1986). In a population study by Olsson and Lindhe (1991) thick gingival biotypes were found to be more prevalent (85%), than thin gingival biotypes (15%). Thick biotypes are characterised by square teeth with short, broad papillae, broad band of keratinised tissue, and thick gingival tissues with thicker underlying bone. Thin biotypes exhibit triangular teeth, long and thin papillae, thin bands of keratinised tissue, and thin gingival tissues with thin underlying bone.

A useful method to assess gingival thickness is to insert a periodontal probe into the midfacial gingival sulcus. If the probe is visible through the tissues then you are dealing with a thin biotype, whereas a thick biotype will conceal the colour of the probe within the sulcus. The significance of gingival biotype in relation to immediate implants relates to the greater potential for facial recession and loss of papillae in thin biotype cases.

Gingival biotype may also be altered by the utilisation of a connective tissue graft, and the use of a connective tissue graft with immediate implant placement has been shown to contribute to mid facial soft tissue stability (Lorenz Seysens et al, 2021). This is a particularly useful technique when there is an increased risk of facial recession (for example a thin gingival biotype, or buccal plate less than 1mm in thickness).

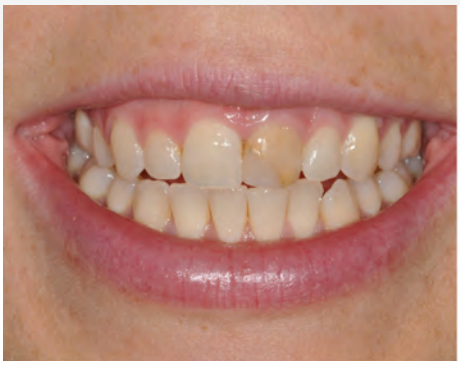
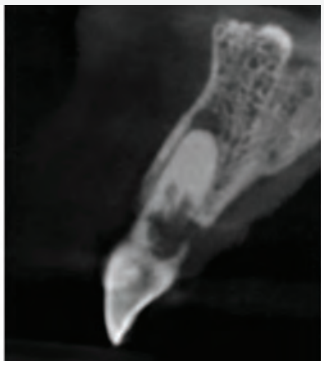


Figure 1

Figure 2



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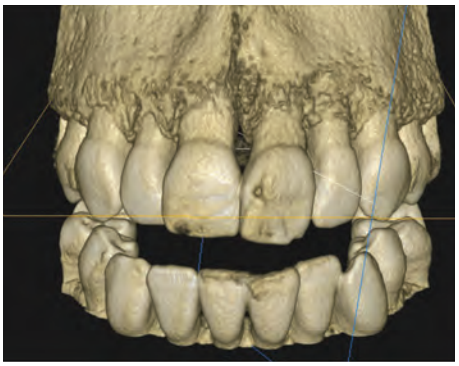

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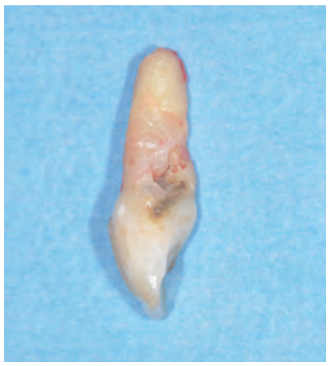

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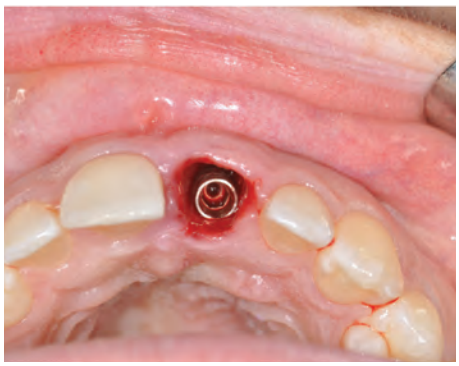

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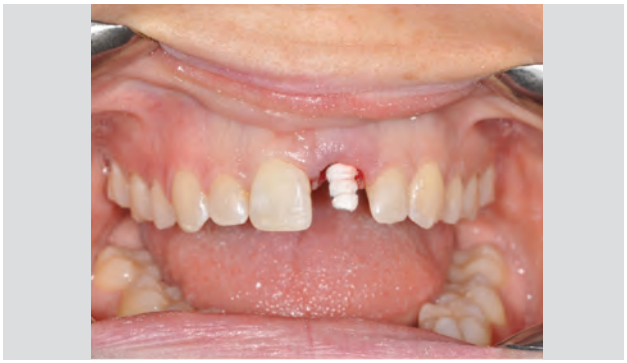

Figure 7

The design of the implant

For immediate placement primary stability is critical, and this is most reliably achieved with the use of tapered implants and an aggressive thread design. The tapered body shape facilitates bony compression as the implant is inserted and it has been shown that tapered implants can achieve higher stability in low density bone due to this compression (Atieh et al, 2018). The narrower tip also reduces the risk of apical fenestration in areas where there is a concavity present in the apical region of the alveolus.

Desirable features at the head of the implant are a platform shift to distance the implant-abutment junction from the rough surface, and a conical connection to create an effective seal at the implant-abutment junction preventing the ingress of bacteria. Both of these features ensure long term crestal bone stability.

The implant chosen is this particular case was a Neodent GM Drive implant. It was selected surgically for its tapered body and dual threaded design with cutting apical threads ensuring high primary stability in immediate placement. From a prosthetic viewpoint, it is ideally suited to use in the aesthetic zone due to its platform shift, horizontal polished portion and deep 16 degree morse taper.

The jump gap

As discussed previously, in 90% of cases in the anterior maxilla we can expect resorption of the buccal plate. To counteract this, immediate implants must be positioned palatally away from the buccal plate, creating a space between the buccal

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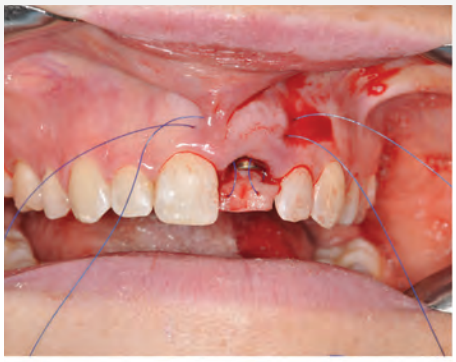

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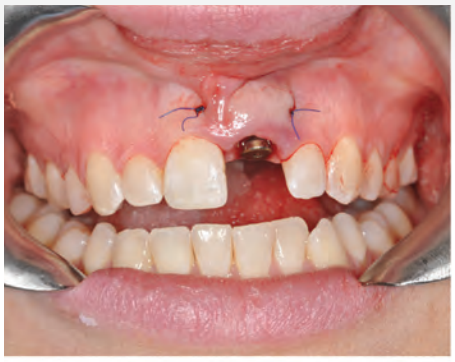

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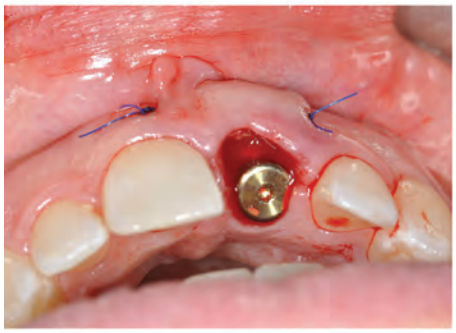

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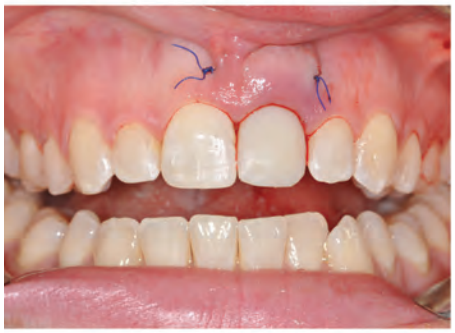

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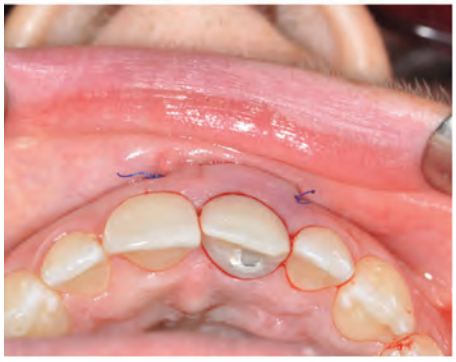

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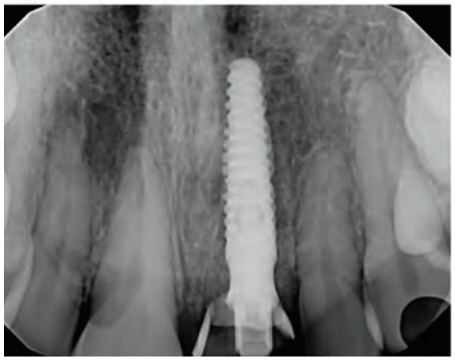

Figure 13

surface of the implant and the buccal plate called the jump gap. Filling this gap with bone grafting material has no effect on osseointegration or survival rates, but it does have a significant effect on maintaining dimensions of the ridge and preventing collapse and reducing the chances of recession. To improve the dimensional stability of the ridge even further it has been shown that grafting the jump gap in combination with immediate provisionalisation results in almost no change in ridge contour (Tarnow et al, 2014).

Case report

This 25 year old patient attended for assessment of UL1 which had been traumatised at age 7 and subsequently developed resorption and was deemed unrestorable. She expressed embarrassment at the colour and shape of the tooth, and felt self-conscious when speaking or smiling. She was also aware of its poor prognosis, and experienced intermittent pain from the tooth. Clinical examination revealed a high smile line with a discoloured, unaesthetic


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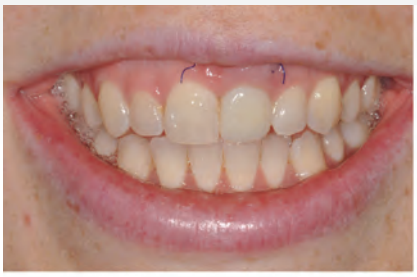

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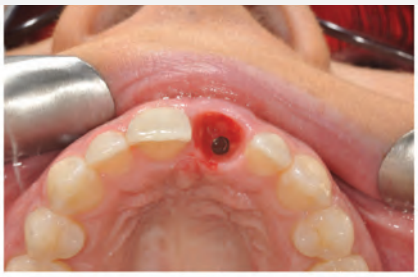

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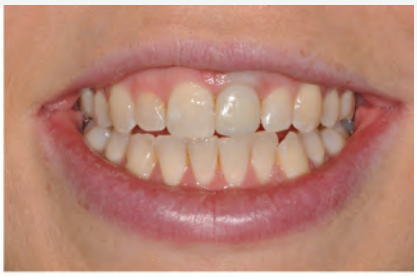

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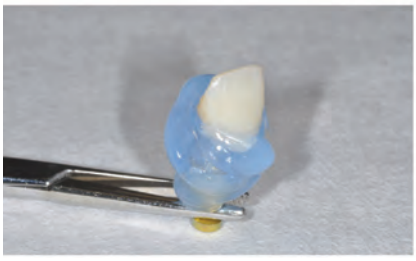

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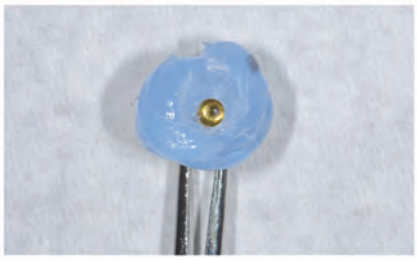

Figure 18

Figure 19

appearance to UL1 detracting from what was otherwise a nice smile (Figure 1). Probing pocket depths were normal, and there was no mobility, bleeding on probing or evidence of infection. The incisors were relatively square shaped, and the patient displayed a thick gingival biotype.

Radiographically, a CBCT revealed an extensive area of root resorption and associated apical radiolucency. There was also some distopalatal bone loss in the coronal one third of the root. The buccal plate was intact, approximately 1mm thick in the midportion of the root tapering out to less than that in the coronal one third, and comprised entirely of cortical bone (Figures 2-4).

The patient expressed a preference for a fixed temporary crown to avoid the use of a denture or other removable option as the implant integrated. Conditions were favourable for an immediate implant and immediate restoration given the thickness of the buccal plate, correct gingival margin level and the presence of good density bone apical to the UL1. There was also no evidence of parafunction and the patient had full posterior occlusion to the second molars. Complicating factors taken into account were the high smile line, a thinner buccal plate coronally (less than 1mm thick), and presence of bone loss both apically and at the distopalatal aspect towards the crown. Implant planning was carried out with CS 3D Imaging Software (Carestream Dental), and the implant virtually placed prior to the surgery.

On the day of the procedure the tooth was removed uneventfully (Figure 5) and the socket thoroughly curetted out, removing any granulation tissue.

Implant osteotomy was performed freehand towards the palatal aspect of the extraction socket, and advanced beyond the apex of the socket. A 3.5 x 16mm Neodent GM Drive implant was placed 1mm subcrestal on the facial aspect (Figure 6), and >45Ncm insertion torque achieved. The GM Drive implant offers very high torque values and exceptional primary stability, even in suboptimal bone density or in areas of limited bone availability – such as extraction sockets, which is one of the reasons I choose it in these immediate load cases. The second reason I select them is for their platform shift and tight morse taper connection which ensure the crestal bone level is maintained – vital in all areas of the mouth, but especially so in the aesthetic zone.

With the implant in position, attention was turned to management of the soft tissues and emergence profile. A PEEK abutment was modified intraorally (Figure 7) and a screw retained temporary crown constructed from Protemp and flowable composite using a pre op impression to recreate the emergence profile of the extracted tooth, and support the interdental papillae.

Further soft tissue management involved filling the space between the buccal aspect of the implant and the inner aspect of the buccal plate with Xenograft (Creos Xenogain, Nobel Biocare). Following this a deepithelialised connective tissue graft was harvested from the left hard palate and secured with two monofilament sutures into a tunnel created under the mucosa buccal to the implant to thicken the gingiva and

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Figure 20

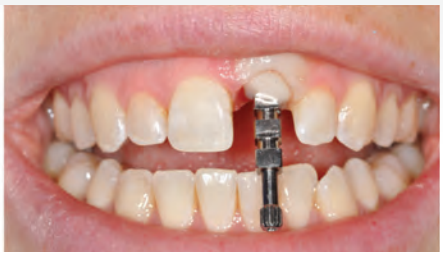

Figure 21

decrease the possibility of future gingival recession (Figures 8, 9 and 10). This was done in view of the thin buccal plate present at the margin and the presence of a high smile line.

Following insertion of the temporary crown, the static and dynamic occlusion was carefully checked and the crown adjusted out of occlusion in all excursions (Figures 11 and 12). The patient was instructed to treat the tooth as decorative and avoid eating on it during the osseointegration process. The final radiograph at placement can be seen in Figure 13.

On review two weeks later, the patient reported no discomfort, the surgical site was healing well, and the sutures removed (Figure 14).

Three months later, the buccal soft tissue contours had been maintained (Figure 15), and the patient actually had a lower gingival margin than was present pre operatively. The temporary crown was added to with composite in the region of the gingival margin to alter the emergence profile and move the gingival zenith slightly apically to match the adjacent central incisor (Figure 16).

Two weeks after this, final impressions were taken using a customised impression technique.

The temporary crown was removed and attached to an analogue, and then a transparent silicone (Memosil 2, Kulzer) was placed around the analogue and the submarginal area of the temporary crown to accurately copy the emergence profile. The buccal aspect of the tooth was marked on the silicone to aid orientation before the temporary crown removed and an impression coping placed into the analogue (Figures 17 and 18). Flowable composite was injected into the well around the base of the impression coping and light cured through the transparent silicone to create a customised impression coping which was a direct replica of the temporary crown (Figures 19 and 20). This was then seated intra-orally and an open tray impression taken with polyether (Impregum, 3M) (Figure 21).

The final crown was made from a zirconia core on a titanium base, cutback and layered in porcelain to mimic the natural anatomy of the adjacent teeth.

It was torqued to 20Ncm, the access sealed with PTFE tape and composite, and the occlusion checked and adjusted as appropriate (Figures 22a and 22b). The final radiograph is shown in Figure 23, displaying the platform shift and slender profile of the titanium base which aid bone and soft tissue preservation.

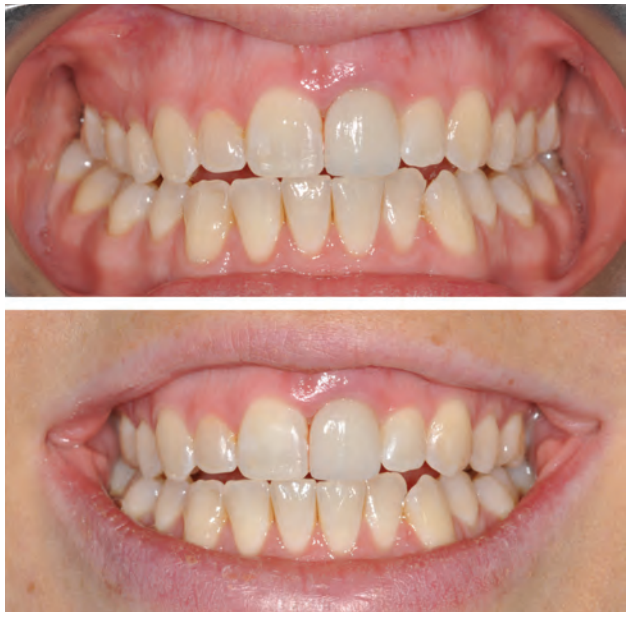

Figure 22a and 22b

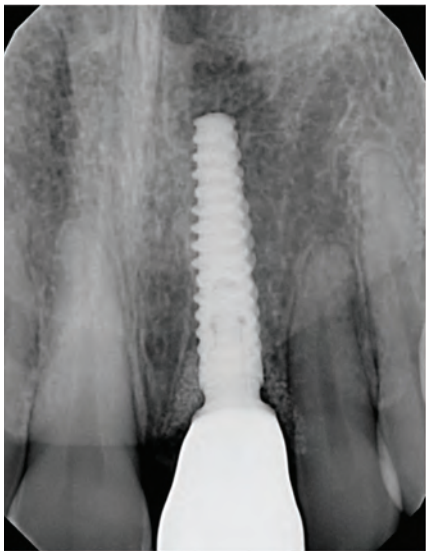

Figure 23

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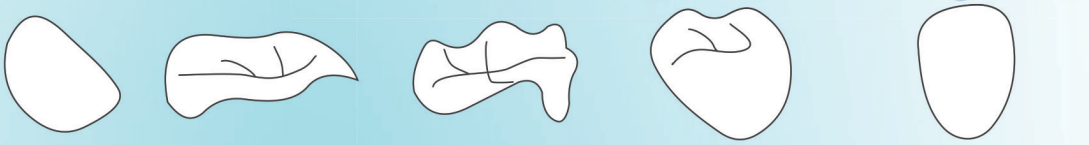

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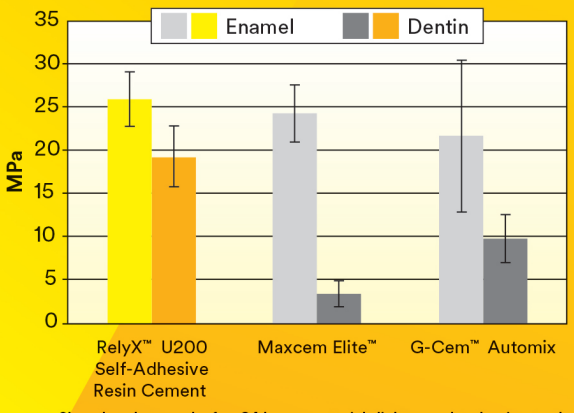
RelyX U200 resin cement is available in an automix syringe delivery system or in a Clicker™ dispenser.

Impressive bond strength

RelyX U200 cement offers impressive shear-bond strength to dentin and enamel, providing a long-lasting and secure restoration.



Shear bond strength after 24 hours, materials light-cured, to bovine teeth.
Source: 3M ESPE internal data.

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Full-arch reconstruction integrating three different cements: A case study

Carlos Eduardo Sabrosa[1]

Introduction

In my own dental practice, three different cements are stocked.

3M™ RelyX™ U200 Self-Adhesive Resin Cement is the luting material of choice for retentive restorations such as crowns and bridges made of zirconia, lithium disilicate or metal.

For cementation of PFM or zirconia crowns or bridges, 3M™ RelyX™ Luting 2 Resin Modified Glass Ionomer Cement is preferred.

When the success of the restoration lies on the adhesive properties of the cement and those restorations need a strong chemical bond, they are bonded with 3M™ RelyX™ Ultimate Adhesive Resin Cement and 3M™ Single Bond Universal Adhesive. Even laminate veneers with a thickness of over 0.5 mm are bonded with this material combination.

Very thin veneers can be luted with 3M™ RelyX™ Veneer Cement. In the following patient case, three different cements were used for different indications in the upper arch.

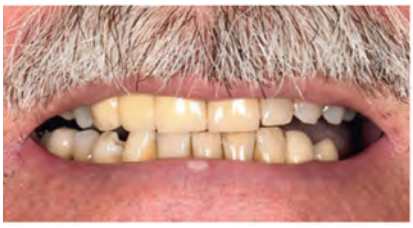

Fig. 1: Initial situation. The patient presented in our practice primarily due to the loss of an implant in the mandible that had been placed a short time ago.

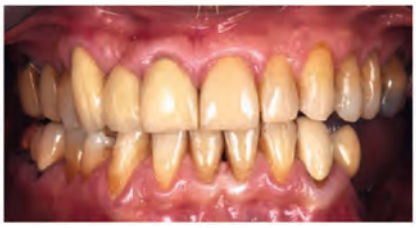

Fig. 2: The dental examination revealed that the patient had multiple inadequate restorations in both arches that needed to be replaced. The maxillary restorative treatment is described here.

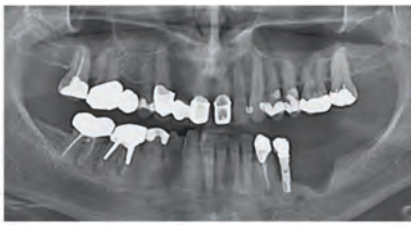

Fig. 3: Radiograph of the initial situation. The treatment plan for the maxilla included the placement of implants with patient specific two-piece 3M™ Lava™ Plus Zirconia abutments in the regions of the right lateral incisor and second premolar and the fabrication of twelve single crowns and two laminate veneers.

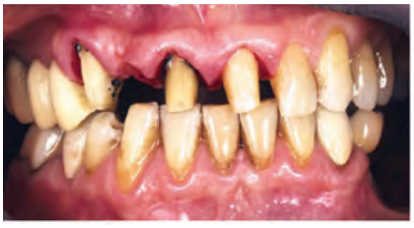

Fig. 4: Situation after removal of the old three-unit bridge and crown in the anterior area. It is evident that secondary caries had to be excavated and some teeth needed endodontic treatment.

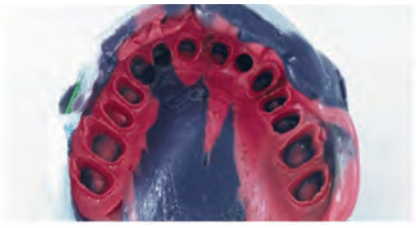

Fig. 5: Impression taken with 3M™ Impregum™ Garant™ L DuoSoft™ and 3M™ Impregum™ Penta™ H DuoSoft™ Polyether Impression Material.

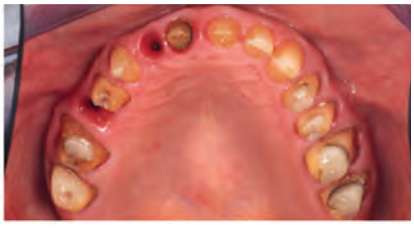

Fig. 6: Occlusal view of the maxilla after successful healing of the implants and removal of the temporaries. Endodontic treatment had been carried out where necessary and the corresponding teeth have received a composite build-up, combined with a fiber post in some cases. Teeth that were not endodontically treated were just built up with a low shrink composite resin.

[1] Carlos Eduardo Sabrosa, DDS, MSD, DScD

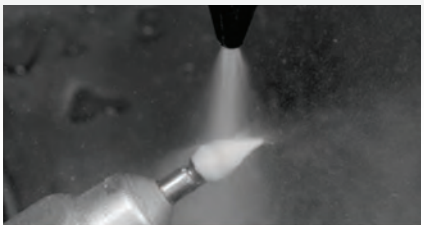

Fig. 7: Sandblasting of the two piece abutment made from a build-up of 3M™ Lava™ Plus Zirconia cemented to a titanium interface in order to create a microretentive surface for cementation of the crowns. Etching with hydrofluoric acid is not effective with zirconia due to the low amount of glass in the material.

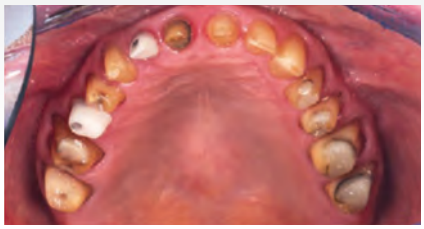

Fig. 8: Occlusal view of the maxillary teeth with the screw-retained abutments in place. All teeth are ready for the final precision impression.

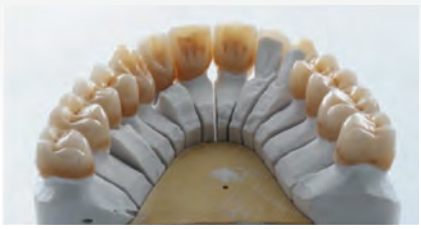

Fig. 9: Finished restorations on the stone model: Twelve 3M™ Lava™ Plus High Translucency Zirconia Crowns and two laminate veneers made of lithium disilicate (IPS e.max® Press, Ivoclar Vivadent) are shown.

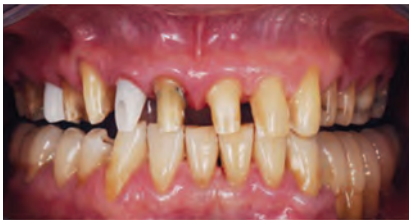

Fig. 10: Situation after cleaning of all teeth in the maxilla with an oil-free pumice paste for removal of any temporary cement residues, thorough rinsing with water and drying.

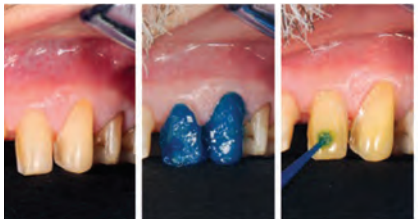

Fig. 11: Adhesive pretreatment of the left lateral incisor and canine. After enamel etching with phosphoric acid, 3M™ Single Bond Universal Adhesive is applied, rubbed in for 20 seconds and air-dried until the solvent has evaporated completely.

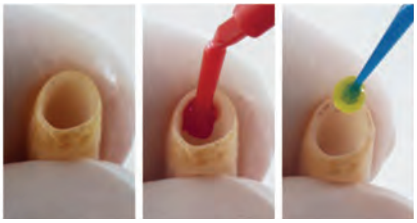

Fig. 12: Hydrofluoric acid is applied to the lithium disilicate veneer restorations and removed after 20 seconds, followed by cleaning in an ultra-sonic bath for five minutes. Then, 3M™ Single Bond Universal Adhesive is applied and used as a ceramic primer.

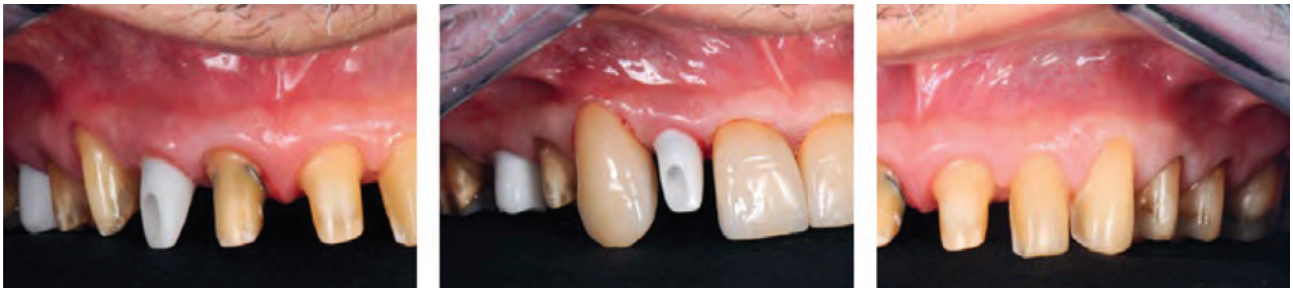

Fig. 13: The self-adhesive resin cement (3M™ RelyX™ U200 Self-Adhesive Resin Cement) is used for the crowns on natural teeth, the resin modified glass ionomer cement (3M™ RelyX™ Luting 2 Resin Modified Glass Ionomer Cement) for the cementation of crowns on implant abutments and the dual-cure adhesive resin cement (3M™ RelyX™ Ultimate Adhesive Resin Cement) for the veneers.

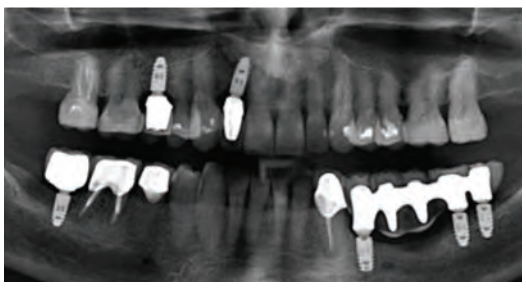

Fig. 14: Final radiograph.

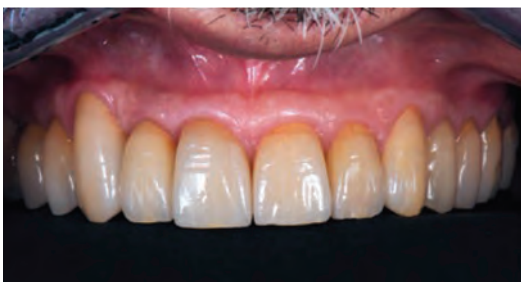

Fig. 15: Treatment result.

Injection moulding technique: A case study

Kostas Karagiannopoulos[1]

Introduction

Direct composite resin restorations now have more applications and indications than ever before. Advances in adhesive dentistry have allowed clinical problems that would once necessitate a more aggressive indirect restoration to be managed in a minimally invasive, additive, direct technique. Moreover, the aesthetic outcomes that direct restorative materials can achieve can be comparable to those of indirect.

Patient awareness is also changing with time and those seeking cosmetic improvements are now more reluctant to opt for materials that require some sort of tooth preparation. The injection moulding technique (IMT) involves injecting a low viscosity resin composite in a pressurised, transparent silicone index made from a diagnostic wax-up, aiming to replicate an already performed mock-up and an approved tooth form arrangement.

Injectable composite resins

Flowable composites have traditionally been considered too weak to be used as a restorative material and were merely used as lining materials under a composite paste. Their main advantage over restorative pastes is the level of adaptation on the tooth surface.

In the IMT, their 'flowable' nature allows for filling the space within a silicone index with a resin under compression. Modern injectable resins, such as G-aenial Universal Injectable (GC), have a high filler content, wear resistance and gloss retention as well as full coverage silane coating of filler particles using FSC technology.

The IMT has the advantage of replicating the excellent anatomy defined by a lab-made diagnostic wax-up whereby it would be used for the fabrication of indirect restorations.

Indirect restorations nevertheless are more time consuming and costly. Direct composite restorations require significant chair time, good operator skills and knowledge of the material used.

[1] Kostas Karagiannopoulos, Consultant prosthodontist, King's College, London, UK

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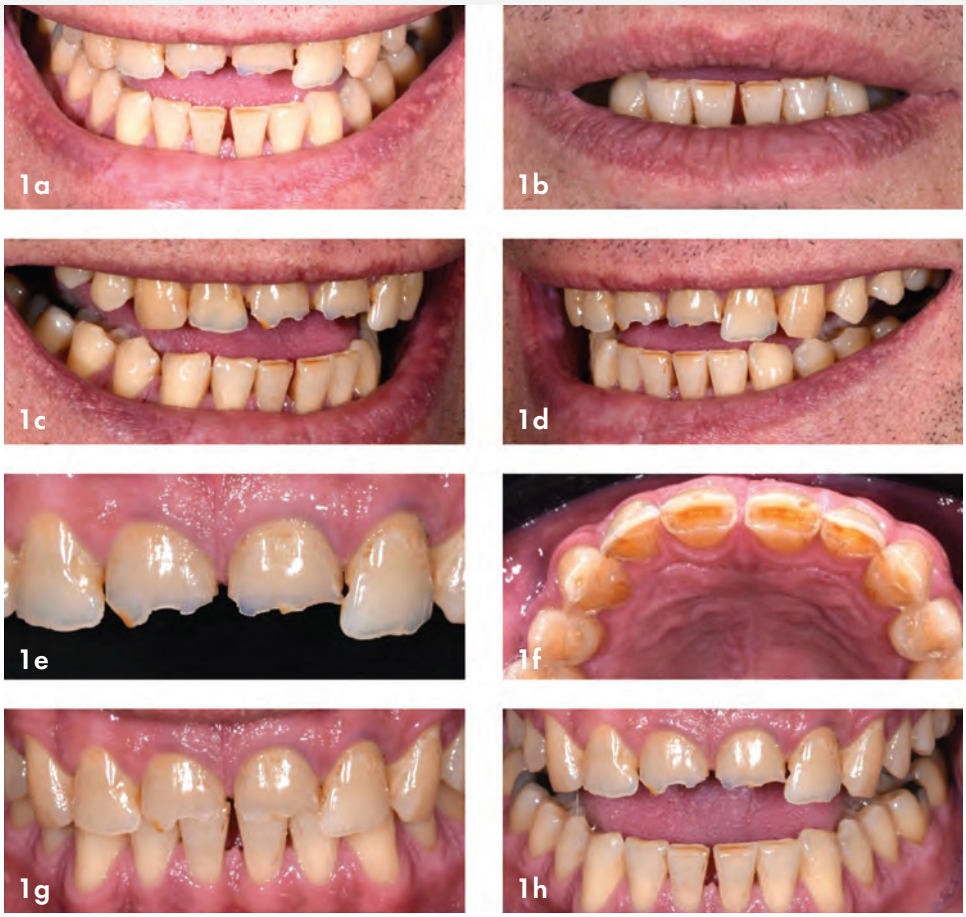

Figure 1: Preoperative photographs

Compared to freehand indirect restorations, the IMT provides quicker, more consistent results with less adjustments required. Table 1 outlines the advantages and limitations of the IMT.

The following case report outlines the steps in restoring an aesthetically-driven case with G-aenial Universal Injectable based on a wax-up.

Case report

A 45-year-old male presented complaining of the appearance of his front teeth. Severe multifactorial, localised tooth surface loss led to short clinical crowns. Worn teeth in occlusion due to dentoalveolar compensation has the restorative disadvantage of lack of interocclusal space.

Due to localised and mainly erosive nature of his tooth wear, the patient decided to proceed with additive resin composites on the affected teeth using the Dahl concept.

All primary disease was controlled, including the intrinsic acid erosion prior to the restorative phase. A full set of preoperative pictures (Figure 1) were taken to carry out an aesthetic assessment. Intraoral optical scans were used to do an occlusal analysis and prescribe a diagnostic wax-up for the six upper anterior teeth (Figure 2).

A mock-up was carried by using bis-acryl resin (Luxatemp, DMG) and a putty/wash matrix (Exaflex, GC) of the diagnostic wax-up. This was done to verify the aesthetic outcome as well as verify the occlusal changes as the occlusal vertical dimension was increased by 2mm (Figure 3).

The approved mock-up provided the patient with the reassurance about his new bite and also the emotional excitement about the final smile.

A clear silicone matrix (Exaclear, GC) of the diagnostic wax-up was made in the dental laboratory and pressurised

Table 1 : The advantages and limitations of the IMT

Advantages	Disadvantages
Excellent anatomy	More visits needed
Verify aesthetics, occlusion, phonetics	Polychromatic teeth not suitable
Smooth, predictable workflow	Lack of long-term survival data
Avoid misunderstandings	
Easy to implement and teach	
Easy to repair with clear stent	

in a hydro-flask for five minutes at two-bar pressure. The clear silicone was compressed against the wax-up using a spaced, Essix-style tray (Figure 4).

The upper anterior teeth were cleaned and roughened with particle abrasion of 50-micron alumina powder (Etchmaster, Groman Dental) and isolated with rubber dam (Isodam, Four D Rubber).

The teeth were etched using 35% phosphoric acid (Ultra Etch, Ultradent) and hybridised with a universal adhesive resin (G Premio Bond, GC) and a dental curing unit (D-Light Pro, GC).

The alternate tooth technique was used to carry out the IMT. PTFE tape was used to protect the teeth that were not to be etched and bonded (Figure 5).

Holes were made through the clear silicone stent at the incisal edge level to allow the tip of the injectable composite through. The syringe of the composite was inserted and injected through the holes in the clear stent once that was seated fully in the mouth.

The space to be filled in with the resin was visually inspected through the clear stent for any voids or bubbles and the resin was polymerised for 30 seconds through the

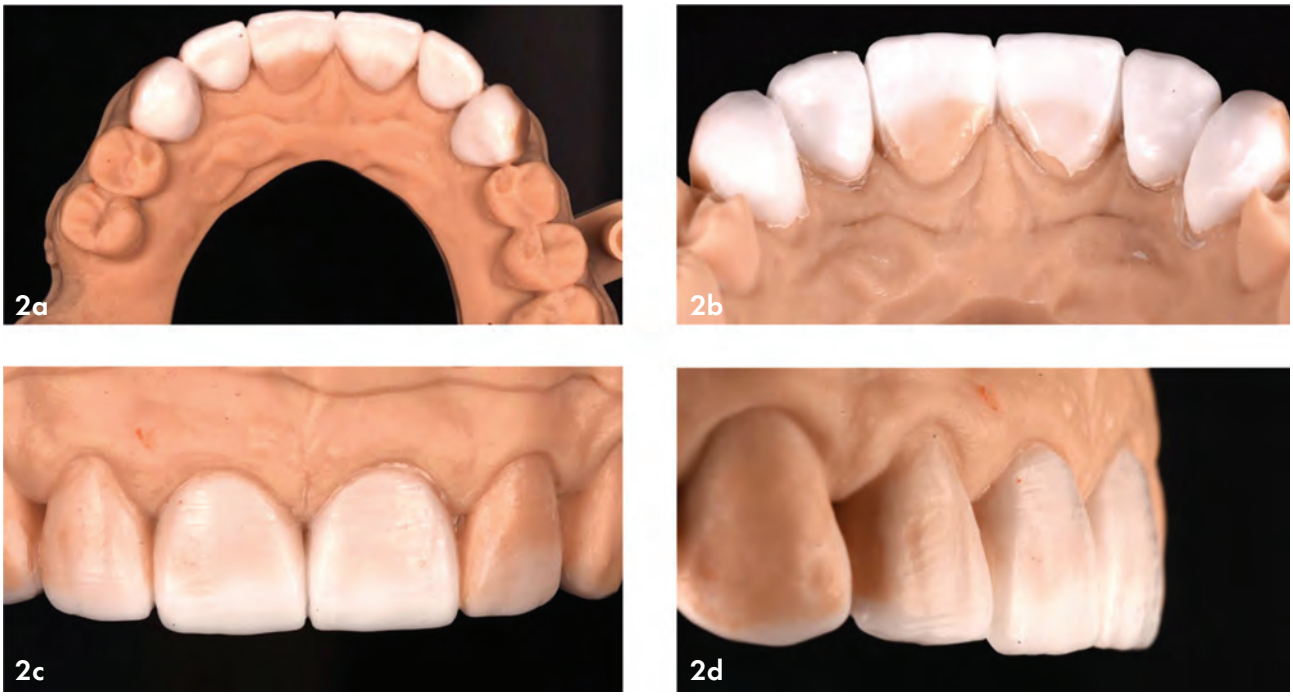

Figure 2: Diagnostic wax-up on printed models

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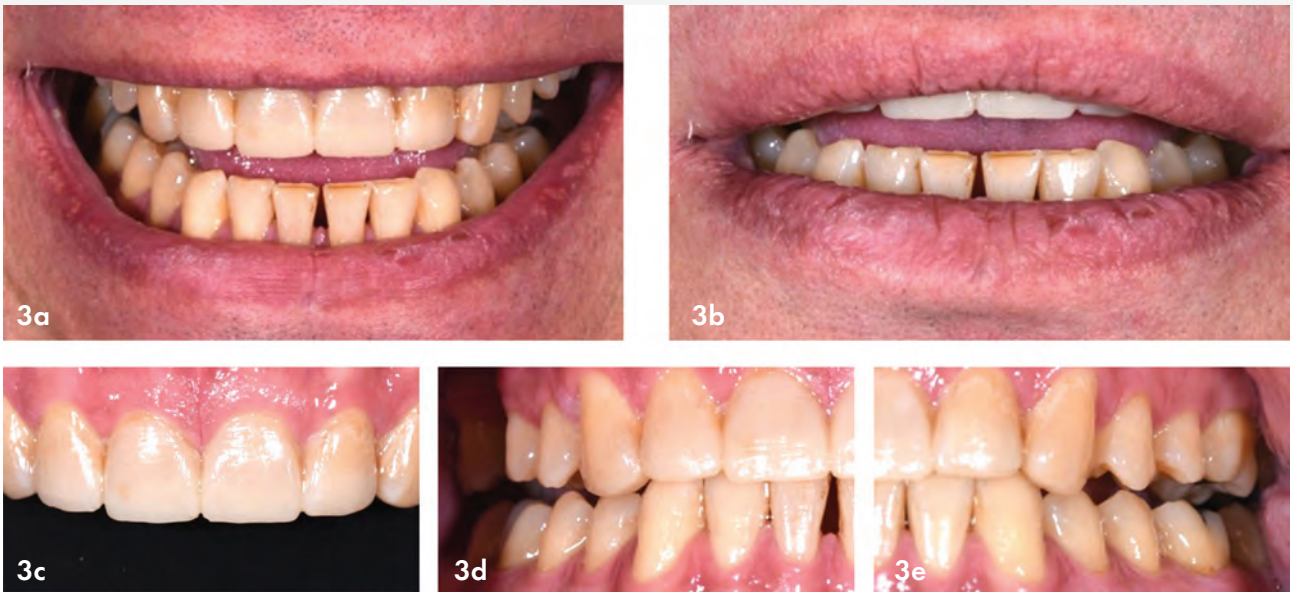

Figure 3: Mock-up carried out in bis-acryl resin

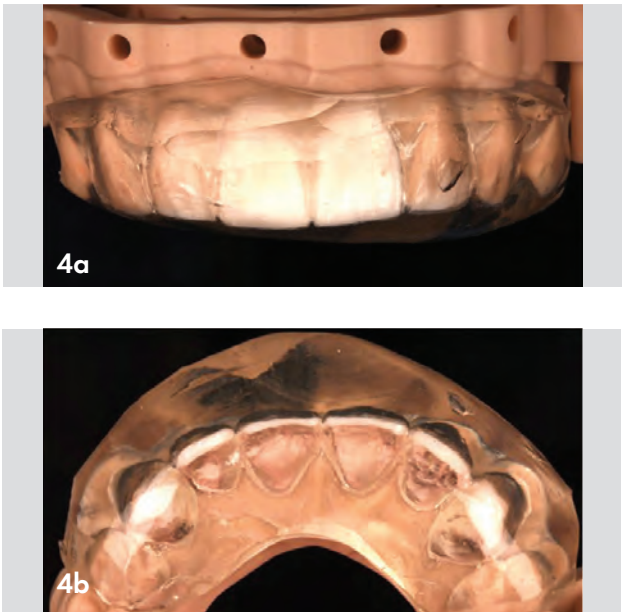

Figure 4: Exaclear stent made on diagnostic wax-up

stent and 30 seconds without the stent. A further 10 second cure was carried out after applying an oxygen inhibition layer gel (Oxygone gel, Cosmedent).

The excess from the first three restorations was managed with proximal strips (Komet strips, West One Dental) and a number 12 surgical blade (Swallow Dental) before the other three were done. The restored teeth were covered with Teflon tape to facilitate excess removal on completion.

Once proximal and gingival excess was removed on all six restorations there would be minimal finishing as the anatomy was wax driven and not freehand.

There may be a need for fine grit diamonds or discs on the cervical junction to avoid any ledges while a natural emergence is maintained. Finishing and polishing spirals (Eve Polishers, Trycare) are usually enough to achieve a high surface lustre.

An additional step would involve a nylon brush (Goat hair brush, Micerium) and a felt wheel (Shiny felt wheels, Micerium) at 5,000rpm.

The final result exhibited good surface texture and lustre while anterior guidance was maintained (Figure 6).

Discussion

With the increasing use of resin composites in cosmetic and restorative dentistry there is value in having techniques that will replicate an already approved aesthetic outcome and occlusal scheme.

The IMT aims at providing this copy/paste approach by using modern injectable resins. Alternative techniques include the index technique as described by Ammannato and colleagues (2015) and the partial and full moulding techniques as described by Dietschi and Saratti (2020).

Each technique has its limitations and the IMT has the

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Figure 5: Isolation and etching on the alternate tooth technique

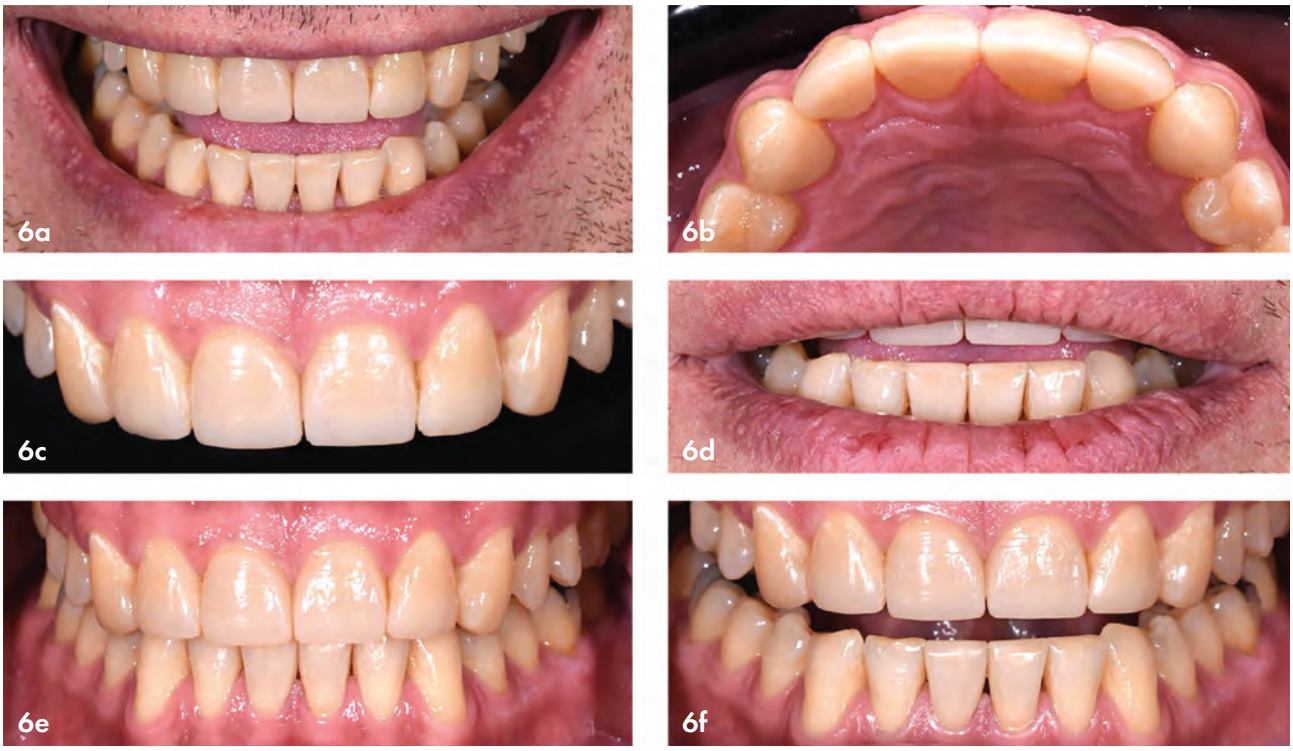

Figure 6: The final result exhibited good surface texture and lustre while anterior guidance was maintainedtooth technique

limitations of working best on mono-shade restorations and having a greater treatment time and cost than freehand composites.

The IMT does require some finishing but significantly less than freehand restorations. Its main benefit after all is the replicated anatomy of a diagnostic wax-up. There is some excess material cervically and proximally but there should not be a need to alter the shape facially/incisally with discs and burs.

It can be used for both purely additive or in subtractive/additive techniques. However, it is mainly intended for fully additive direct restorations where a mock-up can be done to assess the proposed aesthetics and occlusion. Similarly, it is indicated for monochromatic restorations although layering is possible through cutback, a palatal silicone key or different stents made at different levels.

This novel technique aims at copying the anatomy of the diagnostic wax-up. It is more consistent and predictable than freehand techniques while avoiding unpleasant surprises for the patient. Furthermore, it does not require complex clinical skills and it is easy to teach

References

Ammannato R, Ferraris F, Marchesi G (2015) The 'index technique' in worn dentition: a new and conservative approach. Int J Esthet Dent 10(1): 68-99

Dietschi D, Saratti CM (2020) Interceptive treatment of tooth wear: a revised protocol for the full molding technique. Int J Esthet Dent 15(3): 264-286

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Karagiannis K. Injection moulding technique: A case study. Clinical Dentistry June/July 2021: 19-24

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Both roots have the added complication of having curves in the Bucco-Lingual plane invisible to the PA radiograph*. However, a CBCT reveals danger zones that then can be managed. In these instances – it can be extremely challenging to ensure adequate safety guidelines to prevent file separation.

EdgeEndo has been used the world over for some years now and has grown in market significance mainly because of the proprietary NiTi that they use in the file design, coupled with the EdgeFile X7's safe-core parabolic cross section, it makes them one of the safest files systems available.

*A preliminary assessment of a new dedicated endodontic software for use with CBCT images to evaluate the canal complexity of mandibular molars - International Endodontic Journal, 51, 259–268, 2018

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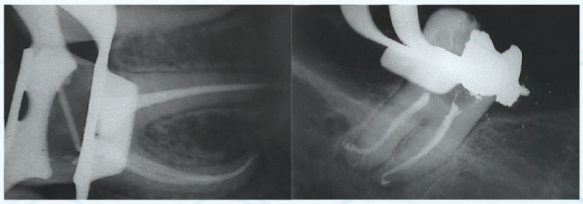
-Prof. Gianluca Gambarini



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EdgeEndo solutions – an interview with Dr. Charles J. Goodis

Dr Charles J. Goodis

Introduction

Henry Schein Dental Warehouse has been offering the endodontic solutions portfolio of EdgeEndo®, one of the world's largest NiTi rotary file suppliers, successfully for two years and has just enlarged this range by EdgeFile® X7, the number one selling EdgeEndo® NiTi system in the United States.

EdgeEndo® is conducting business in 35 countries around the world. The company's mission is to deliver high quality dental products and solutions at affordable prices which in turn benefits practitioners and patients everywhere.

US based Endodontist, Dr. Charles J. Goodis, Founder of EdgeEndo®, received his DDS from the University of Michigan, his GPR residency at the University of Minnesota, and his Endodontic residency at the University of Connecticut. Dr. Goodis has dedicated his career to constantly improving the root canal procedure. His findings led him to create more effective root canal instruments and procedures. He's been working as an endodontist in Albuquerque, New Mexico, USA for 25 years.

Dr. Goodis, please tell us something about the company and the main products.

My background in mechanical engineering and training in endodontics, as well as trying to help the patient and dentist do the best they can, inspired me to found EdgeEndo. Edge has been in the US market since 2012. In this short time, we have become one of the largest endo companies in the world. We now offer our products in 35 different countries.

Our main products are NiTi files that are heat-treated through our proprietary FireWire process. Our best-selling system is the EdgeFile X7. It's one of the leading files used by endodontist in the US, Canada, New Zealand, Australia and many countries in the Middle East. EdgeTaper Platinum and EdgeOne Fire have also been very successful systems in these markets. EdgeEndo has been well received in the industry. In addition to files, we also sell a full assortment of accessory products including gutta percha and paper points.

What are the benefits of the EdgeEndo files and which endodontist will benefit mostly from these files?

The patient of course wants a quick root canal procedure because any time you can reduce chair time, they appreciate. And the patient wants a precise root canal clean-up to get rid of the pain but preserve the tooth. Both is supported by the flexibility paired with the stability, our files provide and thus allow endodontists to perform an accurate and fast procedure. In addition, the reasonably-priced files make the treatment also more efficient in respect of costs.

How do you achieve the balance between offering high-quality endodontic products at low price?

Quality and value are paramount in importance at EdgeEndo. We have a very detailed quality system that allows us to produce a consistent, high quality product.

Unfortunately, being an endodontist treating patients, I saw how high costs are and I thought to myself we can still offer a great product at a good price which provides value for the money. I think reasonable prices are important to a dental practice because as the dental fee structure changes in the US some dentists are making less money than they did before, and I believe offering a high-quality instrument at a lower price really helps dentists succeed.

Which is the most important instrument for root-canal preparation? How many files does one require as a rule?

My personal preference is EdgeFile X7, it is super flexible, efficient and unbelievably strong. Each system varies somewhat. As a rule, most root canals can be completed with between 1 and 3 files.

We've simplified the technique for systems to help the dentist and eliminate waste. As an endodontist, I never used all of the different sizes in an assortment pack. With my file systems you can purchase the files needed and follow the techniques we've worked on with other dentists to develop.

A common concern within root canal preparation is the cyclic fatigue. How resistant are the EdgeFiles (perhaps with reference to a clinical study)?

Our file systems are very resistant to cyclic fatigue. We've done both internal and 3rd party peer reviewed testing to ensure our files are more resistant. Dentist can refer to all of the published research on our site that back up our claim (https://web.edgeendo.com/studies/).

What if I already have a working system and technique? Are the EdgeFiles compatible?

Yes, I designed many systems to be an easy transition for the doctor to integrate Edge into their practice utilizing the same technique and motor settings. If a dentist switched to Edge they can still use the gutta percha points, paper points and obturators they have in stock.

Do customers need new motors for the application of the files?

The motor currently being used by dentists should be able to work with our files. The only time we advise purchasing a new motor is when a dentist wants to use one of our reciprocating systems, such as EdgeOne Fire, which works in a reverse-reciprocating motion and can't be used with a rotary motor.

The heat treatment process of the EdgeEndo files seems to play a big role in the quality and thus differs from files of other manufacturers. Can you describe the advantages to us?

We spent a lot of time creating geometrically the best instruments out there. The proprietary FireWire heat-treatment process vastly improves the NiTi metallurgy, delivering excellent strength and flexibility, improving resistance to cyclic fatigue or in other words, reducing the chances our files will separate. Another benefit of FireWire NiTi is it enables EdgeEndo files to not "bounce back", preserving canal anatomy, and carefully follows the canal as they shape.

How do you minimize the risk of file breakage with your files and are there any improved properties here compared to the files of other manufacturers?

Our files combine the attributes of being highly efficient and flexible, due to the proprietary FireWire heat treatment process, while being extremely safe and resistant to fracture. They are designed with a safe-unwinding feature. The files start unwinding before breaking. Unwinding signals to a practitioner that the file is fatigued and can break if they keep instrumenting with the file. This helps with stress and results in a more enjoyable procedure for the practitioner and patient. The patient is only in the chair for the time intended and this saves time and cost for both.

Thank you, Dr. Goodis, for these interesting insights.

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Peri-implant diseases: Risk indicators and preventive measures

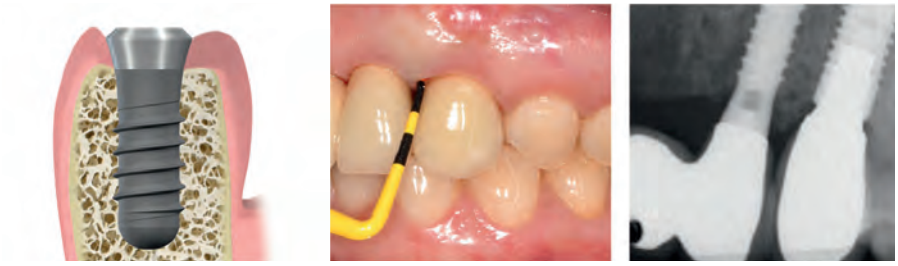
Giovanni E Salvi[1]

Definitions

Peri-implant health and peri-implant diseases were recently defined at the World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions[1].

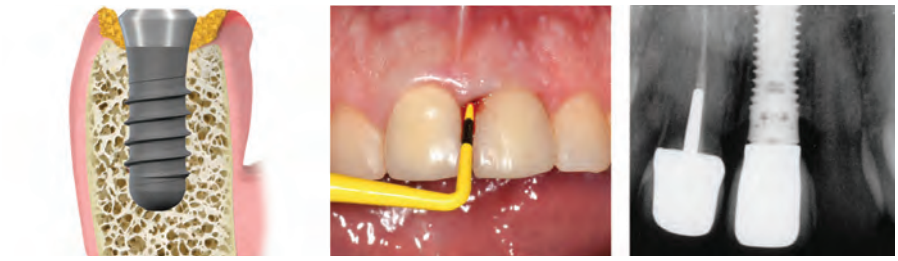
Peri-implant health

Peri-implant health was characterized at the clinical level by the absence of signs of soft tissue inflammation, e.g. absence of bleeding on gentle probing (BoP) and suppuration[1].

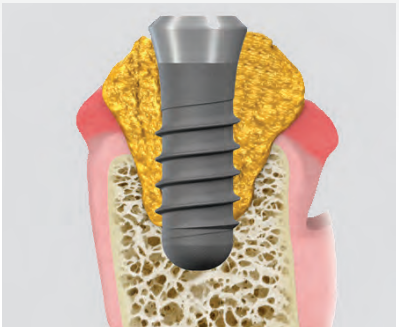
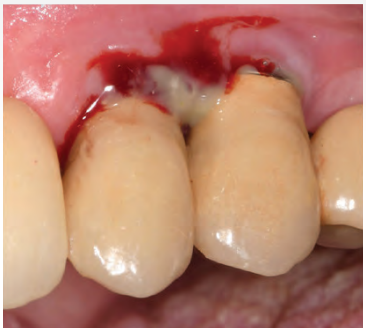
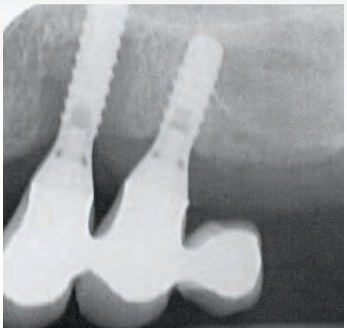


Peri-implant mucositis

Peri-implant mucositis was defined as presence of BoP and/or suppuration with or without increased probing depth compared to previous examinations in conjunction with the absence of bone loss beyond crestal bone level changes resulting from initial bone remodelling.[5] Visual signs of inflammation may vary and peri-implant mucositis may be diagnosed around implants with variable levels of bone support.



[1] Prof Dr med dent Giovanni E Salvi, member of the editorial board of Journal of Clinical Periodontology and Clinical Oral Implants Research and associate editor of Clinical Oral Implants Research.
Associate professor, Department of Periodontology and Director of the graduate program in Periodontology, University of Bern, Switzerland.

Peri-implantitis

Peri-implantitis was defined by the presence of BoP and/or suppuration, increased probing depths compared to previous examinations and presence of bone loss beyond crestal bone level changes resulting from initial bone remodelling.[5]

Prevalence of peri-implant diseases

The prevalence of peri-implant diseases has been widely investigated. Outcomes of a systematic review reported a weighted mean prevalence of peri-implant mucositis of 43 % (range: 19 - 65 %) and peri-implantitis of 22 % (range: 1-47 %).[10] Results from cross-sectional studies indicated that the frequency of peri-implantitis ranges between 13 and 26 %.[2] However, based on the wide range of reported prevalences reflecting the high heterogeneity of the applied clinical and radiographic thresholds for disease definition, an adequate estimate of peri-implant diseases seems difficult.[10]

Risk indicators for peri-implant diseases

A number of risk indicators have been identified that may lead to the establishment and progression of peri-implant mucositis and peri-implantitis.

The following risk indicators and their corresponding preventive measures are presented:

Insufficent self-performed plaque control: Poor self-performed plaque control increases the risk for peri-implant diseases[11].
Prevention: High levels of self-performed plaque control are critical for the maintenance of peri-implant soft tissues without inflammation.

Excess cement: Presence of cement excess is associated with peri-implant mucositis and peri-implantitis.[15,26]
Prevention: Attention should be paid to cementation in order to avoid excess cement. Alternatively, screw-retained restorations may be considered.

Lack of keratinized and attached peri-implant mucoza: Implants not surrounded by attached and keratinized mucosa are more prone to plaque accumulation and recession, even in patients with sufficient oral hygiene and enrolled in maintenance therapy.[20]
Prevention: Care should be taken before, during or after implant placement to ensure that keratinized and attached mucosa is present around dental implants.

Untreated peri-implant mucositis: Patients diagnosed with peri-implant mucositis that remains untreated for a period of 5 years are more likely to develop peri-implantitis compared with those receiving a yearly treatment for peri-implant mucositis.[7]
Prevention: Early diagnosis and treatment of peri-implant mucositis reduces the risk for the development of peri-implantitis.

History of treated periodontitis: The survival and success rates of implants placed in patients with treated periodontitis are lower compared with those in patients without a history of periodontitis.[23]
Prevention: High-quality treatment of periodontitis prior to implant placement is recommended. Deep residual pockets with BoP jeopardize long-term implant success rates.[6,18]

Lack of adherence to maintenance care: Implant survival and success rates are lower in patients not adhering to regular maintenance care programs.[12,19]
Prevention: A recall interval tailored to a patient's risk profile (i.e. every 3 - 6 months) is recommended.[14,21]

Tobacco use: Tobacco consumption leads to an increase in peri-implant soft tissue complications and to elevated peri-implant bone loss or implant loss.[3,13,16,25]
Prevention: Smoking cessation protocols increase implant survival rates.[4]

Cleanable implant-supported restoration: Implant-supported restorations with inadequate access for plaque control exhibit an increased risk for peri-implantitis compared with those with good access for plaque control.[22]

Prevention: Implant-supported restorations should provide unrestricted access for plaque control.

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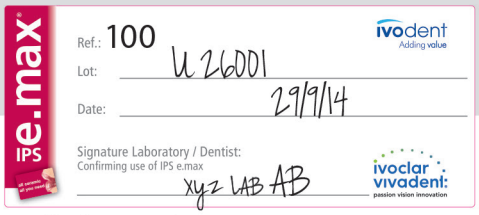
[1] based on sales figures
[2] Ivoclar Vivadent, Scientific Report IPS e.max_Vol.3, *Study Report,* 2018



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The color gradient of natural teeth and their intelligent imitation

Stefan Roozen[1]

Introduction

Nowadays, more and more monolithic restorations are being made. Around 90% percent of all posterior teeth are ordered in a key shade (for example: Vita A3 or A2). It is no longer necessary to laboriously layer these simple colors. For some time now, lithium disilicate and modern translucent zirconia have made it possible to make them aesthetically enough without great effort, from a single material without veneering. Just mono.

This variant can also be used successfully in the anteriorarea. This is particularly efficient and makes economic sensewhen restoring entire jaws. In case of smaller rehabilitations, however, the surrounding clinical environment requires a more individual approach and the effects of nature should be reproduced to the given extent in order to achieve good integration. Front teeth in particular are extremely multifaceted and can be very different in color and shape. From opaque to transparent, different in chroma and color value, highly dynamic and full of effects in the incisal third.

Therefore, the staining technique can be combined with the newly developed SQIN - the new Initial micro-veneering type of ceramic - in order to achieve the necessary complex depth of natural teeth.

The example of nature

The essential color components of the natural tooth are hue, chroma and translucency.

- Hue: the base colors. A (red-brown), B (yellow), C (gray) and D (red-gray). (Vita classic shade guide)
- Chroma: the saturation of the respective color value.
- Translucency: in the translucent area, the light is reflected less and penetrates more through the tooth. This area is therefore also described as an absorbing zone.

The color gradient of the tooth (Fig. 1)

- The cervical 1/3: mostly with increased chroma of the base color (a)
- The central 1/3: base color, area with the highest brightness value (b)
- The incisal 1/3: area with increased translucency; absorbent area (c)

[1] Stefan Roozen, MDT, Laboratory manager & chief technician, Pils Zahntechnik GmbH, Austria
His main areas of work are complex prosthetic reconstruction (tooth and implant supported), demanding restorations in the aesthetic and functional area.

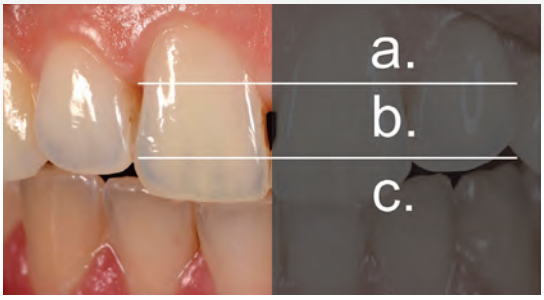

Figure1: The color gradient of the tooth: a) increased chroma; b) base color; c) increased translucency

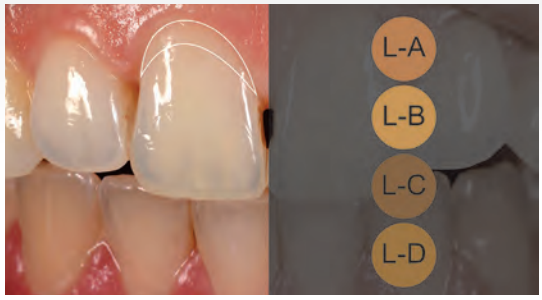

Figure 2: The cervical area

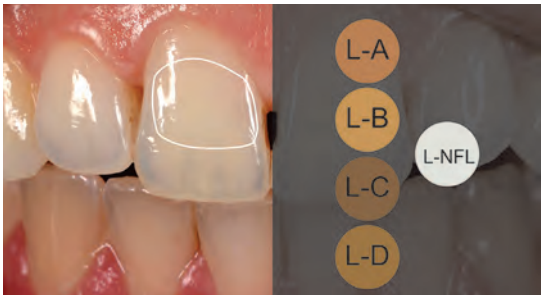

Figure 3: The central third; (L-NFL: Neutral Fluo)

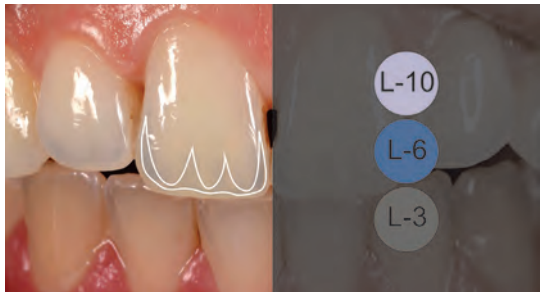

Figure 4: The incisal zone; (L-10: Twilight; L-6: Dark Blue; L-3: Dark Grey)

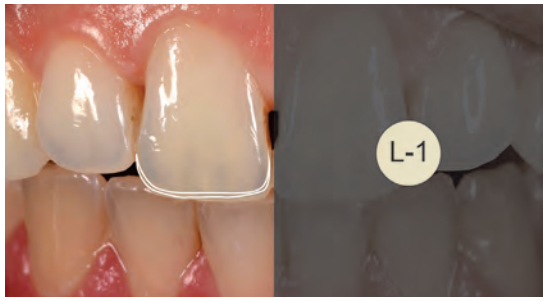

Figure 5: The halo; (L-1: Vanilla)

The imitation and the material

The new Lustre Pastes ONE are a further development of the proven Lustre Pastes NF. These natural looking fluorescent glazes are applied to the surface and create a three-dimensional end-result due to the special mixture of fine feldspar based glass ceramic particles. Thanks to its ceramic structure, they are suitable both as finish for monolithic indications and can be used in combination with veneering ceramics (internal and external usage).

The cervical area (Fig. 2) usually has an increased chroma. The corresponding color tone (e.g. L-A) is applied a little more intensively in order to achieve more color saturation.

The central third (Fig. 3) is the area of the actual tooth color. The chroma is checked with L-A, L-B, L-C or L-D according to the target color. These are applied gently so that they let through. They can be used pure for a higher color saturation (e.g. A3.5, A4, B4, C4, ...) or can be softened with L -NFL to achieve a lighter shade (e.g. A1, B1, C1, ...)

The incisal zone (Fig. 4) is imitated with absorbent colors. Bluish, purple and gray pastes (L-10, L-6, L-3, ...) create the illusion of transparency. Alternatively or in combination, a unique Opal paste can be applied. (L-OP).

Other effects such as white spots, cracks or the reproduction of the halo can create additional dynamism and liveliness.

The halo (Fig. 5) is painted on as a bright, shining band.

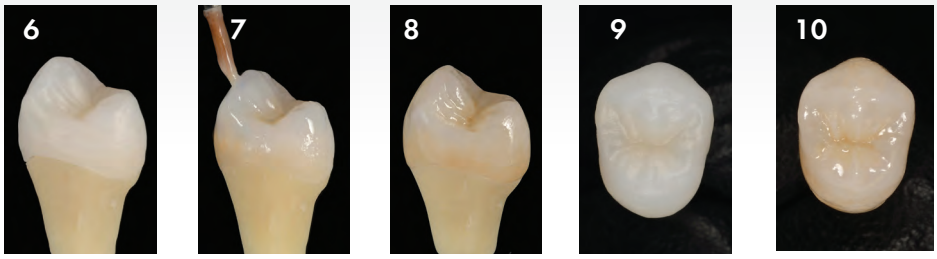

***Figure 6**: Before: Zr crown; **Figure 7**: Application of Lustre Pastes ONE; **Figure 8:** After: Finished crown; **Figure 9**: Before: Zr crown; **Figure 10**: After: Finished crown*

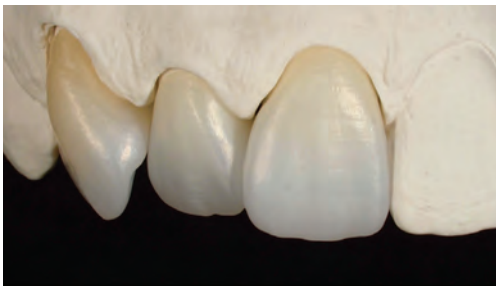

Figure 11: Sintered Zr crowns after firing

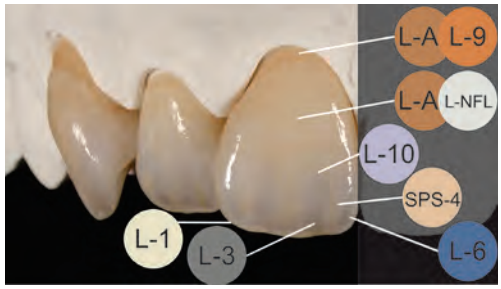

Figure 12: Refined with Lustre Pastes ONE, after firing

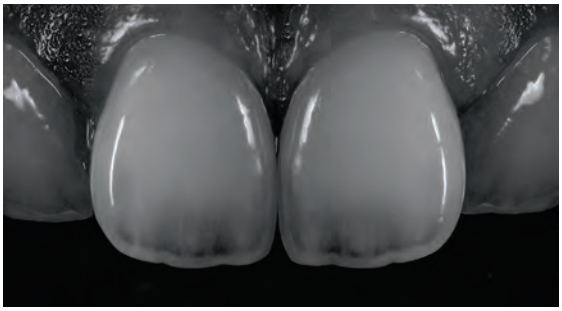

Figure 13: Grayscale image of natural teeth showing the variance in color value throughout the teeth, especially in the incisal third.

This shows the bundling of light on the cutting edge and enhances the transparent effect.

The monolithic implementation

Lithium disilicate and translucent zirconia are mainly used as restorative material nowadays. The fully anatomically shaped crowns are simply glazed and refined in color using the Lustre Pastes ONE.

Lustre Pastes ONE can also be combined with Initial Spectrum Stains (fine ceramic stains), thus offering unlimited color options.

When it comes to key colors, it is often sufficient to use just a few pastes. For example, with this premolar shown in Figs. 6-10, L-A (Lustre Body A) was applied in the appropriate intensity until the desired chroma of the respective A-color was achieved. L-6 (Enamel Effect Dark Blue) was used very discretely on the cusp tips to imitate some translucency. The tooth color is already visible upon the application, even before firing.

The corresponding tooth areas are color-coded for more individuality. The three-dimensional effect of the pastes creates a dynamic result (Figs. 11-12).

The Micro-Layering Upgrade

Natural teeth can sometimes have a very complex depth and individuality in their enamel layers (Fig. 13).

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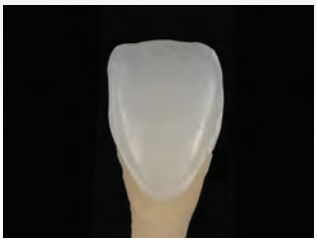


Figure 14: Zr crown, 0.3 mm labial reduction

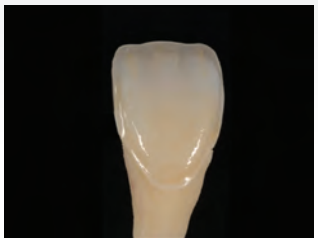


Figure 15: Lustre Pastes ONE – coloring and wash fire

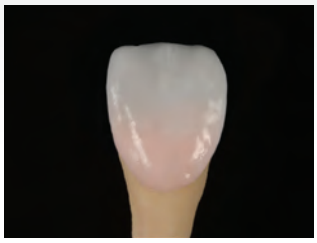


Fig 16: Micro-ceramic layering with Initial SQIN

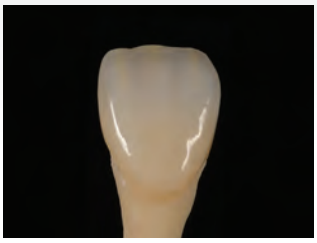
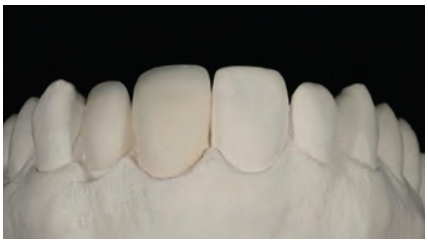


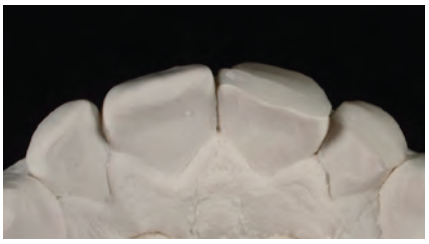
Figure 17: Result after firing

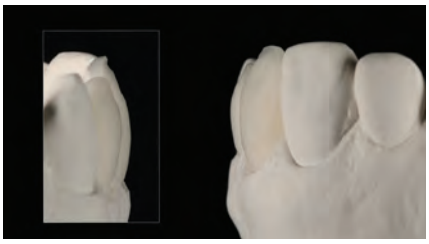
applied on the surfaces that have been previously fired with Lustre Pastes ONE. The end-result is achieved in just one firing. This is made possible thanks to the newly developed feldspar-based SQIN ceramic powders. Using the special mixing liquid (Form & Texture Liquid) the application is very comfortable – easy to form your final shape, easy to mimic texture. After the final, shiny firing result – the so called –"self-glazing effect" is obtained. Due to its high homogeneity, the mass remains very stable during processing and shows hardly any shrinkage after firing, so that shape and texture no longer need to be corrected (Figs. 14-17).

Minimally invasive meets Minimal-Layering

With this new micro-layering concept – Initial IQ ONE







Figures 18-20: Initial LiSi Press (LT-B0) veneers with minimal labial reduction

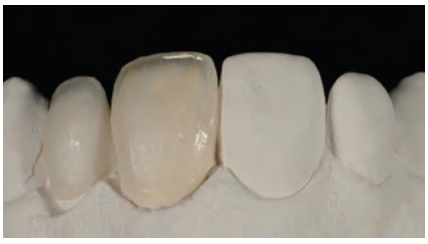


Figure 21: Lustre Pastes ONE

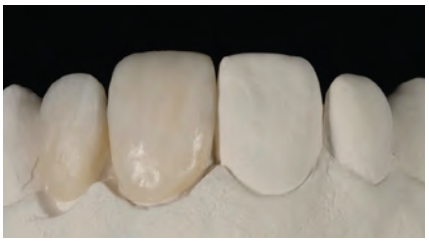


Figure 22: SQIN micro-ceramic layer before firing

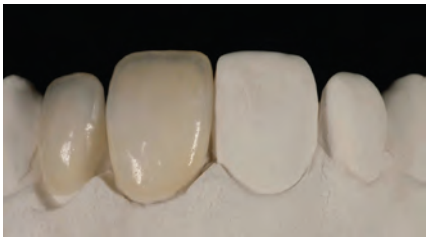


Figure 23: Firing result with "self-glaze" effect of SQIN.

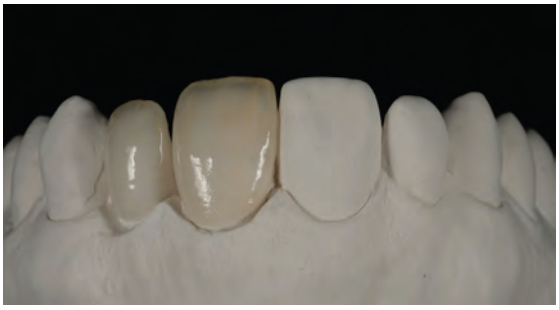


Figure 24: External glaze firing with Initial Spectrum Stains

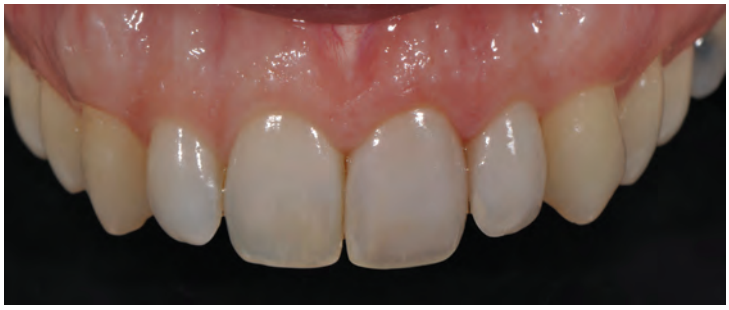


Figure 25: Clinical outcome (Dentist: Dr. Johannes Bantleon, Vienna, Austria)

Figure 26: Zirconia structure

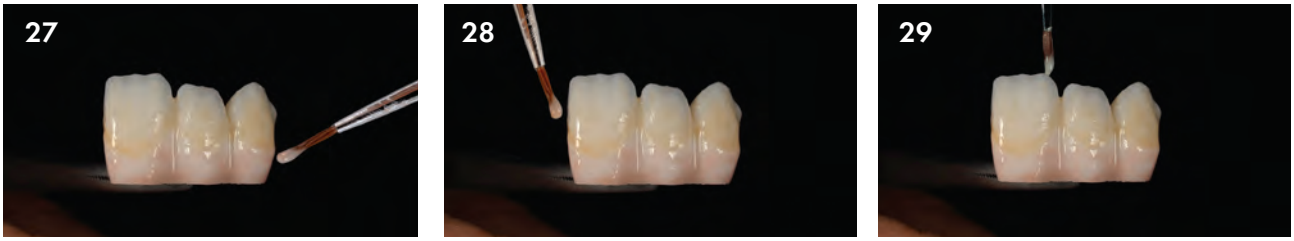


Figure 27-29: Zirconia structure, application of different tooth-colored (Initial Lustre Pastes ONE) and gingiva-colored pastes (Initial Lustre Pastes NF Gum)

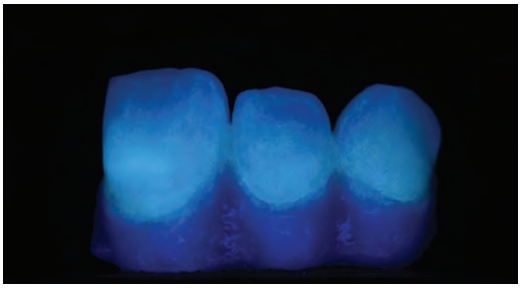


Figure 30: Fluorescence of the white areas, non-fluorescence of the red areas

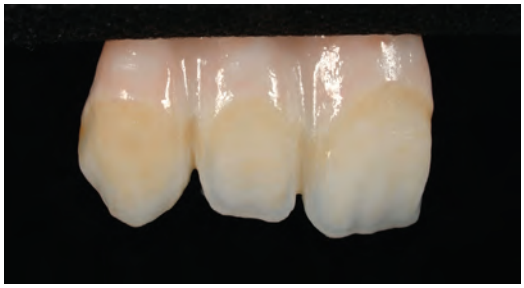


Figure 31: Initial Lustre Pastes ONE after firing

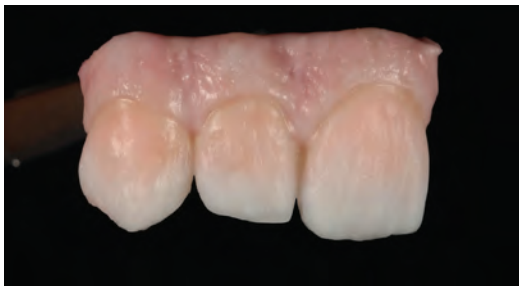


Figure 32: Red and white SQIN ceramics before firing (shaping & texture possibilities!)

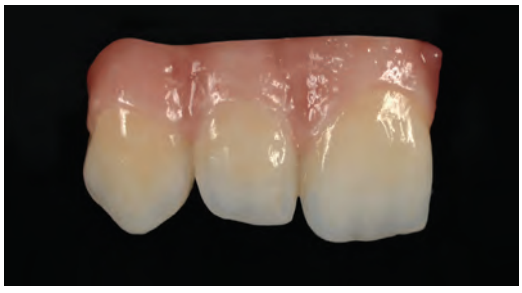
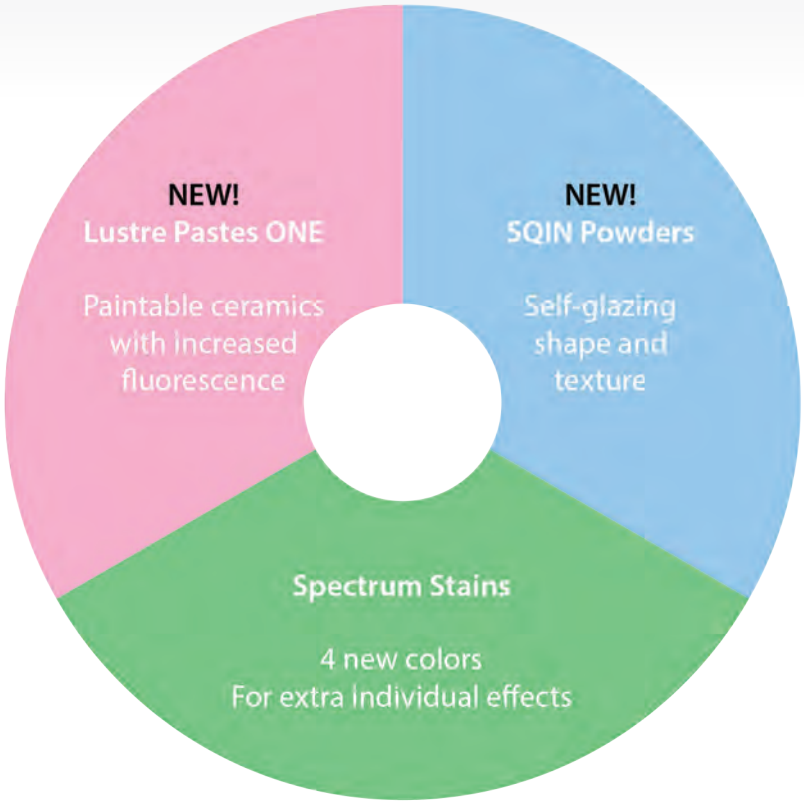


Figure 33: Result after firing

SQIN - a high degree of aesthetics is achieved in the smallest of spaces. As a result, modern treatment methods that are particularly gentle on the tooth structure do not represent a compromise. Small rehabilitations in aesthetically sensitive areas can thus be carried out without great effort (Figs. 18-25).



Initial ONE SQIN micro-layering concept

The gingival reconstruction

Especially in implantology, we often come across the situation of reconstructing gingiva with our prosthetic superstructures. The red-white gradient deserves special attention. Here, too, the technology of Initial IQ ONE SQIN concept is used. The different gingival regions can be reproduced with three different SQIN gingival powders. A more intense red for areas with strong blood circulation and a lighter shade for the firm gingiva are essential. Furthermore, a neutral type completes the line-up. In contrary to the tooth-shaded SQIN powders, all SQIN gingival powders are inherently non-fluorescent (Fig. 30). The way it works is the same as with tooth-colored ceramics. First, Lustre Pastes ONE and/or Lustre Pastes NF Gum shades are applied to give an ideal color base and create a good bond with the ceramic layer (connection firing). Then SQIN gingiva- and tooth-colored ceramic is applied in a final firing.

Conclusion

The new Initial ONE SQIN microlayering concept - offers a complete range of materials, assuring a high level of aesthetics and reduced working time. It fits to the actual full ceramic market tendency using zirconia and lithium disilicate as base materials. Using minimal veneer thicknesses minimize chipping and fractures, thus avoiding complaints. This technology is compatible with the digital workflow without compromising the individuality of the patient's wishes, and thus to be successful in the demanding dental market.

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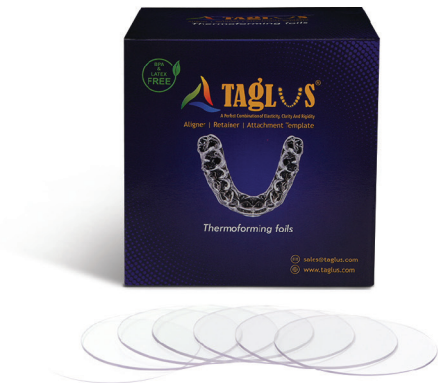

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Top tips in local anaesthesia

Ian Corbett[1]

Introduction

Successful local anaesthesia is paramount to almost all that we do in clinical dentistry. Dental injections and dental pain are frequently cited by patients as reasons for non-attendance. If we can achieve pain-free dentistry, we also gain patient satisfaction, as well as making our work less stressful.

My research interest over many years has been local anaesthesia. I have had the pleasure of working with the team at Septodont throughout. Septodont supports independent research internationally and seeks advice and evidence from leading research teams on product development. This is apparent in the quality of its pain management range.

Local anaesthesia equipment

1. Buy quality.

When it comes to purchasing new needles, remember that not all needles are the same! Look for a product with a multifaceted bevel design that aids needle penetration and reduces needle deflection as it passes through the tissue. Check for a high manufacturing standard and a good quality assurance system. Inferior needles may cause greater injection pain and tissue damage due to bluntness, metal barbs or shards and damaged tips.

2. Length.

It is useful to have long and short needles for blocks and infiltrations, respectively. An ultra-short needle may be useful for periodontal ligament injections, although not necessary. Never use a short needle for an inferior alveolar block: although needle breakage is rare with modern needles, it generally occurs at the attachment to the plastic hub. Do not bend needles, which will weaken them. The needle should not be inserted all the way to the hub, as if the needle breaks it will be difficult to retrieve.

3. Diameter.

Needle diameter or gauge refers to the external diameter of the needle, not the internal diameter, which has complex relationship to flow, and there is little advantage in increasing diameter. Patients are unable to discriminate between the commonly used needle diameters in terms of injection pain.

4. Use safer sharps.

Mandated by UK health and safety law, a safer sharps system should be used where feasible. There are several different designs are available, get samples from company representatives and find one that you feel comfortable using.

5. Avoid resheathing needles.

Any form of needle resheathing device carries a risk and it is easy to be distracted while doing this. There is also a risk when removing the sheathed contaminated needle for

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disposal and cleaning of the syringe. Think about the risks to the whole team.

6. Disposable items.
Fully disposable syringe systems may be cost effective – the cost of a single use safety syringe may be less than that of small-scale sterilisation costs. Whereas partially disposable syringes, where the handle is reusable, will save on waste. Consider the environmental impact of waste and the disposal costs for contaminated sharps.

7. Single injection.
Single-use systems can be reused on the same patient at a single visit, however, surgical grade sharps, blunt very easily and needle penetration force and pain increase with each injection. Best practice is to use a new needle for each injection administered.

8. Aspiration system.
Whatever system you use, make sure that you are familiar with the aspiration system. Some syringes need a compatible anaesthetic cartridge, with some designs no longer available. Take a moment to check the syringe you are using.

9. Change.
If you are changing to a safety syringe for the first time, or changing suppliers, make sure you are aware of any differences in set-up or use. It takes time to adapt to change, so be patient with the learning process.

10. Needlestick.
Your practice should have a needlestick policy in place in the unfortunate event that this occurs. Make sure you are familiar with it.

Local anaesthesia solutions

1. Lidocaine.
For many years, lidocaine has been considered the gold standard in local anaesthetics. Available as a 2% lidocaine, 1:80000 adrenaline dental cartridge, lidocaine is ideal for inferior alveolar nerve blocks. The highest adrenaline concentration of the dental local anaesthetics also makes this the first choice to minimise bleeding during procedures.

2. Articaine.
Considered the new standard in many countries, articaine has been available in the UK since 1998, with increasing popularity. Studies have identified a potential risk of neurotoxicity when 4% articaine is used for nerve blocks, and, as efficacy for blocks is the same as 2% lidocaine, articaine is best reserved for infiltration anaesthesia where the thiophene ring structure of articaine increases lipid solubility and aids diffusion. Articaine is rapidly broken down by serum esterases, in addition to the liver, however, as articaine has a high binding to proteins, which act as a reservoir, it has a long duration of action.

3. Mepivacaine.
Available as a plain solution, mepivacaine has largely replaced prilocaine with felypressin as the go-to anaesthetic for avoiding adrenaline. This is the longest acting of the local anaesthetics without adrenaline.

4. Bupivacaine.
While not available as a dental preparation, bupivacaine and levobupivacaine are long acting local anaesthetics most often used for achieving post-surgical pain control.

5. Adrenaline.
In dental solutions, adrenaline concentration ranges from 1:80 000 to 1:200 000. It is added to prolong the anaesthetic effect by reducing local blood flow and preventing the anaesthetic being washed out of the tissues, a secondary effect is to reduce bleeding.

Responsible for the heart racing, shaky effects reported by patients and often mistaken for allergy, aspiration will avoid inadvertent intravascular injection, although some patients appear sensitive to these effects.Lowering the dose of adrenaline does not reduce efficacy and therefore a 1:200 000 concentration is ideal for all but surgical procedures. Adrenaline is unstable and an antioxidant preservative is added to all adrenaline-containing solutions, frequently sodium metabisulphite, which is a known allergen.

6. Think volume. Always use the minimum anaesthetic volume to achieve the required effect. 2.2ml of solution is enough to achieve a block or infiltration anaesthesia. Consider a different technique if this doesn't work.

7. Stay within dose limits. A good rule of thumb is a single cartridge of anaesthetic per 10kg patient weight, up to a maximum of seven cartridges. Keep your cartridges in sight until the end of the procedure for ease of checking your dose. If using more than one type of anaesthetic then the maximum dose is the lowest maximum for either, not twice as much.

8. Always aspirate.
Systemic toxicity can be the result of intravascular injection as well as overdose. Get into the habit of always aspirating prior to injection.

9. Check the label.

Always ensure you have the correct solution and it is within the expiry date. As anaesthetics are drugs, you should always record which solution, the total volume and technique used for each patient. It is good practice to record a positive or negative aspiration. There is no need to record the batch number, although this could be recorded as part of your stock control procedures.

10. Allergy.

True allergy to current amide local anaesthetics is rare. Signs and symptoms, such as perioral rash and swelling, itching and hives, abdominal pain and wheezing and airway compromise. If an allergy is suspected, the patient should be referred to your local immunology service for hypersensitivity testing. Usually multiple local anaesthetics will be tested that allows for identification of those safe to use.

Local anaesthesia storage

1. Keep it dark.

Local anaesthetic should be stored in its original packing, preferably in the dark, which prevents oxidation and degradation of the solution.

2. Room temperature.

Solutions should be stored in a cool place or at room temperature. There is no need to refrigerate anaesthetic solutions. It is good practice to place a maximum/minimum thermometer in cupboards for storing pharmaceutical products and keep a daily record, especially in hot weather.

3. Expiry date.

Anaesthetic solutions generally have long expiry times, usually in excess of one year.. Good stock control and stock rotation should ensure that the expiry date is not reached. Never use a product beyond its expiry date, as it may become ineffective and, more importantly, because of the risk of microbial contamination.

4. Don't warm.

There is no benefit in terms of patient comfort or effectiveness in warming anaesthetic solution. Keeping solution in anaesthetic warmers for prolonged periods can lead to chemical degradation. There may be discomfort from using cold solution, for example from a refrigerator. Room temperature is ideal prior to injection.

5. Perform cartridge checks.

Always carefully check the cartridge prior to use. Check that you have the correct anaesthetic agent and concentration. Check whether you are using an adrenaline-containing or plain solution. Check the expiry date. Finally, check the condition of the cartridge, septum and bung for contamination or damage. Small cracks in the glass may frequently go unnoticed, which can lead to the glass breaking when injection pressure is applied.

6. Discolouration.

Discolouration of anaesthetic solution is an indication of oxidation. The solution should be clear; solutions with a yellow hue should be discarded.

7. Bubbles.

Anaesthetic cartridges frequently have a small bubble visible in the solution. This is part of the filling process. Anything other than a bubble of 2-3mm diameter would suggest that the cartridge has leaked and, as a result, may have bacterial contamination. Discard any cartridge with a large bubble.

8. Disinfection.

While local anaesthetic solution within the cartridge is sterile, the glass cartridge itself is not. Cartridges should not be placed in disinfectant or sterilising liquids due to the risk of this entering the cartridge and then being injected into the patient. If a sterile field is required, then a clean cartridge can be placed in a sterile, fully enclosed syringe system using a four-handed aseptic non-touch technique.

Local anaesthesia techniques

1. Think patient.

Check the medical history every time. Do you need to modify your anaesthesia in terms of the solution or technique? What has worked well in the past? How anxious is your patient and how will this change your approach?

The injection is often given as reason for dental anxiety and non-attendance. Getting the injection and anaesthesia right is key to a successful practice.

2. Think procedure.

What do you want to achieve this visit? This dictates the technique to be used. Are you working on a single tooth or multiple teeth? Will the gingiva be involved, for example in placing a rubber dam clamp? Do you need pulpal anaesthesia? Pulpal anaesthesia is often difficult to achieve with an inflamed pulp. Are you scaling? Deep scaling can affect the tooth, soft tissues and bone, like a dental extraction. Consider your treatment plan and ensure you have anaesthetised all the relevant structures.

3. Know your anatomy.
Spending a little time revising the anatomy of the jaws, becoming familiar with nerve and vessel pathways and territories, will improve your success rate and help avoid complications. It may have been a long time since BDS anatomy lectures.

4. Block versus infiltration.
Block anaesthesia, where solution is deposited by the nerve trunk to anaesthetise all upstream branches, is a good way to anaesthetise large areas with low volumes.

5. Start simple.
A simple buccal infiltration will be enough for most of teeth and for restorative procedures. Although articaine buccal infiltration is effective for mandibular molar anaesthesia, don't forget your IANB technique. Combine techniques for optimum anaesthesia. I often use the anterior ramus technique for an IANB, touching bone early and deflecting the needle parallel to the ramus towards the mandibular foramen, which works well for me. Learn a new technique or refresh an old one. When was the last time you gave a closed mouth or Vazirani-Akinosi IANB block?

6. Needle bevel.
The needle bevel may be marked on the plastic hub of the needle in quality products. This allows the bevel to be orientated during needle penetration and injection. The bevel should be rotated so that the opening faces towards the bone. This prevents the needle from piercing the periosteum covering the bone, avoiding sub-periosteal injection, which can be painful as solution strips the periosteum from the bone. Bevel to bone also aids in depositing the solution towards the bone and hence the teeth or foramen, rather than out into the tissues.

7. Speed.
Slow injections increase efficacy. Ideally, a cartridge should be administered over one minute, which increases the efficacy of an inferior alveolar nerve block by around 50%. Try timing your own injections, it is surprising how long a minute feels. Slow injection keeps the solution localised.

8. Rapid and forceful injections can damage the tissues and lead to necrosis.
This can be particularly painful in the palatal mucosa, which has little space to accommodate volume.

9. Foramen.
Don't inject into a foramen! The mental foramen is usually palpable through the buccal mucosa. The nasopalatine foramen is landmarked by the incisive papilla.
Injecting within the canal may disrupt the nerve and cause a prolonged altered sensation. If the needle enters the foramen, withdraw and reposition.

10. Explain sensation, recovery time and give specific instructions regarding eating and drinking.
Consider technique and solution combinations to prolong or shorten the duration of anaesthesia, depending on the procedure and predicted level of postoperative pain. Give good analgesic advice.

Supported by Septodont
With a research interest and international recognition in the field of dental anaesthesia, having published extensively, lectured internationally, and awarded a European Federation for the Advancement of Anaesthesia in Dentistry prize, Mr Ian Corbett shares his thoughts in on all things anaesthesia – from solutions and storage, to measuring success and dealing with failure.

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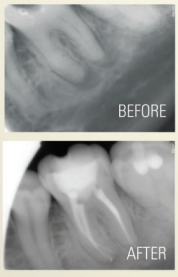

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DFDBA grafting versus natural healing after extraction: A Randomised Controlled Clinical Trial

JPJ Olivier[1], J Marnewick[2], TC Postma[3]

Abstract

The aim of this study was to determine the quality of bone available for implant placement using DFDBA as grafting material in combination with a resorbable collagen membrane, compared to bone in extraction sockets that were left to heal naturally. A total of 20 sites were identified from eight patients requiring replacement of two or more extracted teeth by means of dental implant supported structures, on contralateral sides of the same jaw. They received DFDBA grafting of the socket on one side and no grafting on the contralateral side at the time of extraction. When implants were placed 16 – 20 weeks later, core samples of bone from these sites were first harvested by means of a trephine drill and those samples were processed and examined histologically to determine which of these sites displayed better quality of bone. One patient's samples could not be utilised. Comparing the samples of the remaining nine non-grafted to nine grafted extraction sites, the difference in the calculated percentages of trabecular bone and collagen as well as the numbers of osteocytes, inflammatory cells and blood vessels were statistically insignificant. The results of the study indicate that statistically there are no significant histological differences between DFDBA-grafted and non-grafted sockets.

Introduction

Dental sockets decrease in volume after tooth extraction and change morphologically.[1,2] With dental implant treatment becoming so widespread, the need to preserve bone after tooth extraction has become an ever-increasing concern for clinicians.[3] Recent advances in bone grafting materials and techniques allow dentists to place implants in sites that were considered compromised in the past. It is well documented that post-extraction maintenance of the alveolar ridge volume by grafting the socket may minimize ridge resorption and allow placement of an implant that satisfies aesthetic and functional criteria.[4,5]

Bone grafting is possible because bone tissue has the ability to regenerate completely, with the grafting material ideally enhancing the natural process of osteogenesis. As host bone grows, it will generally replace graft material completely, assisted by new bone growth from vital osteogenic cells resulting in a fully integrated region of new bone.[6]

This natural process of osteogenesis is supported by two distinct processes, namely osteoconduction and osteoinduction. Osteoconduction occurs when bone graft material serves as a scaffold for new bone growth by the host bone. Osteoblasts from the margin of the grafting site utilise the bone graft material as a framework upon which to spread and generate new bone. Osteoinduction, on the other hand, involves the stimulation of osteoprogenitor cells to differentiate into osteoblasts, leading to new bone formation – described by Marshall R Urist in a study done in 1965.[7] This process is facilitated through Bone Morphogenetic Protein (BMP), a growth factor bonded to cell surface receptors that stimulates mesenchymal cells to differentiate into osteoblasts.[8-11] Growth factor enhanced grafts are produced using recombinant DNA technology.[6] They consist of either human growth factors or morphogens (BMPs coupled with a carrier medium, such as collagen).

Different types of grafting material exist namely autograft, allograft, xenograft and alloplastic material. Autograft comprises of autogenous tissue transplanted from one site to another site in the same individual. Autografts possess osteoconductive, osteoinductive and osteogenic properties – as long as it includes bone marrow and sufficient blood supply in the transplant site.[6] Because it fulfils these three basic requirements of bone regeneration, autogenous bone grafts are considered the gold standard in bone regenerative procedures. Limitations involving autogenous bone

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[3] TC Postma, MChD, DHSM, PhD, Head Clinical Unit, Department of Dental Management Sciences, University of Pretoria

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grafting - such as the need for second surgery for harvesting, significant donor site morbidity, limitations in quantity of bone and the potential for complications, have led to the search and study of alternative materials.[10]

Allograft refers to tissue grafts that originate from genetically different donors of the same species, of which Demineralised Freeze-Dried Bone Allograft (DFDBA) is a common example.[6] DFDBA undergoes sterilisation and deactivation of proteins normally found in healthy bone and is commercially available in different formulations such as blocks, matchsticks, conical shapes and particulate form, commonly known as bone sugar.[3] It involves a process of demineralisation with an agent such as hydrochloric acid, whereby calcium and phosphates are removed, but the osteoinductive extracellular matrix is left - which consists mainly of non-structural proteins, including growth factors such as BMPs and type 1 collagen. Apart from being osteoconductive, allografts may therefore also have some osteoinductive properties, although these osteoinductive properties may vary significantly between products from different bone banks due to different manufacturing processes.[12,13]

Xenograft refers to grafts harvested from a donor of a different species, such as bovine, porcine or equine. It is chemically processed in a specific way, resulting in a product with osteoconductive properties, but lacking osteoinductive and osteogenic properties.[3,6,14]

Alloplastic graft material is purely synthetic, for example hydroxyapatite or tricalcium phosphate.[2,15] Similar to xenografts, these grafts are also osteoconductive without osteoinductive or osteogenic properties.

Bone graft material that has both osteoconductive and osteoinductive properties such as DFDBA may therefore serve as both a scaffold for existing osteoblasts and initiate the formation of new osteoblasts, theoretically promoting faster integration of the graft. Histologic studies focusing on the healing patterns of dental extraction sockets after 16 to 20 weeks of healing, comparing commercially available DFDBA to mineralised grafting materials (FDBA), have shown that DFDBA results in greater vital bone gain (28% to 53%) than FDBA (17% to 27%) after three to six months. These properties and the fact that DFDBA is very reasonably priced and easily obtainable, makes it an attractive method of bone grafting during implant placement.[16]

However, because grafting may introduce added risks of post-operative complications and greater cost to the patient, while benefits are not ensured, it is necessary to determine if DFDBA adds value to the bone healing processes related to implant placement.

The objective of this study was therefore to ascertain whether there is any advantage in augmenting dental extraction sockets with DFDBA, by utilising a technique of grafting sockets with DFDBA in combination with a collagen membrane (experimental) and comparing it to sockets that were left to heal naturally (control) in the same jaw of the same patient. The generally accepted parameters indicating new bone formation were used namely a physical count of the number of osteocytes, the quantity of trabecular bone, collagen estimate, inflammatory cell count, blood vessel count and the remaining graft material. Samples of bone from both experimental and control sockets were compared after histological analysis to establish which of the sites displayed a better quality of healed bone, to possibly ensure greater implant stability and better integration.

Method

The study was conducted as a randomised (controlled) clinical trial investigating the histologic difference in bone quality after healing between non-grafted sockets and sockets grafted with DFDBA and a resorbable membrane. The study was conducted by the 1st author as investigator, both in private practice and the School of Dentistry, Faculty of Health Sciences, University of Pretoria (Faculty of Health Sciences Research Ethics Committee approval on 30 June 2016 – Reference nr 231/2016).

Inclusion/exclusion criteria

Basic criteria for selection were patients requiring at least two non-molar extractions, within the same jaw, with planned subsequent dental implant placement. Patients had to be at least 18 years old and given voluntary consent to participate in the study. Single-rooted non-molar teeth due for extraction - with radiological evidence of sufficient bone support and tooth orientation conducive to ideal implant placement, were selected to ensure adequate depth of socket for harvesting of a core biopsy without including surrounding native bone.[4] Multirooted teeth were excluded because of the possibility of interradicular bone being harvested, as well as sockets with a severe dehiscence. Exclusion criteria: impaired immune system, immunosuppressive therapy, uncontrolled systemic disease, anti-inflammatory drug therapy, history of allergy to DFDBA or collagen membranes, teeth with periapical pathology and extensive bone loss during extraction process.

Clinical protocol

Intra-oral examination, peri-apical and panoramic radiological images and Cone Beam Computerised Tomography (CBCT) scans were performed pre-operatively. If deemed necessary, customised acrylic occlusal stents were fabricated on study models to serve as fixed reference guides for both accurate harvesting of core samples and subsequent placement of implants. Intra-operatively the relevant teeth were removed utilising a low-trauma technique to ensure preservation of socket walls. Root remnants and failed fixed prosthesis were removed in advance.

The random allocation of which sockets to graft with DFDBA and which to leave undisturbed was done by the flip of a coin with the patient as witness, purely because it is and has always been regarded as a simple, unbiased method of deciding between two options and is being used regularly in scientific studies.[20]

In the DFDBA graft group a full-thickness gingival flap was raised to expose both labial and facial aspects of the alveolar

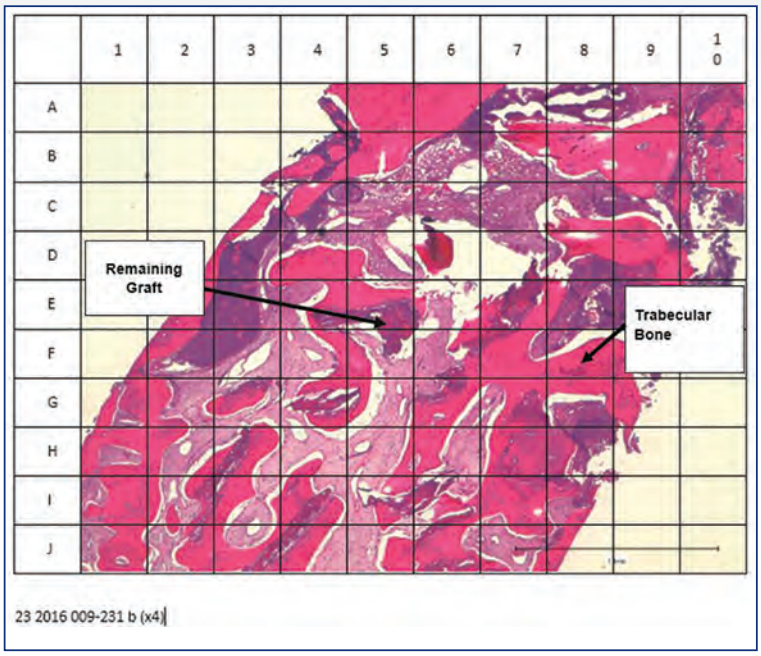

Figure 1: Example of the grid with the imported image (4x magnification).

ridge before commencement of tooth removal. After tooth removal and placement of the DFDBA grafting material, a resorbable collagen membrane was placed to completely cover the socket and extend to a minimum of 3mm beyond the alveolar crest, whereafter the gingival flap was replaced and sutured with monofilament non-resorbable sutures.1 The membrane acts as a barrier against the ingrowth of soft tissue into the healing site while helping to prevent loss of the grafting material at the same time. Current clinical trends tend to favour the use of resorbable membranes, although the study of different types of bone substitution materials combined with different types of membranes is ongoing and their efficacy in obtaining optimal results in immediate extraction socket preservation still needs to be defined.[20] The DFDBA was supplied by the National Tissue Bank of the University of Pretoria (ISO 9001:2000 and ISO 13485:2003) with the collagen membrane being a Jason Membrane (botiss biomaterials GmbH, Germany)

Post-operatively all patients received the same prescription of a 0,2% chlorhexidine rinse twice daily for ten days, the same antibiotic regime of Clindamycin 150mg four times a day for four days and the same analgesics as needed for four days. Clindamycin was chosen due to its effectiveness in both soft tissue and bone infections and also because none of the subjects reported to be allergic to Clindamycin. The analgesic of choice was a standard composition containing 400mg Ibuprofen and 325mg Paracetamol – providing analgesic, anti-inflammatory and antipyretic action.

Sutures were removed after ten days. All cases displayed excellent and uneventful healing at that stage. The quality of bone was assessed 16 to 20 weeks after grafting, as Beck and Mealy, 2010,5 demonstrated that allografted sites did not yield greater bone formation at 24 weeks as opposed to 12 weeks. However, new bone formation is known to be time and subject dependent,[2,4,10] but these variables were eliminated in this study by each patient serving as his own control.

To ensure that only bone from the extraction socket was harvested and also not to compromise primary stability of the implants, at re-entry core samples of at least 8mm (but no longer than10 mm) in length were harvested by means of a 3,6mm internal diameter trephine - with abundant water supply to prevent overheating of the bone, as the first step in the implant placement drill sequence. The cores were removed from the trephine using a thymosin probe placed into the window of the bur to displace the material. The harvested cores were then stored in a 10% neutral buffered formalin solution in numbered containers. After harvesting of the core biopsies, the final osteotomies were prepared and each of the sites received a dental implant (Neodent, Institut Straumann, Switzerland) with good primary stability established in each case.

Images of each harvested core specimen were digitally captured and examined to differentiate between the parameters indicating new bone formation, as described before.

Data collection

A copy of each slice was printed to check for and eliminate overlaps in order to prevent duplication, resulting in a total of 7200 data containing blocks.

The slices were evaluated for the previously mentioned

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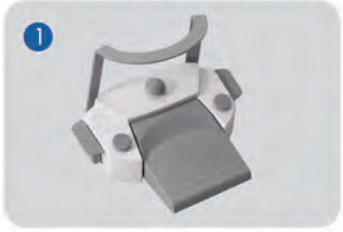

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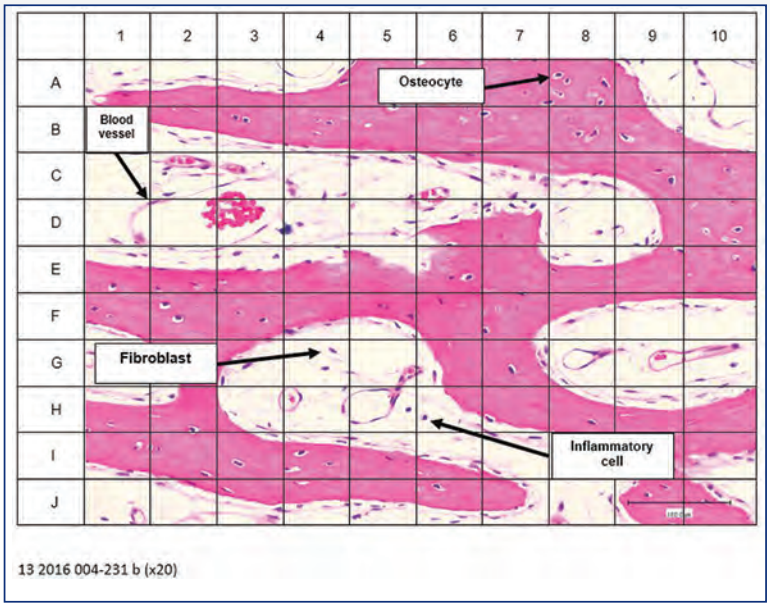

Figure 2: Example of the grid with the imported image (20x magnification).

histological parameters of osteogenesis[15,26,27] by counting the number of osteocytes as well as calculating/estimating percentages of trabecular bone, collagen and RG under 4x magnification and then counting the number of inflammatory cells and blood vessels under 20x magnification.

A case number was assigned, and the location of the implant recorded (tooth number) indicating if it was grafted or not (1 = Yes; 0 = No) . The slide number (typically 4 slides per site, numbered: 1, 2, 3, 4) and grid block number (Figures 1 and 2) were also recorded. Data coverage estimates were done (2 units = 100%; 1 unit = partial coverage (1-99%); 0 = no data) because not all grid blocks were 100% filled with tissue. Inflammatory cells, blood vessels and osteocytes were counted per grid block. The prevalence of collagen, trabecular bone and remaining graft were also subjectively estimated as an absolute percentage and recorded in coverage categories (0 = none; 1 = ≤33.3%; 2 = >33.3%-66.7%; 3 = >66.7%). The co-author controlled the integrity of the datasheet and the primary investigator corrected a minority of initial input errors through recounting. After all the counting was concluded, inflammatory cell, blood vessel and osteocyte counts were summed per site. The categorical estimates (0, 1, 2 and 3) for collagen, trabecular bone and remaining graft were totalled, using the "Countif" function in Excel that enabled the calculation of percentage distributions for each category. The percentage distributions were in turn used to calculate a total estimate for each case, using the numerical midpoint of each category as the utility weight. This method will be referred to as Estimate 1. In addition to this the mean score of the collagen, trabecular bone and remaining graft subjective percentage estimates by the primary investigator were recorded as the second value in this regard. This method will be referred to as Estimate 2. It was decided to use two different methods to estimate the prevalence of tissue types because of the subjectivity of the measurement and the lack of any existing methods that can perform this measurement objectively. It can be argued that if there is strong correlation between the two different ways of measurement then it would indicate that there is some reliability in the methods.

Sample identification was done by the primary investigator and randomly controlled by the supervisor. Inter-examiner reliability testing: The primary supervisor of this project repeated the counts and estimates of 72 randomly selected grid blocks. The Random function in Microsoft Excel was used to isolate the 72 records. The primary investigator of this project repeated the counts and estimates of 72 selected grid blocks that was identified using the same methods as described, above. photo-documented using a Leica DMD108 (DMD= DigitalMicroimagingDevice) Microscope (Leica, Germany) and the best of the two was then utilised to conduct the rest of the study. Some of the slices tore and folded quite considerably during processing and were therefore discarded. Four images (with a scale bar) of each slice were captured: three under 4x magnification - one from each extremity and one from the centre, covering the whole of the sample and one under 20x magnification from the centre of the core, providing a total of 80 digital images.

To count the osteocytes (under 4x magnification) and inflammatory cells (under 20x magnification), the grid method was opted chosen. A 10x10 grid (100 blocks per

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grid) was created in Microsoft Word and each digital image was imported into the grid and numbered according to the unique study number allocated to each patient (Figure 1 and Figure 2). Using the scale bar (= 1mm) as reference, the size of one grid block of the 4x magnification slices was calculated to be 0.080mm² (Figure 1). Each block of the 20x magnification slides (scale bar = 100µm) was calculated to be 3 071,75µm² (Figure 2).

Data analysis

The data analysis consisted of descriptive statistics to compare differences in counts between grafted and non-grafted sites and paired t-tests or appropriate non-parametric equivalent analyses (Wilcoxon Sign Rank Test) to establish statistical significance. Significance was set at 0.05. The inter-class correlation coefficient was used to report the intra- and inter-rater agreement.

Results

Eight patients requiring at least two non-molar extractions in the same jaw and one patient requiring three non-molar extractions in both upper and lower jaws, were finally selected to participate. This sample yielded ten sites for natural healing (control) and ten sites grafted with DFDBA and a collagen membrane (experimental). Upon re-entering of the sites, one of the subjects (Subject 7) produced only connective tissue in the coronal 8mm of the non-grafted site. The histological data of subject 7 was eliminated from the study. This resulted in a total of nine grafted and nine non-grafted sites. Six subjects had two sites each and one subject had six sites (four maxillary and two mandibular) totalling 18 sites.

The total sample comprised one male and seven females with ages ranging between 30 and 68, with a mean age of 54,87.

The 18 sites were histologically analysed with nine biopsies in each group. The DFDBA grafted group consisted of two maxillary canines, one maxillary second premolar, one mandibular first premolar and five mandibular canines, whereas the non-grafted group consisted of one maxillary central incisor, one maxillary canine, one maxillary second premolar, one mandibular first premolar and five mandibular canines. The majority of sites (twelve) were from the mandible and the balance (six) from the maxilla.

Clinically, there was no loss of graft material at the four-week follow-up appointments and all the sites healed without complication.

An erratic pattern emerged with no conclusive link between estimated collagen percentages for grafted and non-grafted sites (Table 1, Wilcoxon Sign Rank Test: P=0.0594). Table 1 also illustrates that six of the sites displayed between 5% and 15% less trabecular bone in the grafted sockets, two of the sites displayed 1% and 6% more trabecular bone in the grafted sockets and one site displayed zero difference. These results were however not statistically significant (Wilcoxon Sign Rank Test: P=0.051).

Table 2 showed varying patterns of osteocyte prevalence without any direct gradient leaning towards grafted or non-grafted sites (Wilcoxon Sign Rank Test: P=0.441). Table 2 also showed that in most instances there were more inflammatory cells present when a graft was placed. These differences were however not statistically significant (Wilcoxon Sign Rank Test: P=0.051).

Remaining graft material were less than 5% for all sites (ranging from 0 to 4%)

Discussion

Dental implant treatment aims to restore form and function of the dentally compromised patient when used to support over-structures. Sufficient volume and quality of bone is necessary for anchoring the implant. While the goal of DFDBA placement in extraction sockets is to preserve the volume of bone available for implant placement,[1,2,5,6,12,13,15] it is important to determine the quality of bone achieved through this grafting procedure.[1,13] Based on this premise, this study therefore aimed to histologically compare dental extraction sites grafted with DFDBA with non-grafted sites before implant placement. The comparison was done by assessing the parameters of osteogenesis: number of osteocytes, percentages of trabecular bone, collagen and remaining graft material, the number of inflammatory cells and blood vessels[7,22,23]

It is pertinent to note that this study could not show a meaningful statistical difference for the six histological parameters of osteogenesis between grafted and non-grafted sockets. It stands in contrast to the reportedly osteoinductive properties of DFDBA. A study by Schwarz et al in 1996[13] showed that there could be major differences in DFDBA preparations produced by different commercial bone banks and their ability to induce new bone, due to the use of various bone processing methods. Factors such as particle shape and size, the pH of the solution and varying types and levels of BMPs have been studied and shown to have an influence on the degree of osteoinductive nature of different DFDBA products. [6,18,24,25]

Table 2 showed more inflammatory cells in grafted areas compared to non-grafted areas. Although these differences were not statistically significant (Wilcoxon Sign Rank Test: P=0.051), such gradients are not surprising and can be interpreted as an indicator of the response of the human body to the introduction of foreign material. Higher sample size may have rendered statistically significant results.

Moreover, it was shown that only between 1% and 4% of graft material remained after 16 to 20 weeks, indicating that almost all of the DFDBA had been replaced by trabecular bone, which correlates with time frames suggested by Beck and Mealy, 2010.[25] The outcome of this study showed that at 16 to 20 weeks after extraction, most graft material had been replaced by bone with no additional benefit in terms of bone quality. This finding is consistent with the findings of a randomised control trial reported by Brownfield and Weltman in 2012.[12]

Table 1: Pairwise comparison of collagen and trabecular bone estimates for sites where a graft was placed, or not.

CASE	SITE ID	GRAFT	COLLAGEN % ESTIMATE 1 (DIFFERENCE)	COLLAGEN % ESTIMATE 2 (DIFFERENCE)	TRABECULAR BONE % ESTIMATE 1 (DIFFERENCE)	TRABECULAR BONE % ESTIMATE 2 (DIFFERENCE)
1	11	No	31	29	47	45
1	13	Yes	28 (-3%)	26 (-3%)	36 (-11%)	36 (-9%)
2	33	No	9	8	55	55
2	43	Yes	21 (+12%)	20 (+12%)	40 (-15%)	38 (-17%)
3	33	No	49	48	39	36
3	43	Yes	47 (-2%)	47 (-1%)	27 (-12%)	26 (-10%)
4	33	No	37	34	42	40
4	43	Yes	32 (-5%)	29 (-5%)	37 (-5%)	35 (-5%)
5	43	No	43	29	36	35
5	33	Yes	37 (-6%)	35 (+6%)	36 (0%)	34 (-1%)
6	43	No	29	25	34	32
6	33	Yes	28 (-1%)	25 (0%)	35 (+1%)	33 (+1%)
7	13	No	72	82	1	1
7	21	Yes	36 (-36%)	35 (-47%)	36 (+35%)	34 (+33%)
8	13	No	28	24	38	36
8	23	Yes	22 (-6%)	20 (-4%)	44 (+6%)	43 (+7%)
8	15	No	33	32	41	38
8	25	Yes	36 (+3%)	35 (+3%)	35 (-6%)	33 (-5%)
8	44	No	23	22	48	46
8	34	Yes	27 (+4%)	25 (+3%)	38 (-10%)	35 (-11%)

Note Patient 7 excluded from pairwise comparison
Collagen Estimate 1: Wilcoxon Sign Rank Test: P=0.0594
Collagen Estimate 2: Wilcoxon Sign Rank Test: P=0.594
Pearson Correlation Coefficient for Collagen Estimate 1 and Collagen Estimate 2: (r): 0.967
Median of Collagen Estimate 1 =31%
Median of Collagen Estimate 12 =29%
ICC (Inter-rater agreement): 0.98 (95%CI:0.97-0.99; P=0.000)
ICC (Intra-rater agreement): 0.99 (95%CI:0.99-1.00; P=0.000)
Trabecular Bone Estimate 1: Wilcoxon Sign Rank Test: P=0.051
Trabecular Bone Estimate 2: Wilcoxon Sign Rank Test: P=0.051
Pearson Correlation Coefficient for Trabecular Bone calculated and Trabecular Bone Estimate (r): 0.997
Median of calculated Trabecular Bone Estimate 1=37%
Median of estimated Trabecular Bone Estimate 2=35%
ICC (Inter-rater agreement): 0.94 (95%CI:0.91-0.96; P=0.000)
ICC (Intra-rater agreement): 0.94 (95%CI:0.90-0.96; P=0.000)

The findings of this study should be interpreted with caution. A major limitation of this study is the small sample size. The seven subjects who finished the study were however regarded as a good cross-section of the average patient attending a general dental practice.

It should be noted that the study did not intentionally differentiate between males and females or between upper and lower jaws. The subjects' age was also not taken into account and similar to other studies this study also did not distinguish between smokers and non-smokers. Although these omissions can be considered as limitations it was deemed not necessarily relevant. The idea was to compare grafted to non-grafted sockets within the same individual so that the same patient serves as both experiment and control, thereby negating differences between different people such as smoking, age and gender.

Although it was not intended as part of the study and the study was not designed to evaluate ridge preservation per se, the subjective clinical observation at the time of harvesting and implant placement was however that the grafted sockets were better preserved in terms of the volume and "feel" of the bone – confirmed by the results of various studies.[1,2,5,6,10,1213,15] This phenomenon greatly facilitates the placement of implants without the need for secondary

Table 2: Pairwise comparison of osteocytes and inflammatory cells counted for sites where a graft was placed or not.

				Osteocytes			Inflammatory cells			Blood vessels		
CASE	SITE ID	GRAFT	ADJ No OF DATA UNITS	/0,.8MM²	/MM²	Dif	n	/ 0.154mm²	Dif	n	/ 0.15MM²	Dif
1	11	No	176	13,53	169,11		18	0,10	0,67	2	0,01	0,07
1	13	Yes	103,0	14,83	185,44	16,33	33	0,32	2.09 (+1.42	8	0,08	0.51 (+0.44)
2	33	No	106,5	32,65	408,10		0	0,00	0,00	0	0,00	0,00
2	43	Yes	101,5	18,34	229,31	-178,79	20	0,20	1.28 (+1.28)	5	0,05	0.32 (+0.32)
3	33	No	194,0	21,84	272,94		8	0,04	0,27	12	0,06	0,40
3	43	Yes	101,5	13,71	171,43	-101,51	20	0,20	1.28 (+1.01)	5	0,05	0.32 (-0.08)
4	33	No	116,0	26,38	329,74		26	0,22	1,46	7	0,06	0,39
4	43	Yes	106,0	20,61	257,67	-72,07	3	0,03	0.18 (-1.28)	4	0,04	0.25 (-0.14)
5	43	No	184,5	17,63	220,39		7	0,04	0,25	9	0,05	0,32
5	33	Yes	139,0	18,76	234,44	14,05	9	0,06	0.42 (+0.17)	14	0,10	0.66 (+0.34)
6	43	No	73,0	19,97	249,66		18	0,25	1,61	6	0,08	0,54
6	33	Yes	81,0	14,93	186,57	-63,09	67	0,83	5.39 (+3.78)	5	0,06	0.42 (-0.12)
7	13	No	75,5	0,20	2,48		0	0,00	0,00	0	0,00	0,00
7	21	Yes	164,0	16,80	210,06	207,58	0	0,00	0,00	0	0,00	0,00
8	13	No	109,0	14,44	180,5		2	0,02	0,12	1	0,01	0,06
8	23	Yes	109,0	22,49	271,08	90,58	12	0,11	0.72 (+0.60)	8	0,07	0.48 (+0.42)
8	15	No	98,5	21,26	265,74		6	0,06	0,40	6	0,06	0,40
8	25	Yes	128,0	20,36	254,49	-11,25	29	0,23	1.48 (+1.08)	13	0,10	0.66 (+0.26)
8	44	No	143,5	27,02	337,8		11	0,08	0,50	6	0,04	0,27
8	34	Yes	106,5	30,08	376,06	38,26	23	0,22	1.41 (+0.91)	3	0,03	0.18 (-0.09)

Note Patient 7 excluded from pairwise comparison
Osteocytes: Wilcoxon Sign Rank Test: P=0.441
Median of osteocytes counted/block=19.364
ICC (Inter-rater agreement): 0.97 (95%CI:0.95-0.98; P=0.000)
ICC (Intra-rater agreement): 1.00 (95%CI:0.99-1.00; P=0.000)
Inflammatory cells: Related Samples Wilcoxon Sign Rank Test: P=0.051
ICC (Inter-rater agreement): 0.81 (95%CI:0.50-0.93; P=0.000)

augmentation procedures and is possibly the main reason why so many clinicians routinely perform socket grafting at the time of extraction.

It should be noted that the primary researcher is not a trained histopathologist, but was however advised by a highly skilled specialist oral pathologist and supervised by an experienced specialist periodontist. Reasonable intra and inter-rater agreement was achieved, ranging from "good" agreement for inflammatory cells and blood vessels and "excellent" agreement for the other indicators.[29] It should be noted that there were one or two blinded recounts, under instruction of the co-author as statistician, by both the primary researcher and research supervisor to achieve adequate inter-rater agreement.

Conclusion

This study compared bone quality of naturally healing sockets to sockets grafted with DFDBA. Histologically, mainly by assessing osteocyte counts, percentage of trabecular bone formation and percentage of collagen/connective tissue, no statistical differences could be found between the grafted and non-grafted sites.

Within the limitations of this study, the findings therefore do not support the use of DFDBA in socket grafting to improve the quality of bone.

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CPD QUESTIONNAIRE 11.4.1

Article: Masterclass in Endodontics: Non-vital bleaching for discoloured endodontically treated teeth. Vorster & Van der Vyver, page 8

1. Which of the following factors define tooth discolouration and its associated aetiology?
a Intrinsic factors
b Extrinsic factors
c A combination of intrinsic and extrinsic
d All of the above

2. Which of the following is a leading cause of local post-operative intrinsic tooth staining?
a Pulpal necrosis
b Tobacco products
c Amylogenesis imperfecta
d Fluorosis

3. True or False: Non-vital bleaching is considered an effective non-invasive endodontic treatment modality to lighten discoloured endodontically treated teeth.
a True
b False

4. True or False: Prior to the placing of bleaching material (when performing non-vital tooth bleaching), gutta percha in the root canal should be reduced 3–4mm below the CEJ.
a True
b False

5. Which of the following are important aspects of access cavity preparation and cervical seal during a non-vital bleaching procedures?
a Mesial and distal pulp horns should be remove in order to prevent further discoloration
b Air-polishing with bicarbonate soda powder can be useful to remove remnants of restorative and root-filling materials
c Additional conditioning of the dentine surface of the access cavity prior to placement of the bleaching gel might improve the bleaching outcome.
d All of the above

Article: Current state of CAD/CAM technology in implant dentistry. Morton, Polido, Lin,page 12

6. According to Rutkūnas et al. 2017, what may affect the overall accuracy of intraoral scanning?
a Implant angulation
b Edentulous span
c Implant placement depth
d All of the above

7. Which statement is correct:
a There are no limiting factors on the accuracy of digital data superimposition when composing an accurate 3D virtual patient.
b Currently, the accuracy of digital data superimposition is a limiting factor when composing an accurate 3D virtual patient.

8. A CAD/CAM system which limits the digital data acquisition process and prosthesis design and manufacturing to one integrated system with no interchangeability is known as.:
a Closed architecture
b Open architecture

9. The most commonly used digital file format is:
a PLY (Polygon File Format or Stanford Triangle Format)s
b OBJ (an open file format developed by Wavefront Technologies)
c Standard Tessellation Language (STL)

10. Which statement is NOT correct: subtractive manufacturing methods includes
a Electrochemical machining
b Powder bed fusion
c Ultrasonic machining
d Photochemical machining

CPD QUESTIONNAIRE 11.4.2

Immediate placement and immediate restoration in the aesthetic zone: A review of the literature and case report. Doherty, page 32

11. In Type 2 placement (according to the protocols categorised by the International Team for Implantology (ITI), the implant is placed:
a 12-16 weeks after extraction.
b Immediately, at the time of extraction
c 4-8 weeks after extraction

12. Which of statement is correct? Following extraction:
a If the buccal plate is less than 1mm there will be minimal bone loss
b if the buccal plate is thicker than 1mm thick there will be a median bone loss of 7mm in height
c If the buccal plate is thicker than 1mm there will be minimal bone loss

13. Thick biotypes are said to have gingival tissues which are:
a 1mm or more in thickness
b 1.5mm or more in thickness
c 2mm or more in thickness

14. In the case described, complicating factors taken into account included:
a A thinner buccal plate coronally
b A high smile line
c Presence of bone loss both apically and at the distopalatal aspect towards the crown
d All of the above

15. In the case described, which statement is true:
a A deepithelialised connective tissue graft was performed
b A subepithelialised connective tissue graft was performed
c Neither of the above

Article: DFDBA grafting versus natural healing after extraction: A Randomised Controlled Clinical Trial. Olivier et al., page 78

16. Which answers are correct (more than one is permitted)
a Allograft refers to tissue graft that originates from genetically different donors from a different species as the recipient.
b Xenograft is osteoconductive and osteogenic, but lacks osteoinductive properties.
c Autograft comprises of autogenous tissue transplanted from one site to another site in the same individual.
d Alloplastic grafts are osteoconductive but without osteoinductive or osteogenic properties.

17. True or False: Osteoconduction occurs when bone graft material serves as a scaffold for new bone growth.
a True b False

18. Which answers are correct (more than one is permitted)
a FDBA produces vital bone gain of 17% to 27% after 3 months.
b DFDBA produces vital bone gain of 17% to 27% after 6 months.
c DFDBA produces vital bone gain of 28% to 53% after 6 months.
d DBA produces vital bone gain of 28% to 53% after 4 months.

19. Which answers are correct (more than one is permitted):
A collagen membrane is used:
a Because collagen stimulates growth of new bone.
b To stop the grafting material from falling out.
c To preserve the blood clot.
d To prevent soft tissue from growing in.

20. Which answers are correct (more than one is permitted)
a Osteoinductivity of DFDBA from different providers can differ.
b Grafted sites showed significantly more osteocytes.
c Bone volume seems better preserved in grafted sites.
d Histologically analysed, DFDBA grafted sockets produce superior bone.

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020511M1CI105	020512M1CI105	020512M2CI85	020513M1CI125	020513M2CI14	020514M2CI105	02051A3CI105
020511M1CI125	020512M1CI125	020512M3CI105	020513M1CI14	020513M2CI85	020514M2CI125	02051A3CI125
020511M1CI14	020512M1CI14	020512M3CI125	020513M1CI85	020513M3CI105	020514M2CI14	02051A3CI14
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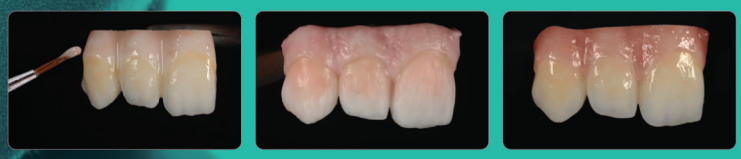

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