INTERNATIONAL Dentistry
MIDDLE EAST EDITION

VOL. 1 NO. 1

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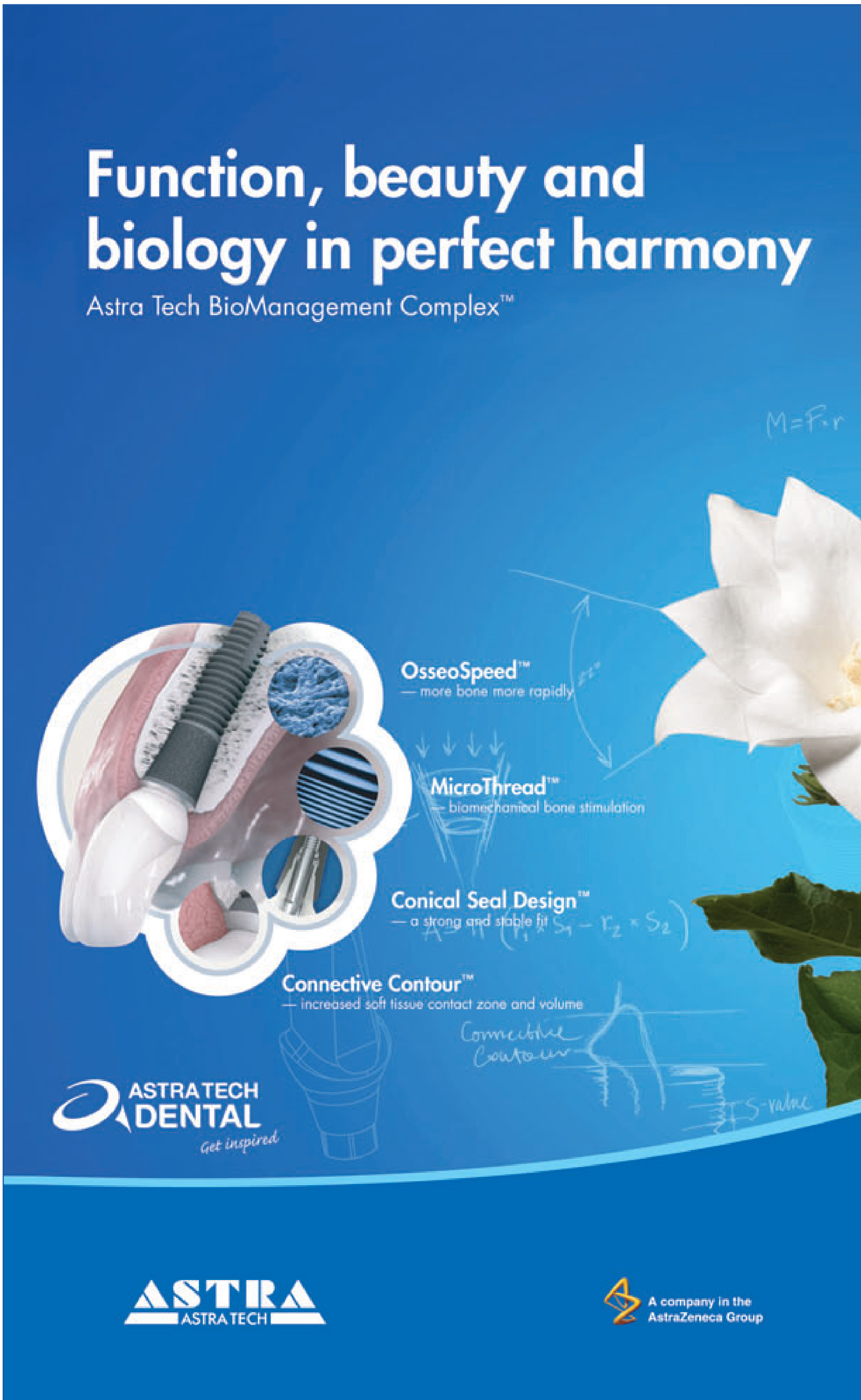

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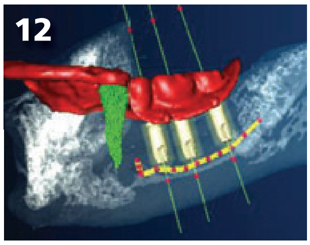
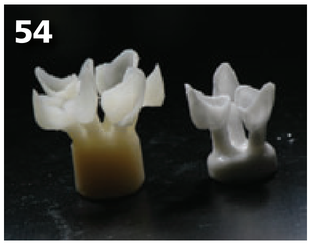
2010





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INTERNATIONAL DENTISTRY - MIDDLE EAST EDITION

The 2010 AEEDC meeting in Dubai is an auspicious occasion to introduce a new journal to the Middle East and it gives me great pleasure to write this first editorial.

Since 2006, the fundamental goal of International Dentistry SA has been to broaden its editorial policy to serve a more international readership.

The Middle East is the third region to be addressed, after Southern Africa and Australasia, in our aim to reach the profession globally. The shift in direction since my appointment as Editor-in-Chief also saw the formation of an Editorial and Review Board, which includes more than 30 international dental opinion leaders and more than 70 reviewers to evaluate the papers submitted to the journals. In the near future we will invite more colleagues from the Middle East to join our Editorial Board as well as submit clinical and research papers.

An important aspect of the transformation of the journals was the decision to publish more original scientific material and so have a wider appeal to clinicians. Not only will readers have access to clinical papers, but also to significant scientific information, which will keep them informed of current developments in all aspects of dentistry.

The latest significant development has been the appointment of two Associate Editors, Professor Simone Grandini and Professor Cecilia Goracci, both of the University of Siena, Italy. Their contribution and input will be of valuable benefit to the future of the journals.

My deepest thanks to all my colleagues on the Editorial and Review Board for their commitment and support, as well as to all our current and prospective readers and advertisers for accepting our direction and supporting our goals.

Finally I would like to thank our publisher, Ursula Jenkins, for her undertaking, her efforts and continued dedication to the journal.

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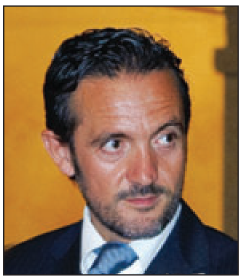

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INTERNATIONAL **Dentistry** MIDDLE EAST EDITION
Vol. 1 No. 1

International Dentistry SA - Middle East Edition is published by Modern Dentistry Media CC, 120 Rena Road, Kyalami Midrand 1684. PO BOX 76021 WENDYWOOD, 2144, SOUTH AFRICA Tel: +27 11 468-1448 Fax: +27 11 468-1162 e-mail: dentsa@iafrica.com www.moderndentistrymedia.com

Push-out bond strength of FRC posts using conventional and wet-ethanol bonding systems: an ex-vivo study

Hani F Ounsi,[1] Ziad Salameh,[2] Moustafa N.Aboushelib,[3] Simone Grandini[4]

Abstract

Purpose: The aim of this study was to compare the bond strength obtained on root canal walls when using two different adhesive systems to bond a fiber reinforced composite (FRC) post inside a root canal and to evaluate the type of failure at the resin-dentine interface. **Methodology**: Thirty-eight central incisors were root canal treated, divided in 2 groups, and restored using FRC posts luted using resin cement (Multilink). Excite DSC was used as bonding agent in group 1 and an experimental ethanol-wet bonding system was used in group 2. The specimens were cut into 1mm-thick sections and a push-out test was carried out after 24h. Fracture type was assessed using optical and scanning electron microscopy. **Results:** Mean and standard deviation for the excite DSC and ethanol-wet groups were respectively 7.6±5.5 and 7.4±5.6 MPa. The Mann-Whitney rank sum test showed no statistical difference between the 2 groups (P=0.708). With regards to failure type, adhesive failure prevailed in the 2 groups. SEM evaluation revealed that adhesive failures occurred mainly at the resin-dentin interface. **Conclusions:** The 2 bonding systems exhibited similar short-term behavior. A baseline is established to test potential improvement of long-term behavior when using ethanol-wet bonding systems.

Running title: Push-out bond strength of FRC posts
Key Words: adhesion, fiber-post, ethanol-wet bonding, interface, dentin, photodarkening

Introduction

In the actual wet-bonding concept, acid-etching of the dentin is required to generate a superficial collagen layer. This layer should remain moist and will receive a primer in order to allow the infiltration of hydrophobic monomers thus creating the hybrid layer.[1] Simplification of bonding procedures reduced 3-step techniques to 2 steps, and later to 1-step with the introduction of self-etching primer adhesives. This simplification was possible by increasing the amount of acidic monomers dissolved in primers.[2] However, some potential problems are associated with the simplification of bonding procedures[3,4] as these simplified adhesives behave as permeable membranes that allow the fluids to cross the adhesive layer after polymerization.[5] The water that migrates to the composite-adhesive interface is trapped as water blisters, which might act as stress concentration sites, which might result in deterioration of the resin-dentin bond.[6] Furthermore, long-term survival of bonded restorations is compromised due to the hydrophilic properties that allow for hybrid layer disintegration at the dentin resin interface.[7,8] This disruption of the hybrid layer was reportedly due to water sorption and also to the action of matrix metalloproteinases that were liberated from the dentinal tissues after the etching process.[9-11] As such processes are mainly water-based,

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different bonding process based on wetting collagen matrices with ethanol rather than water was suggested.[12] The authors postulated that among other advantages, using an "ethanol-wet" bonding system would improve long-term behavior of resin-dentin bonds. This preliminary study even demonstrated superior bond strengths to dentin for the ethanol-wet bonding system. However, we cannot extrapolate these findings to intra-radicular bonding processes, as the previous study was performed on coronal dentin that differs from root canal dentin.[13,14]

The aim of this study was to compare the bond strength obtained on root canal walls when using two different adhesive systems to bond a fiber reinforced composite (FRC) post inside a root canal and to evaluate the type of failure at the resin-dentine interface. The null hypotheses tested were that there are no differences (1) in the bond strength achieved at the resin-dentine interface between the adhesive systems tested and (2) in the failure modes between the different groups.

Material and Methods

Preparation of the specimens

38 central incisors free from caries or previous restorations were cleaned of external debris, examined by transillumination for cracks, and stored in an incubator at 37°C at 90% relative humidity before testing. Teeth were extracted for periodontal reasons and patients' consent was obtained. Crowns were cut perpendicularly to the long axis of the tooth 2mm above the cemento-enamel junction using a diamond disk under water-cooling. Root canals were instrumented using stainless steel K-files # 10, 15, 20 (Dentsply-Maillefer, Ballaigues, Switzerland) and Glyde (Dentsply-Maillefer) to the visual working length (1 mm from the apex). Cleaning and shaping was continued using ProTapers (Dentsply-Maillefer) according to the manufacturer's instructions and to F3 size. Root canals were irrigated between instrumentation with 2mL 5.25% NaOCl and all teeth were obturated using the Schilder technique, using calibrated gutta-percha points (F3, Dentsply-Maillefer) and AH Plus sealer (Dentsply-Maillefer).

Root canal filling was removed with a Largo drill No. 1 (Dentsply-Maillefer) to a depth of 9 mm and a post-space was prepared with #3 calibrating drills (Ivoclar-Vivadent, Schaan, Liechtenstein) and the specimens were randomly distributed into 2 groups (n=19).

38 FRC Postec Plus® #3 (Ivoclar-Vivadent) were used (Max Ø: 2mm, Min Ø: 1mm). Each post was cleaned with Total Etch® (Ivoclar-Vivadent) for 60s according to the manufacturer's instructions, rinsed with water and dried. The posts were then placed in 10% H2O2 for 20 minutes then rinsed with water and dried after which they were dipped in a 10% sodium ascorbate solution for 10 minutes and treated with a silane coupling agent for 60s (Monobond-S®, Ivoclar-Vivadent). For both groups, surfaces were carefully air dried after silane application and the two different adhesives were applied respectively onto the posts of each group in the following manner: a generous amount of adhesive was applied with a microbrush to the posts with gentle agitation to ensure complete coverage. Air-drying followed at a distance of 15-20 cm to evaporate the solvent, moving closer as the resin stopped moving. Light-curing followed for 20s.

The canal walls were etched (Total Etch®) for 15s, then rinsed with water and dried with paper points. Excite DSC® (Ivoclar-Vivadent) was applied to the canal walls and excess material was removed using paper points. The posts were then luted using Multilink Automix (Ivoclar-Vivadent) and light polymerized using a halogen light-curing unit (Blue Phase, Ivoclar-Vivadent) for 40s with the tip of the unit directly in contact with the post.

In Group 2, 100% ethanol was used to flush the water from the canal and left in place for 1 minute. Care was taken to keep the canal moist with ethanol at all times during the procedure unless otherwise specified. Three 1-minute iterations were performed; after which the two components of the autopolymerizing version of resin 2 were prepared (solvate 50% resin A in 50% ethanol, and 50% resin B in 50% ethanol) (1:1 in weight). They were mixed in a 1:2 ratio as a primer for a hydrophobic dentin adhesive and placed on the root canal walls using a microbrush (Microbrush X). Ethanol was allowed to slowly evaporate. The posts were then luted using Multilink Automix (Ivoclar-Vivadent) and light-curing will follow using a halogen light-curing unit (Astralis10, Ivoclar-Vivadent) for 40s with the tip of the unit directly in contact with the post.

Push-out test

After 24h of storage at room temperature, 1mm-thick horizontal sections from each specimen was obtained using a precision cutting device and a diamond coated disc (Buehler, Lake Bluff, IL) and push-out test was conducted using a Universal Testing Machine (Controls, Milan, Italy). A stainless steel pin (1mm diameter) was placed in contact with the post section and was loaded at a crosshead speed of 0.5 mm/min until failure occurred by dislodgment of the post section. The retentive strength of the post segment was expressed in mega

Table 1

Descriptive statistics of Excite DSC and wet-ethanol groups (PF: premature failures; Means are given in MPa).

Group	n	PF	Mean (SD)
Excite DSC	90	8	7.6 (29.1)
Wet-ethanol	98	5	7.4 (30.8)

Pascals (MPa), by dividing the load at failure in newtons by the interfacial area (A) of the post fragment. The latter, being the lateral surface of a truncated cone, was calculated by the formula: $A= \pi(R+r)[h^2 +(R-r)^2]^{0.5}$, where $\pi = 3.14$, R = coronal post radius, r = apical post radius and h = root slice thickness.

Fracture type

Specimens were examined using stereomicroscopy to determine the type of failure whether cohesive, adhesive, or mixed and randomly selected samples were examined using scanning electron microscopy (SEM).

The level of significance was set at $P<0.05$. Statistical analyses were performed using SPSS version 11.0 software (SPSS Inc., Chicago, IL).

Results

Premature failures were considered as zero-bond values and were included in the study. Descriptive statistics (Table 1) revealed that mean and standard deviation for the excite DSC and ethanol-wet groups were respectively 7.6±5.5 and 7.4±5.6. However as the data failed the Kolmogorov-Smirnov test, a Mann-Whitney rank sum test was performed and showed no statistical difference between the 2 groups (P=0.708).

With regards to failure type, adhesive failure prevailed in the 2 groups (Table 2). Although, there were differences between the groups, they were not statistically significant (Fisher exact test).

SEM evaluation revealed that, in some samples, adhesive failures occurred mainly at the resin-dentin interface (Figure 1). It also revealed that such failures were not purely adhesive but rather either mainly adhesive with minor cohesive areas or with minor occurrences on the resin/fiber-post interface (Figure 2). Although present, cohesive failures were less frequent and displayed residual cement on both fiber-post and dentin (Figure 3).

Discussion

The main advantage of using "ethanol-wet" bonding systems would reside in the improvement of the long-term behavior of resin-dentin bonds.[15] However, this improvement cannot be properly defined unless we have a baseline from which to start, namely a comparison of immediate bond-strength values between conventional and wet-ethanol bonding systems. Push-out test has several advantages when compared to other bond strength measurement techniques. It allows using thin sections from every specimen and thus several readings could be obtained from every single specimen. Additionally, it reduces the influence of mechanical retention associated when trying to pull an entire post from the root canal. However, even a single poorly prepared sample could translate into biased results. The premature failures were predominantly observed in the apical-most part of the posts. Coronal and apical data

Table 2

Distribution of adhesive vs. cohesive failures in the 2 groups.

Group	Adhesive	Cohesive
Excite DSC	75	15
Wet-ethanol	73	25

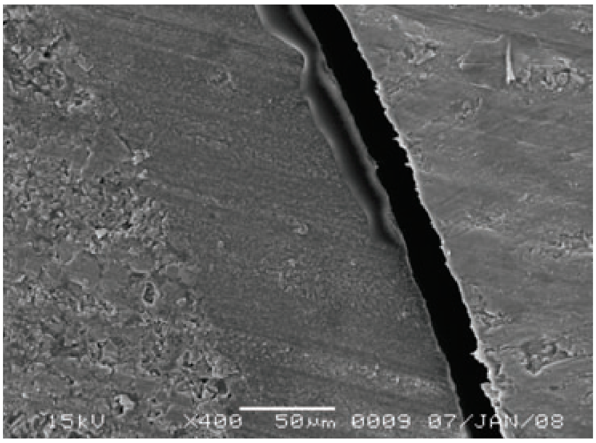

Figure 1: Scanning electron image of adhesive failure. The luting resin is still bonded to the fiber-post with the failure occurring on the resin/dentin interface.

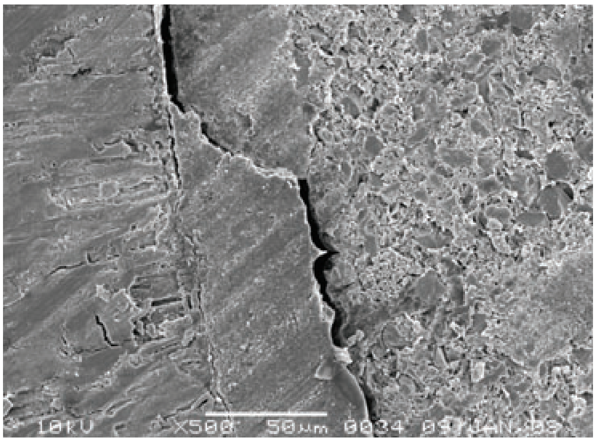

Figure 2: Scanning electron micrograph of a double adhesive failure with part of the failure occurring on the resin/dentin interface and the other part on the resin/fiber-post interface.

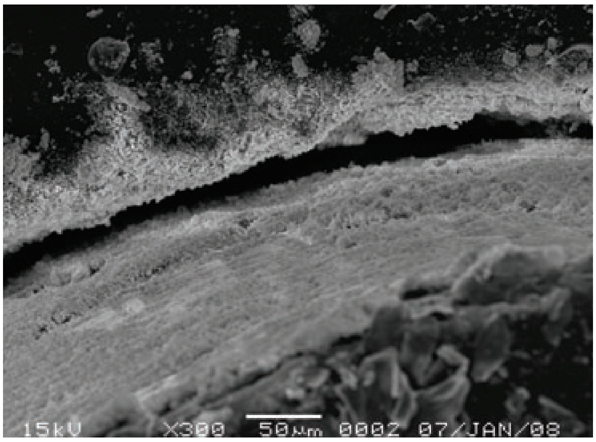

Figure 3: Scanning electron micrograph of a cohesive failure displaying residual luting cement on both interfaces.

were however pooled as the distribution appeared to be similar for the 2 groups and the aim of the study was primarily to compare the two bonding systems.

The presence of water inside the hybrid layer seems to be responsible for bond strength reduction since water droplets trapped inside would act as stress raisers.[16] Furthermore, water will allow for aging/degradation phenomenae as it provides a suitable environment for matrix metalloproteinases hydrolytic action on collagen.[7,17] Ethanol-wet bonding was developed theoretically in an attempt to reduce water content/uptake in hybrid layers by dehydrating the collagen mesh obtained after etching prior to infiltrating it with the hydrophobic resin.[17]

Following smear layer removal, dentinal tubules on the canal wall are rendered patent and possess physical properties similar to that of capillary tubes.[18] One advantage of solvating the bonding resin in ethanol would be to decrease the surface activity of the resin thus allowing for better wetting and penetration. The surface tension reducing ability of ethanol is well documented. Cunningham et al.[19] investigated the effect of ethanol on the spreading property of NaOCl as measured in a capillary tube. Ethanol reduced the surface tension of the NaOCl and significantly improved the ability of the irrigant to spread in vitro. Furthermore, as surface wetting can also be affected by altering the surface activity of the dentin,[18] wetting root canal walls with ethanol prior to applying the bonding agent should also improve resin penetration. Obviously, resin penetration depth into dentinal tubules could be correlated to leakage resistance. The data remains inconclusive as some studies showed correlations[20,21] and others did not.[18] Further research remains needed to assess relationship between sealer penetration and leakage resistance.

When tested on coronal dentin[15], the ethanol-wet bonding technique demonstrated improved bond strength after occluding dentinal tubules. According to these authors, the reduced bond strength in patent tubules could be attributed to water recontamination of the hybrid layer in deep dentin. They hypothesized that water derived from the pulp chamber could have contaminated the chemically dehydrated dentin surfaces hence resulting in poor wetting by hydrophobic monomers, which justified the use of tubular occlusion materials as a possible solution to the problem of water recontamination. While many studies assessed water content of endodontically treated teeth, few papers described water movement.[21,22] Hypothetically, this "weeping dentin phenomenon" should require positive pulpal pressure in order to extrude liquid through the dentinal tubules such as in vital teeth and would be unlikely in endodontically treated teeth. Hashimoto et al.[23] showed that without pulpal pressure, no fluid movement was detected and furthermore that with the notable exception of air blows, most other procedural steps produced an inward movement of fluid in the dentinal tubules. Furthermore, a recent study[24] showed that water affecting hybrid layers did not spontaneously permeate from root dentin of endodontically treated teeth but rather originated from an incomplete evaporation of primer solutions.

A possible explanation to the low push out strength observed in the apical sections could be related to the light transmission characteristics of the posts.[25] These authors showed a 60-68% reduction in light transmission between 4mm and 8mm from the canal entrance. Dual-cure resins include monomers that are polymerized by self and light activation. Light activation initiator systems are generally based on camphoroquinone, which absorbs visible light energy between 400 and 500nm[26] and associates with a tertiary amine, then dissociates into free radicals. Although these modes of activation are independent, light activation is required to increase the degree of conversion.[27] Another possibility could be the inclusion of rare earth elements in the composition of some fiber-posts. The post used in this study contains ytterbium for radiopacity. This rare earth element has associated with the photodarkening phenomenon, which is an optical effect described for amorphous light transmitting media.[28] It involves the interaction of radiation with amorphous glass thus creating absorbing color centers in the optical media due to the resonant interaction of light with the rare earth compounds. In particular, Ytterbium-doped optical fibers have exhibited severe transmission losses, which are strongest at short wavelengths (e.g., in the visible spectral range).[28] As such losses are reported to increase during operation (proportionally to the seventh power of the density of excited ytterbium ions), ytterbium-doped fiber posts could theoretically lose their light transmission characteristics, and the amount of light that reaches the resin cement beyond a certain depth would not be effective for setting off the light-induced initiation of the polymerization reaction. However, this remains speculative and further research is required to confirm or otherwise infirm this hypothesis.

The type of failure is adhesive and seemed to happen mostly on the resin/dentin interface. This is accordance with a study by Ounsi et al.[29] as push-out resistance between the post and the resin was found to be around 30MPa while push-out strengths observed were around 7.5MPa. It should be stressed that alternate bonding strategies are being studied. Bouillaget et al.[30] improved push-out bond strength of intracanal bonded resin cones by using an indirect technique. They hypothesized that bond strengths to radicular dentin could be improved by utilizing procedures that compensate for polymerization shrinkage. However, several studies admitted that there are no immediate applications for this technique before its optimization.[30,31] Based on these findings, the proposed hypothesis was accepted.

Since this study established identical baseline behavior for both bonding systems, long-term follow-up studies can now be conducted to investigate the influence of water and fatigue on bond strength performance.

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Utilisation of computer based guided surgery in the management of partial edentulism

Patrick Henry,[1] Jill Depiazzi,[1] Glen Liddelow,[1] Brent Allan,[2] David Dunn[3]

Introduction

Recently, increased emphasis has been placed on the immediate loading of implants to simplify treatment and provide immediate function with minimal interference to patient lifestyle. A number of papers have concluded that implants rigidly connected across the midline offer survival rates comparable to that of implants loaded after a transitional healing period of several months. Whilst earlier studies focused on the symphyseal region of the edentulous mandible[1-4], other studies have also demonstrated successful outcomes for the endentulous maxilla.[5-8] In the partially edentulous jaw only limited information exists as to the outcome of immediate loading, with early reports of encouraging short-term results.[9,10]

Further developments in this area have included the use of guided surgery protocols involving prefabrication on the basis of models derived from three dimensional implant planning software, of both surgical templates for flapless surgery and dental prostheses for immediate loading.[11-12] This Teeth-in-an-Hour™ concept (Nobel Biocare AB, Göteborg, Sweden) utilizes a CT scan derived customized surgical template for flapless surgery together with a prefabricated prosthetic superstructure and has proven to be a very reliable treatment option in selected cases.[13] Thus far, the majority of patients treated with this method have been edentulous in one or both jaws.[14]

Case Selection

All of the standard inclusion and exclusion criteria pertinent to dental implants are applicable. Sufficient residual jaw bone must be present to house the implants adequately within bone. The procedure described is via a flapless approach, therefore bone quality must be sufficient to avoid perforation of the outer cortex during preparation of the installation site and subsequent engagement of soft tissue. An oral opening of 40mm in the incisor region is required for ease of instrumentation. The anterior region offers amenable access, however posteriorly, particularly in the mandible, difficulty can be encountered especially when the opposing arch is dentate.

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Treatment Planning Protocol

The sequential steps described for the edentulous jaw application[15] are identical for the partially dentate situation except that the fabrication of the template and guide are more technique sensitive because teeth are involved.

Radiographic guide

A radiographic guide is fabricated on articulated study casts poured preferably from polyvinylsiloxane impressions so that the possibility of multiple casts exists. Acrylic resin denture teeth are set up on a radiolucent base of either light cured or autopolymerising acrylic resin. The teeth must fulfill esthetic expectations and functional requirements. Following patient acceptance of the set up, further material is added to cover the incisal edges of the existing dentition and to increase the occlusal vertical dimension in order to separate the teeth at the implant installation site. It is imperative that there is no cuspal or incisal overlap of the planned prosthetic teeth and the dentition of the opposing arch so that the replacement teeth can be clearly visualized radiographically. Several inspection windows are prepared in the occlusal aspect of

Figure 1: Fabrication of radiographic guide.

Figure 1a: Radiographic guide, occlusal view.

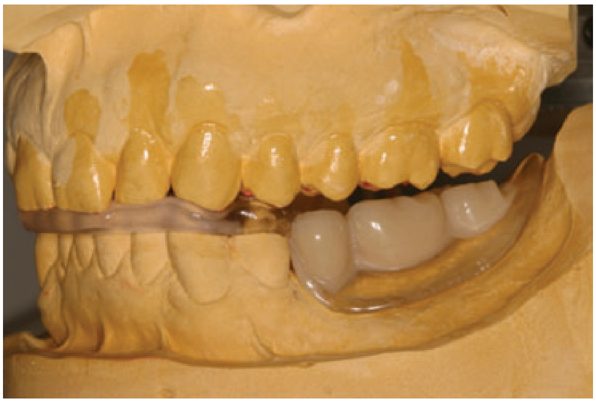

Figure 1b: Opening of occlusal vertical dimension to prevent tooth overlap.

Figure 1c: Inspection windows and gutta percha markers.

Figure 1d: Radiographic occlusal index.

the guide to confirm accurate seating of the device as illustrated in Figure 1. Six to eight 1-1.5mm diameter pieces of gutta percha are then placed strategically around the guide so that the device can be radiologically recognized in the subsequent CT examination. It is important that the denture base material be fully extended facially in the edentulous areas because the flange areas will be used to position anchor pins during the software planning. Finally an occlusal index is fabricated from radiolucent heavy bodied silicone rubber material as shown in Figure 1. This index is used to stabilise the guide during the CT scan procedures.

CT scan

A double scan technique is used whereby the first scan is taken with the radiographic guide in position whilst the second scan is taken only of the guide itself. Alteration of the CT technical specifications to reduce the radiation dose during the second scan permits the guide to be fully visible radiographically. The CT scans are then combined and converted into the 3D format using NobelGuide™ Software (NobelGuide™ Clinical Premium, Nobel Biocare AB, Göteborg, Sweden). The software is then utilized to visualize and plan implant placement with simultaneous visualization of the prosthetic objective.

Implant treatment planning

The software is used to plan total implant treatment, firstly implant selection and predictable placement and secondly the design and type of prosthetic solution. The implant is surrounded by a 1.5mm safety zone which acts as an indicator of potential violation of adjacent vital anatomical structures such as tooth roots and the inferior dental nerve, as well as illustrating possible perforations of the bony envelope. Utilization of the software to plan a mandibular posterior situation is shown in Figure 2. The anchor pins are placed to avoid the implants and adjacent teeth. Preferably two pins are used to ensure good stabilization of the subsequent surgical guide and they should be positioned to minimize interference with lips and cheeks as well as to maximize surgical access for instrumentation.

The occlusal location of the teeth is used in the planning

Figure 2: Software planning sequence, implant placement.

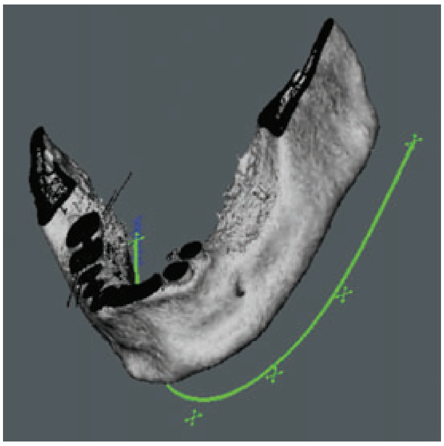

Figure 2a: Lateral view, posterior mandible.

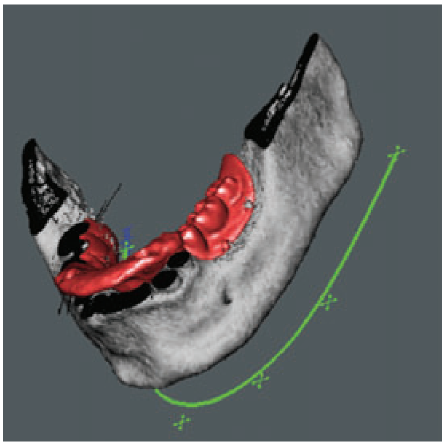

Figure 2b: Lateral view, posterior mandible, with radiographic guide.

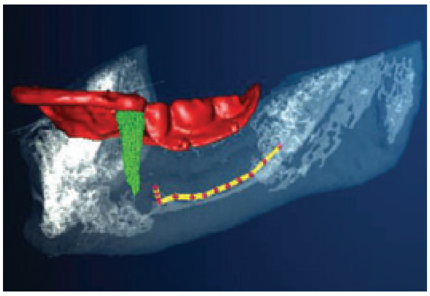

Figure 2c: Tracking of inferior alveolar dental nerve.

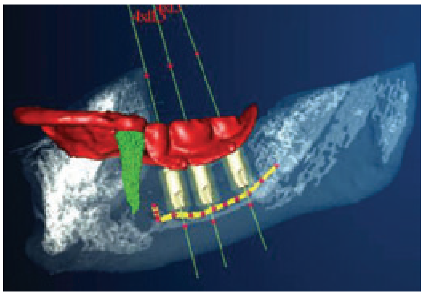

Figure 2d: Implant placement with safety zones.

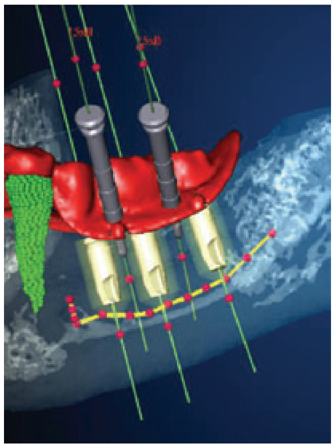

Figure 2e: Positioning of anchor pins into template and between implants.

process to orientate the inclination of the implants in a prosthetically driven manner. The available height between implant head and occlusal surface is measured to determine abutment type and prosthetic design, as seen in Figure 3. A minimum of 9mm is required for the use of Guided abutments (Nobel Biocare AB, Göteborg, Sweden) for a screw retained retrievable bridge. A minimum of 5 mm is required for the use of customized Procera® (Nobel Biocare AB, Göteborg, Sweden) zirconia abutments and cemented Procera® zirconia ceramic bridge. Situations with less than 5mm vertical space distribution can be planned to use smaller dimension abutments such as the 1mm MultiUnit Abutments™ (Nobel Biocare AB, Göteborg, Sweden) or planned for a screw retained prosthesis direct to implant level.

Surgical template

The surgical template is manufactured industrially (Nobel Biocare AB, Göteborg, Sweden) using a sterolithographic process to produce the template in a medical grade plastic material with a 7-10 day turnaround time. Essentially, it is a replica of the radiographic template, containing sleeves to direct instrumentation and implant placement and anchor pin sections for stabilization. The surgical template has two functions, firstly for implant placement and

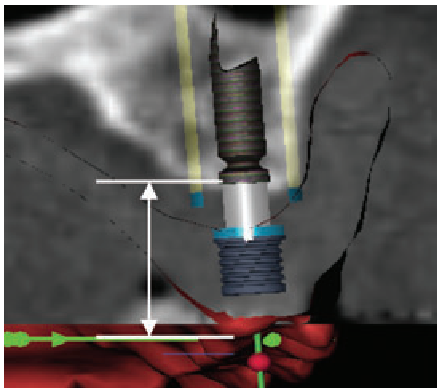

Figure 3: Measurement of occlusal-implant head dimension to determine available space for abutment type and prosthesis design.

Figure 4: Reconstitution of master cast from the surgical template.

Figure 4a: Duplicate master cast with residual ridge area removed.

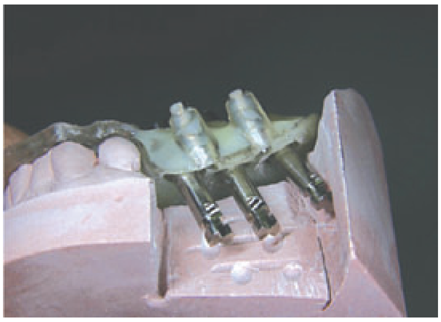

Figure 4b: Retrofit of surgical template with implant laboratory analogues attached.

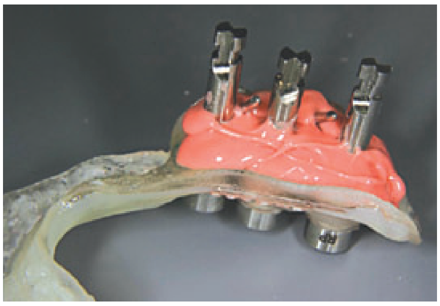

Figure 4c: Insertion of laboratory anchor pins and injection of rubber material to simulate soft tissue contours.

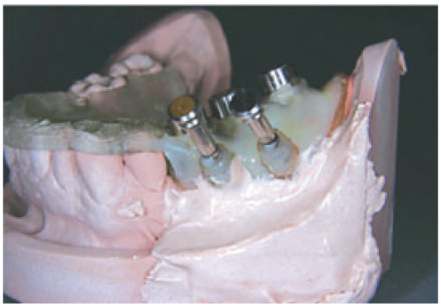

Figure 4d: Reconstitution of cast with diestone.

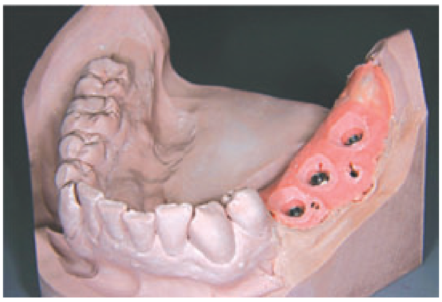

Figure 4e: Removal of anchor pins and surgical template from reconstituted cast.

secondly for reconstitution of the master cast which is then used for fabrication of the prosthesis. The cast is produced as illustrated in Figure 4. The reconsitiuted cast is remounted on the articulator using the radiographic guide if insufficient teeth are present to adequately stabilize the occlusal position. The template is then tried in the mouth to assess stability using the inspection windows to determine accuracy of seating. A surgical occlusal index is prepared using a heavy bodied silicone rubber material. This index is important for template stabilization in the first step of the surgical protocol.

Prosthesis manufacture

The reconstituted master cast is used to construct the planned prosthetic option, either retrievable screw retained Guided abutment bridge construction or a cemented bridge on customized zirconia Procera® abutments. Either solution may be definitive or provisional. Definitive screw retained prostheses utilize a Procera® titanium implant bridge framework veneered with either plastic crown and bridge material or titanium compatible ceramic material. Provisional screw retained prostheses are simply constructed with acrylic resin incorporating appropriate sleeves to anchor Guided abutments. Cemented solutions can utilize definitive Procera® zirconia frameworks veneered with NobelRondo™ zirconia porcelain or alternatively acrylic bridgework if a provisional procedure is planned. Examples of the different designs are shown in Figure 5 for a retrievable Teeth-in-an-Hour™ prosthesis and in Figure 6 for a cemented solution.

Alternatively pre-made prosthetic concepts can be dismissed and the treatment plan may be to install implants and then proceed with a surgical impression and fabrication of a provisional prosthesis utilizing traditional clinical and laboratory procedures and materials.

Clinical procedures

In principle, protocol and sequencing is identical to that of the completely edentulous application.[11,12] Figure 7 illustrates the steps in clinical procedure. The number of anchor pins may be variable dependant on numbers of

Figure 5: Retrievable prosthetic solution for Teeth-in-an-Hour™

Figure 5a: Retrievable Procera® implant prosthesis with resin veneer, fitting surface.

Figure 5b: 3D expandable Guided abutment.

Figure 5c: Clinical appearance, buccal view.

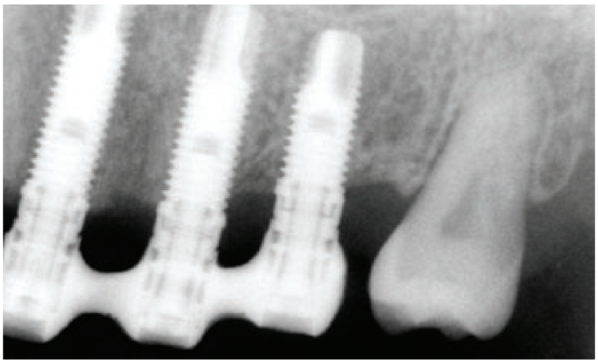

Figure 5d: Radiographic visualization of Guided abutments.

implants. In single missing tooth situations it may not be possible to place an anchor pin and in these cases the template is held in place by finger pressure with constant evaluation of the inspection windows to confirm accurate seating. Alternatively, palatally positioned anchor pin sites may be considered. The number of template abutments will also vary according to the number of implants. If three implants are to be installed generally the first one will be the centre one together with a template abutment. If two are to be placed generally the distal one is placed first together with a template abutment and careful observation of the anteriorly located inspection window to confirm accuracy of template position. Following prosthesis insertion, periapical radiographs are taken to confirm fit of the componentry. The occlusal scheme is designed and adjusted to be shim free in centric occlusion and to avoid or eliminate eccentric contact.

Post operative instructions emphasize that the restoration is to be considered an esthetic replacement in the first instance and is not to be used for heavy masticatory function for 6 weeks. Traditional implant follow-up and maintenance protocols are mandatory.

Single tooth indications present a limitation in planning and installation of implants as the software cannot guide the precise rotation of an external hex or internal trilobe. This means that some tweaking of the implant may be required to accurately establish proper alignment and orientation of contact points of the pre-made crown fabricated on a reconstituted cast. Such minor repositioning of the implant is always done by advancing the implant because reversing it would jeopardise installation stability.

Accuracy of the method

The overall total error in dental implant guided surgery is an accumulation of the errors inherent not only to the reformatting of CT scan, software manipulations and template manufacture, but also to the multiple steps associated with clinical procedures. The original studies carried out by van Steenberghe et al[11] reported that difference between planned and achieved implant locations was on average 0.8 ± 0.3mm at the entry level and 0.9 ± 0.3mm at the target level. These differences were most prominent in the longitudinal direction of the implants with a maximum of 1.1mm. Finally the match between planned and actual implant axis was on average 1.8 ± 1.00 degree. Clinically these discrepancies can be compensated two ways in the Teeth-in-an-Hour™ procedure. The guided abutment, visualized in Figure 5B is designed to have a 3D capability of adjustment as it is tightened, with built in capability to adapt over and beyond the error dimensions discussed above. Alternatively the

Figure 6: Cemented prosthetic solution for Teeth-in-an-Hour™

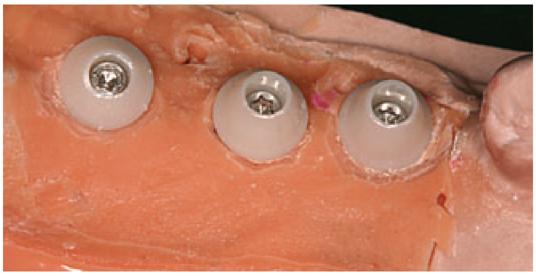

Figure 6a: Cast with zirconia abutments, lingual view.

Figure 6b: Tapered cylindrical design of abutments.

Figure 6c: Procera® zirconia cementable prosthesis, occlusal view and fitting surface.

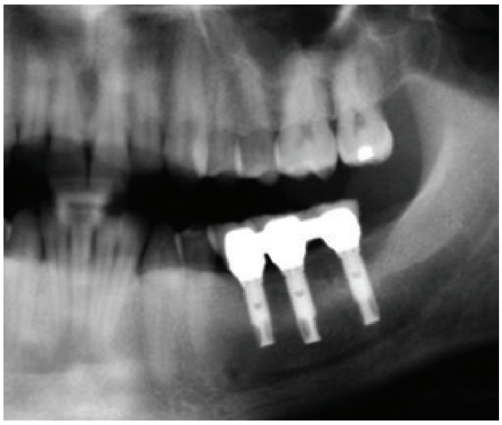

Figure 6d: Post operative panoramic radiograph.

cemented solution compensates for the error by having the luting agent occupy the spatial error between abutment and prosthesis. It should be noted that the customized Procera® abutments are fabricated in a conical design so that rotational errors are irrelevant and only vertical discrepancy is significant. This is dependant on implants being installed within an axial inclination differential of 30°. Alternatively the clinician may decide not to use a reconstituted cast to fabricate the prosthesis, but instead to record an impression following implant insertion and employ traditional methods of prosthesis fabrication.

The sum total of dimensional error associated with clinical procedures including impressions and occlusal records as well as laboratory phases of articulator mountings etc together with the various dimensional changes associated with dental materials involved of course result in discrepancies similar to those inherent in traditional crown and bridgework methodology. Not withstanding these considerations however, it must be emphasized that the single most crucial consideration in the overall accuracy of the method is in fact the positioning and precision of the radiological guide. This device is fundamental to the provision of the planning data and manufacture of the surgical template.

Clinical applications of guided surgery

NobelGuide™ is a total concept offering flexibility and broad application. Figure 8 illustrates the possibilities. It may be used only as a treatment planning tool to evaluate and determine implant installation sites by clinicians using the traditional methods for the planning and execution of implant treatment. It may be taken a step further to the stage of surgical template with the template used only for implant installation. Following the surgical phase traditional methods may then be employed to either place healing abutments as a single stage surgical procedure or to take an implant or abutment level impression and proceed with a provisional or definitive restoration when convenient. This procedure eliminates all considerations of the error of the method and furthermore gives the clinician the opportunity, if required, to carry out adjustments in implant position with respect to depth of installation and relationship to the marginal bone and soft tissue levels.

Alternatively the surgical template may also be used to reconstitute a master cast to fabricate prosthetic solutions that are either definitive or provisional and either screw retained or cemented, thus encompassing the Teeth-in-an-Hour™ concept. The decision making process with respect to pathways, either definitive or provisional, is

Figure 7: Clinical Sequence, anterior maxilla.

Figure 7a: Pre operative view following traumatic loss of 4 unit bridge placed on lateral incisors.

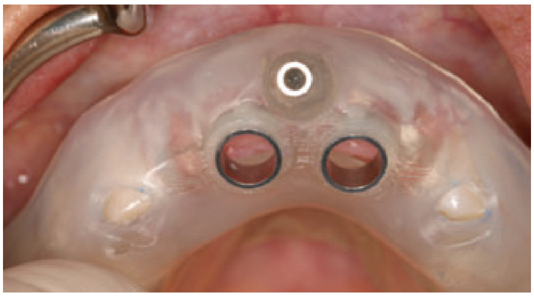

Figure 7b: Surgical Template.

Figure 7c: Surgical index and anchor pin placement.

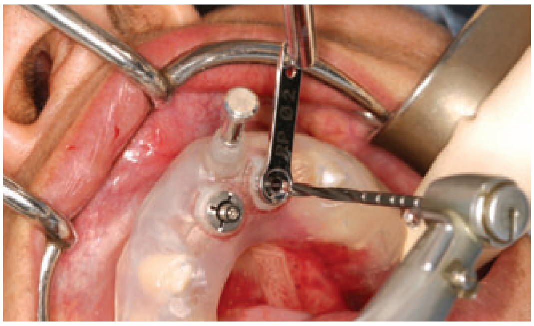

Figure 7d: Instrumentation sequence with right template abutment placed.

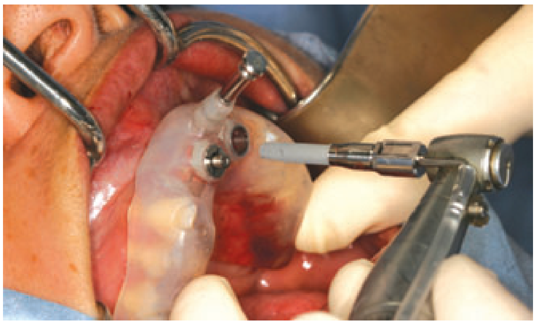

Figure 7e: Installation of second implant.

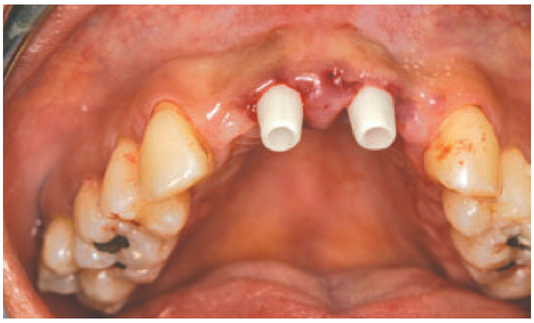

Figure 7f: Template removal and insertion of zirconia abutments.

Figure 7g: Provisional cemented prosthesis in acrylic resin.

Figure 7h: 6 month follow-up prior to commencement of definitive prosthetics.

based on a consideration of several factors. Final pathway Teeth-in-an-Hour™ restorations offer minimal flexibility and higher risk in esthetically demanding situations. Provisional pathway restorations offer the advantages of giving the clinician and patient time to evaluate esthetic and functional results particularly in situations of high esthetic demand, thus facilitating the opportunity to satisfy patient expectations. Thus flexibility is maximised,

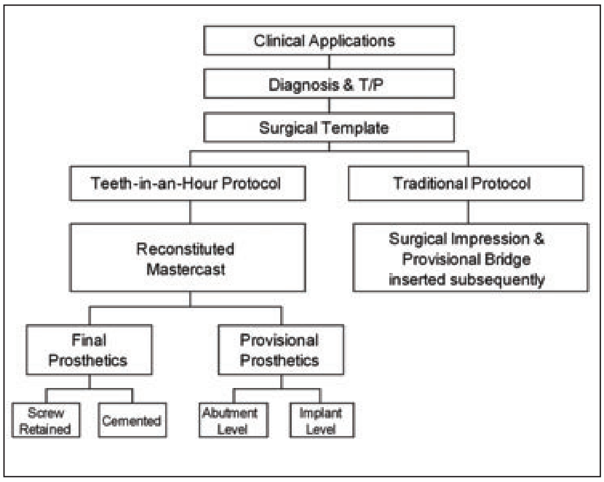

Figure 8: Clinical application of NobelGuide™

stress is reduced and the necessity to remake final restorations minimised. These advantages are further enhanced in situations requiring secondary soft tissue manipulations in high end esthetic cases.

Results

The outcome of the first 13 prostheses placed in 10 consecutive patients with a follow-up time of 12-24 months is shown in Table 1. The patients ranged in age from 35 – 57 with two of the patients being male. 34 implants were placed to support 16 partially edentulous bridges and 2 missing single teeth. The implant types and dimensions employed are described in Table 2.

One prosthesis failed to seat adequately in a posterior maxillary location with very soft bone type (Case 4). It was concluded that one implant had been installed off centre because the implant mount was difficult to remove from the template indicating that it was off centre on the hex of the Brånemark implant used relative to the guide sleeve inclination. Therefore the prosthesis could not be inserted. An implant level impression was taken and the treatment subsequently completed using traditional methods of fabrication.

Two implants failed. In Case 7 the distal implant (Brånemark System® 15mm long RP) of the three unit splinted design failed 6 month postoperatively. The situation was asymptomatic and the failure was detected by stability assessment at follow-up. The implant was removed, and immediately replaced with a wider diameter implant and single stage surgery. It was left to heal for 4 months and then the prosthetic work remade.

The second implant (NobelReplace® Tapered 8mm WP) failed in a bilateral posterior mandibular partially edentulous patient where considerable difficulty was experienced with instrumentation access (Case 12). 4 months post-operatively the patient developed discomfort in the left posterior region and prosthesis removal revealed failure of the distal implant. It was separated from the bridge, removed and left to heal. The shortened prosthesis was replaced on the two anterior implants as an interim measure. The failed implant was replaced 3 months later with single stage surgery. The bridge was successfully remade 5 months later. Thus the cumulative survival rate of the implants placed using Teeth-in-an-Hour™ protocol was 94.1%.

Advanced considerations

Maintenance of keratinised tissue

NobelGuide™ is fundamentally a flapless procedure using a punch technique whereby a section of keratinized tissue is lost. This is of concern to some clinicians in critical esthetics areas or in locations that could benefit by soft tissue augmentation. In these instances the protocol can be amended to placement of the template with anchor pins followed by removal of the template. A flap is then raised, either mid-crestal or palatally situated and reflected following which the template is reinserted and the drilling sequence commenced. Soft tissue augmentation procedures can be performed concurrently if required. This approach provides clinicians with the advantages of controlled and precise implant placement, together with the flexibility of soft tissue manipulation and conservation of tissue.

Simultaneous bone grafting

In these situations the surgical template is inserted and anchor pins positioned. It is then removed to permit a lingualised incision followed by flap reflection beyond the labial periphery of the template. The template is then reinserted with anchor pins repositioned. Implant placement is carried out, template removed and bone grafting augmentation completed. The situation is then managed as a 2 Stage procedure.

Guided surgery with simultaneous extraction

This can be ulitised in selected cases but requires careful consideration, both technically and clinically. The implant installation guide sleeve incorporated in the template must be of greater dimension than the corresponding tooth root dimension in the proposed extraction installation site to ensure implant stability. This in principle rules out most molar sites. It must also be emphasized that this procedure is unpredictable in terms of the resultant bony envelope after extraction of the tooth and the subsequent remodeling of the marginal hard and soft

Figure 9: Failure to seat Teeth-in-an-Hour™ provisional bridge.

9a: Post operative panoramic radiograph showing ill fitting prosthesis on 2 implants. This requires immediate removal and retrofit of the deficient Guided abutments to prevent overload of adjacent implants.

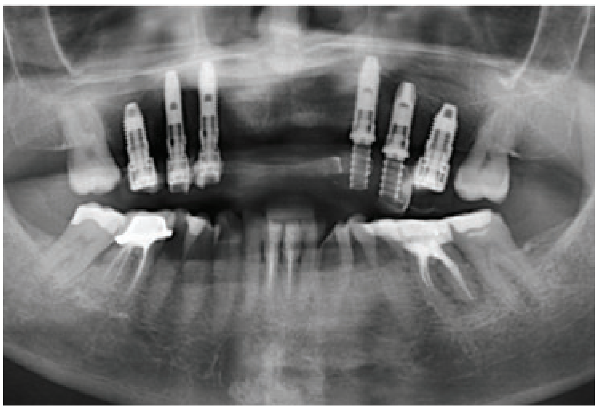

Figure 9b: Retrofit of temporary abutment cylinders at sites of deficient abutments and reconstitution of the provisional bridge.

tissues. Therefore it is often contraindicated in the esthetic zone. Nevertheless, there is a clinical demand for such procedures and appropriate protocols are currently under evaluation in clinical trails.

Problems and complications

The problems and complications associated with immediate loading of dental implants using traditional methods are applicable to guided surgery and immediate loading. However, there are additional complications inherent to guided surgery that deserve consideration. The commonest problems are all related to protocol violation resulting in surgical template inaccuracy. The use of an inadequate number of radiological markers in the radiographic guide can result in malpositioning of the surgical template which is quite distinct from an inherently unstable or inaccurate radiological guide.

Insertion of template abutments requires careful attention to tightening force because a template can be deformed with application of excessive pressure. Care must be taken at implant installation to ensure that implant insertion is absolutely central and vertical to the guide sleeve inclination, otherwise the implant may be positioned off centre with or without jamming of the implant mount within the guide sleeve. These errors may be reflected in failure to seat the prosthesis as evident in Figure 9. If cases are planned without reference to prosthetic componentry dimension and the available space between occlusal level and implant head level, gross occlusal interference can result at prosthesis placement.

A fundamental tenet of prosthodontic discipline is that the original master cast should be maintained in the patient records and duplicates used for all laboratory work stages. In the event of a production line accident involving irreversible damage to the master cast, retrofitting a radiological guide or surgical template accurately may mean that the sequencing goes back to the start resulting in the CT scan and reformat diagnostic data becoming useless. Consequently the patient must receive additional and not insignificant radiation to redo the CT scan. Furthermore the clinician has to absorb the costs of manufacture of the additional surgical template.

On receipt, surgical templates may require adjustment to fit the cast accurately. Again the source of additional working casts to retrofit the template in the laboratory is dependant of the availability of a master cast for duplication. Templates may be manufactured where the thickness of plastic material around the guide sleeves results in failure to seat because of contact point interference. This additional thickness is a result of CADCAM manufacture where the dimension of material for strength and support reasons during construction of the template is industrially controlled and automatic. This problem can be offset by ensuring that the mesio-distal dimensions of the residual alveolar ridge is sufficient to accommodate the dimensional requirements of guide sleeve and plastic support where possible.

In the posterior regions limited mouth opening may prevent placement of instrumentation which is of increased length to accommodate the dimensions of the template guide sleeve. This can be sometimes overcome by assembling the instrumentation into the template extra-orally and then reinserting the combined template and drilling instrumentation simultaneously. Whilst this is

Table 1 Patient Implant – Prostheses Specifications

Case Number	Patient Number	Prosthesis Type	Prosthesis Location	Number of Implants	Implant Type	Immediately Loaded	Implant Failures	Follow-up Months
1	1	splinted crowns	posterior mandible	3	Brånemark System®	Yes	-	24
2	2	4 unit bridge	anterior maxilla	2	Brånemark System®	Yes	-	22
3	3	4 unit bridge	posterior maxilla	3	NobelReplace™	Yes	-	22
4	4	splinted crowns	posterior maxilla	2	Brånemark System®	No	-	22
5	5	3 unit bridge	posterior maxilla	2	Brånemark System®	Yes	-	21
6	6	splinted crowns	posterior maxilla	3	Brånemark System®	Yes	-	21
7	7	splinted crowns	posterior maxilla	3	Brånemark System®	Yes	1	20
8	7	splinted crowns	posterior maxilla	3	Brånemark System®	Yes	-	20
9	8	single tooth	anterior maxilla	1	NobelReplace™	Yes	-	18
10	8	single tooth	anterior maxilla	1	NobelReplace™	Yes	-	18
11	9	splinted crowns	posterior mandible	2	NobelReplace™	Yes	-	17
12	9	splinted crowns	posterior mandible	3	NobelReplace™	Yes	1	17
13	10	10 unit bridge	anterior maxilla	6	NobelSpeedy™ Tapered	Yes	-	12
13	10	13	34				2	
Cumulative Survival Rate = 94.1%								

more onerous and time consuming, it may avoid abandoning the procedure.

In immediate loading protocols, a fallback position strategy should be employed in treatment planning as it is possible to place an implant that has insufficient primary stability for immediate loading. The fallback strategy is to either place healing abutments, or remove the implant and install a larger dimension implant. If the case at hand is a Teeth-in-an-Hour™ situation it means that the procedure must be aborted, however the fallback position could be to convert the treatment plan to implant placement, surgical impression and traditional pathway provisional prosthesis.

Discussion

Experience with guided surgery and immediate loading is limited in the partially edentulous application and the evidence base is sparse. As yet, no five year study results have been reported, and current studies are only short-term with results yet to be reported. However, the limited short-term results reported in this paper do compare favourably with the results reported for both partially edentulous bridge patients[14] and single tooth applications[15] using the traditional 2 stage surgery protocol after 1-2 years of loading. Our cumulative survival rate of 94.1% is similar to that reported in the multicentre partially edentulous jaw study (94.3%)[14]. In the multicentre single tooth study a success rate of 97.2% was reported[15], but this did not include any implants placed in the posterior maxilla, which is an area of soft bone quality and higher failure rate. Only 2 single tooth implants were placed in this study, both successful after 1-2 years of loading. Thus the results of this study are encouraging. Furthermore patient demand for immediate function solutions is increasing.

Patient benefits include maximized comfort with minimal invasiveness, pain and post operative swelling. Dentist benefits include increased predictability in planning and increased safety in implementation. Difficulty in assessing the primary stability of implants can be experienced in guided surgery because tactile sensibility is offset by the influence of the template guide sleeve. Insertion torque can be unreliable because of frictional resistance of the implant mount against the guide sleeve particularly where access is difficult and compromised. Resonance frequency analysis has been used to differentiate successful and failing implants placed into immediate or early functional loading.[16] We have found that this modality can be a useful adjunct in assessing implant stability following removal of the surgical guide. This modality measures implant stability electronically and the result is interpreted as an implant stability quotient (ISQ) on a scale of 0-100. (Osstell, Integration Diagnostics, Sävedalen, Sweden) In our experience a measurement of ISQ 60 is subjectively used as the lower limit for immediate loading where occlusion is favourable. In the event that this is not attained, the

Table 2 Implant Types

Brånemark System®			NobelReplace™			NobelSpeedy™ Replace		
Length	**3.75mm ø**	**4.00mm ø**	**Length**	**4.3mm ø**	**5mm ø**	**Length**	**4.00mm ø**	**5.00mm ø**
10		1	8		1	10		2
11.5		1	10		3	13	1	
13		4	13	3		15	3	
15	6	6	16	3		18		
	6	12		6	4		4	2
18			10			6		
34								

protocol reverts to a fallback strategy of delayed loading as can occur in situations of poor bone quality or compromised installation.

The pre-production of a prosthesis and the Teeth-in-an-Hour™ concept is a realistic possibility in selected cases. Nevertheless, the majority of clinicians favour the provisional pathway concept because of flexibility in prosthetic outcome, particularly in esthetically demanding cases. NobelGuide™ is seen to be a global rehabilitation concept offering potential for a range of clinical solutions. It is universally applicable as a planning tool in all implant cases.

Conclusion

Guided surgery with immediate loading of implants is possible in the partially edentulous situation in selected cases. NobelGuide™ is a CT scan related global concept with universal applications for diagnosis and treatment planning. An industrially derived surgical template can be provided for the predictable and safe placement of implants and can be further used to reconstitute a cast for the pre production of various prosthetic solutions. Implants placed using this modality demonstrate similar survival rates to those placed using traditional protocols.

Acknowledgement

The authors gratefully recognize the encouragement and expertise of Dr Matts Andersson for his efforts in making the treatment of the patients discussed in the paper possible.

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XP BOND in self-cure mode used for luting porcelain restorations: 3 year recall

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Abstract

Purpose: The aim of this clinical study was to evaluate, after 3 years of clinical service, certain clinical parameters of Empress II restorations luted under clinical conditions with XP BOND in combination with SCA and Calibra cured in self-cure mode. **Materials and methods:** Fifty-three restorations were placed in 38 patients from March 2006 until April 2006. No patient received more than two restorations. Luting procedures were performed following manufacturers' instructions. The restorations were evaluated for post-op sensitivity, marginal discoloration, marginal integrity, secondary caries, maintenance of interproximal contact and fracture at baseline, after 2 weeks, 6 months, 1-, 2- and 3 years of clinical service. **Results:** At the 3-year recall, 51 restorations were re-evaluated. Clinical examinations found no restoration affected by post-operative sensitivity. Of the 51 restorations, only 5 showed bravo score and 2 charlie score for marginal integrity/stain. 1 restoration showed bravo score at vitality test. All other parameters showed alpha scores. **Conclusions:** All the evaluated restorations were in place and acceptable. Post-operative sensitivity recorded after using XP BOND with SCA and Calibra in self-cure mode was clinically acceptable.

Key Words *Ceramic crowns, Self-curing, Clinical Trial, Bonding*

Introduction

When introduced, experimental tests showed XP BOND having high values in microtensile bond strength data compared to other systems when the adhesive was used with SCA and Calibra in self-cure mode.[1] Then, the baseline, 1-year and 2-year reports of post-operative sensitivity and clinical parameters on XP Bond, (DENTSPLY De Trey, Konstanz, Germany) used in combination with SCA and Calibra dual cure resin cement for luting indirect posterior porcelain restorations were published.[2,3,4] Post-operative sensitivity can be commonly found in vital teeth in which porcelain crowns were luted.[5]

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When porcelain restorations are luted on vital abutments, a perfect bonding, which has to integrate all parts into one coherent structure, is necessary.[6] Luting material and technique, as well as the substrate characteristics, therefore represent success determining factors.[7]

Among different combinations of adhesive-luting materials dual-curing bonding systems are often the first choice,[8-17] as they allow polymerization of the adhesive materials and resin cement below thick ceramic restorations.

The aim of the present prospective clinical trial was to evaluate the 3-year clinical behaviour of Empress II restorations (Ivoclar-Vivadent, Schaan, Liechtenstein), luted with the adhesive system XP BOND (DENTSPLY DeTrey, Konstanz, Germany) with SCA (DENTSPLY Caulk, USA) and Calibra resin cement (DENTSPLY Caulk, USA), both used in self-cure mode.

Materials and Methods

A consecutive sample of 53 restorations in 38 patients in need of one or two single-units was placed. Partial or full restoration was performed from the pool of patients

Table1
Changes in pre- and post-operative sensitivity during the observation period of 3 years (1 = lowest sensitivity, 10 = highest sensitivity).

	XP Bond / SCA / Calibra [n]		
Restoration	**Pre-operative sensitivity and/or post-operative sensitivity 2 weeks after placement**	**Type of restoration**	**Post-operative sensitivity (3 year)**
1 (#5)	6	Inlay (OD)	0
2 (#7)	1	Inlay (MOD)	0
3 (#10)	1	Inlay (MO)	0
4 (#11,14)	2	Onlay	0
5 (#26)	1	Onlay	0
6 (#20,29)	3	Inlay (OMD) and onlay	0
7 (#32)	1	Inlay(OM)	0
8 (#39)	4	Onlay	0
9 (#43)	3	Onlay	0
10 (#46)	1	Inlay (OMD)	0
11 (#53)	3	Inlay(OMD)	0

accessing the department of Restorative Dentistry of the University of Siena. Patients' written consent to the trial was obtained after having provided a complete explanation of the aim of the study.

Inclusion criteria

Males and females aged 18-60 years in good general and periodontal health were included.

Exclusion criteria

Patients with the following factors were excluded from the clinical trial:

1. Nonage (< 18 years); 2. Known pregnancy; 3. Disabilities; 4. Potential prosthodontic restoration of teeth; 5. Pulpitic, non-vital or endodontically treated teeth; 6. (Profound, chronic) periodontitis; 7. Deep carious defects (close to pulp, < 1mm distance) or pulp capping; 8. Heavy occlusal contacts or history of bruxism; 9. Systemic disease or severe medical complications; 10. Allergic history concerning methacrylates; 11. Rampant caries; 12. Xerostomia; 13. Lack of compliance; 14. Language barriers.

Test stimuli and assessment

Before restoring the tooth, a pain measurement was performed utilizing a simple pain scale based on the response method. Response was determined by a one-second application of air from a dental unit syringe (at 40-65 p.s.i. at approximately 20°C), directed perpendicularly to the root surface at a distance of 2 cm and by tactile stimuli with a sharp #5 explorer. The patient was asked to rate the perception of the sensitivity experienced during this thermal/evaporative stimulation by placing a mark on a visual analog scale or line beginning at 0 and ending at 10 (where 0 = no pain and 10 = excruciating pain). In order to translate these scores into easily understood pain levels, a score of 0 was defined as no pain, 1-4 as mild sensitivity (which was provoked by the dentist air blast), and 5-10 as strong sensitivity (which was spontaneously reported by the patient during drinking and eating). Only patients scoring low on the analog scale were included in

Table 2a, 2b and 2c

Performance criteria according to Ryge at 6 month (Table 2a), 1 year (Table 2b), 2 year (Table 2c) and 3 year recall (Table 2d)

Table 2a

Criteria and number of restorations evaluated at 6 month recall		XP Bond / SCA / Calibra			
		alpha	bravo	charlie	delta
Marginal discoloration and integrity	53	53	0	0	0
Secondary caries	53	53	0	0	0
Vitality test	53	53	0	0	0
Interproximal contacts	53	53	0	0	0
Retention	53	53	0	0	0
Fracture	53	53	0	0	0

Table 2b

Criteria and number of restorations evaluated at 1 year recall		XP Bond /SCA / Calibra			
		alpha	bravo	charlie	delta
Marginal discoloration and integrity	53	51	2	0	0
Secondary caries	53	53	0	0	0
Vitality test	53	53	0	0	0
Interproximal contacts	53	53	0	0	0
Retention	53	53	0	0	0
Fracture	53	53	0	0	0

Table 2c

Criteria and number of restorations evaluated at 2 year recall		XP Bond / SCA / Calibra [n]			
		alpha	bravo	charlie	delta
Marginal discoloration and integrity	53	49	2	2	0
Secondary caries	53	53	0	0	0
Vitality test	53	52	1	0	0
Interproximal contacts	53	53	0	0	0
Retention	53	53	0	0	0
Fracture	53	53	0	0	0

Table 2d

Criteria and number of restorations evaluated at 3 year recall		XP Bond / SCA / Calibra [n]			
		alpha	bravo	charlie	delta
Marginal discoloration and integrity	51	44	5	2	0
Secondary caries	51	51	0	0	0
Vitality test	51	50	1	0	0
Interproximal contacts	51	51	0	0	0
Retention	51	51	0	0	0
Fracture	51	51	0	0	0

the study, whereas high score cases were excluded by the assumption that irreversible pulp inflammation may be sustaining the high sensitivity. The status of the gingival tissues adjacent to the test sites was observed at baseline and at each recall. Patients were recalled to the department for testing post-operative sensitivity after 2 weeks, 6 months, 1- 2- and 3 years.

Clinical Procedure

For standardization purposes the same operator performed all the clinical procedures. Following anaesthesia, rubber dam was placed, all carious structures were excavated, and any restorative material was removed. Preparation was performed using conventional diamond burs in a high-speed hand piece, with no bevel on margins. The preparation design was dictated by the extent of decay and pre-existing restorations. The Residual Dentin Thickness (RDT) was evaluated on a periapical radiograph, and teeth with RDT thinner than 0.5 mm were excluded. After preparation, the impression of the prepared tooth was taken and sent to the laboratory. A temporary restoration was inserted. One week after, the ceramic restorations were luted following manufacturer's instructions. The restorations were placed in the time period between March and April 2006 and examined for post-op sensitivity at baseline, after 2 weeks, 6 months, 1-, 2- and 3 years by the same operator. At each recall, data regarding post-operative sensitivity, stability and longevity were collected with reference to the USPHS criteria. The following parameters were therefore assessed: Post-operative sensitivity - the patient comfort with the restoration under function, cold and warm stimuli, and a gentle air stream was assessed. Sensitivity was defined by a scale from 0-10 as described above.

The null hypothesis tested was that the XP Bond in self-cure mode cannot prevent post-operative sensitivity after 3 years of clinical service.

The other evaluated clinical parameters were: marginal discoloration and integrity, secondary caries, fracture, vitality test, retention and interproximal contacts.

Results

The results are summarized in Tables 1-2. All 53 teeth were evaluated at baseline, after 2 weeks, after 6 months, 1 - 2 years. Only 51 restorations were evaluated after 3 years. At baseline 3 patients showed pre-operative sensitivity in 5 teeth. 10 cases of post-operative sensitivity were observed at the two week recall and only 3 after 6 months. In one case, post-operative sensitivity increased from 0 to 6 immediately after luting the restoration (after the anesthetic effect wore off), but dropped to grade 3 after 6 months. In the 7 cases showing an increase in post-operative sensitivity after 2 weeks, hypersensitivity disappeared completely after 6 months. In 2 cases, a residual post-op sensitivity of grade 2 remained after 6 months. After 2 years of clinical service, minor post-operative sensitivity was present only in one patient. No adverse events/ effects did occur. All other parameters showed alpha scores. After 3 years of clinical service, no post-operative sensitivity was reported in any of 51 re-evaluated restorations (Table 2). 5 restorations showed bravo scores and 2 charlie scores for marginal parameters. 1 restoration showed bravo score for pulp vitality. After 3 years of clinical service all restorations were still clinically acceptable.

Discussion

According to the results of this clinical study, XP Bond in self-cure mode could prevent post-operative sensitivity over 3 years of clinical service and the null hypothesis was rejected.

With the intention of controlling any additional source of variation beside the patient related variability, in this clinical trial all the restorations were placed by one operator. 2 weeks after the placement of all restorations, post-operative sensitivity was found in around 19% (11 cases) of the restored teeth with a medium score of 1.9. Only one of these 11 cases showed a high degree of post-operative sensitivity (score 6), whilst in other cases the sensitivity was not spontaneous. The case in which the post-operative sensitivity was high at the beginning (score 6) showed residual sensitivity after 1 year but with a clinically acceptable score 2. This observation is in agreement with a study that reported hypersensitivity to be the most common post-operative complication (16). However, at the 6 month recall, the score dropped from grade 6 (strong) to grade 3 (mild) and after 1 year, to grade 2. At 2 year recall almost no post-operative sensitivity was found.

After 1 year of clinical service, two restorations scored bravo for marginal stain/integrity, a score still clinically acceptable. This observation might be explained by the marginal wear of the composite luting cement undermining the mechanical support.[8,13] This observation was confirmed after 2 and 3 years of clinical service and lower scores were found for marginal stain/integrity. To prevent excessive marginal wear, it is therefore mandatory to have the narrowest gap possible between cavity preparation and ceramic restoration. Optimal fit (ranging from 50 to 100 μm) is preferred,[8] particularly if the margins extend below the cemento-enamel junction.[2,5] Further clinical recalls will clarify if the margins can be affected during longer clinical service.

The utilization of a correct bonding technique is mandatory to achieve good clinical results in ceramic inlay luting.[2] In direct resin restorations, the bonding agent is routinely light-cured prior to the insertion of the composite. In ceramic luting procedures, pre-curing of the adhesive resin may make restoration seating more difficult. The use of a self-cure bonding agent is also advantageous. In the present study, a self-curing cement was chosen for luting the restorations. Self-cure cements are also able to achieve an adequate degree of conversion at sites where light-curing may be hindered by the thickness of the ceramic. The setting time of the resin cement can also be directly correlated to room temperature, glass plate and mouth temperature.

It is important to understand the underlying chemical principles for each system. In the case of XP BOND, mixing with the self-cure activator SCA activates components of the SCA that are able to polymerize the adhesive interface on contact with the initiator from sufficiently initiated self- or dual-cure materials. Therefore, the self-cure mode for luting ceramic restorations of XP BOND mixed with SCA is guaranteed only when applied in combination with Calibra.

According to the data of this study, the mix of XP BOND with SCA in combination with self-activated Calibra showed clinically acceptable control of post-operative sensitivity at the 3 year recall. These findings will be re-evaluated during the next recalls at 4- and 5 years.

Conclusions

XP BOND with SCA and Calibra used in self-cure mode showed no residual post-operative sensitivity in 51 luted porcelain restorations after 3 years of clinical service.

Clinical relevance: The results of this 3 years study reveal good clinical performance of XP BOND in combination with SCA and Calibra in self-cure mode.

Acknowledgement

This research was sponsored by DENTSPLY DeTrey, Konstanz, Germany.

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Genetic testing in the management of periodontal diseases

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Abstract

The growing understanding of the role of genetic variation in chronic inflammation presents opportunities to identify high-risk individuals for early intervention before tissue damage occurs. An abnormal inflammatory response has been linked to cardiovascular disease (CVD) and specifically to diabetes, where there is an increased susceptibility to infections such as periodontal disease. Activation of interleukin-1 (IL-1) and of tumour necrosis factor-α (TNF-α) represents some of the earliest events in response to injurious challenges and increased levels may correlate with severity of inflammatory disease. Identification of genetic risk factors underlying chronic inflammation may therefore be of value when treating refractory periodontitis and possibly peri-implantitis. The detrimental effects on periodontitis of risk factors such as smoking, stress, bacterial infections and nutritional deficiencies appear to be greater in persons with a genetic predisposition to chronic inflammation. Early detection of gene mutations shown to be associated with the more severe forms of periodontitis and peri-implantitis, as part of a comprehensive cardiovascular genetic screening in conjunction with medical and lifestyle assessments, may therefore provide a more targeted approach to the management of these diseases.

Introduction

Chronic periodontitis driven by gene-environment interactions may increase the risk of other common diseases. A meta-analysis based on seven cohort studies has shown that periodontal infection significantly increases the risk of both cerebrovascular and coronary heart disease (Khader et al. 2004; Dumitrescu 2005), with insulin resistance as an important contributing factor. Large-scale longitudinal epidemiologic and intervention studies are necessary to validate this association and to determine causality (Scannapieco et al 2003). Cardiovascular diseases are responsible for 16.6 million deaths per annum worldwide, of which 7.1 million deaths are caused by coronary heart disease (Kapp 2002).

Diabetics are at 2-4 times greater risk for the development of cardiovascular disease (CVD), the leading cause of diabetes-related deaths (Laakso 1999). Diabetes affects approximately 18 million individuals with an increase of approximately 1.3 million new cases a year in adults. Diabetes is strongly related to a hyper-inflammatory trait with increased susceptibility to infections, including periodontal diseases. Periodontitis is caused primarily by bacterial infection, although the host must be genetically susceptible. Periodontitis affects 7-15% of the adult population (Papapanou 1999) and, in subjects with metabolic dysregulation, may lead to systemic disease as a result of over-expression of inflammatory mediators. Thus both genetic and environmental factors influence the host response, which is essentially protective in nature, while an impaired immune response could worsen tissue destruction. There is large variation in the results of studies on the association between periodontitis and systemic diseases. Confounding

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and effect modification may explain this variation and need to be considered in the decision making process (Ylostalo et al 2006)

The fact that individual genetic factors are not determinants of the more prevalent forms of chronic periodontitis, challenges the usefulness of DNA testing. A review of the literature was undertaken to determine whether genetic testing could be of value as an adjunct to diagnosis, as a predictor of, or as an aid to the management of periodontitis.

Heritable susceptibility

Dental diseases with a Mendelian inheritance pattern are relatively rare and inheritance cannot explain most common forms of periodontitis. A specific genotype pattern involving two polymorphisms of the interleukin-1 (IL-1) gene cluster with high levels of IL-1 production was shown to increase the risk of chronic periodontitis in the general population (Kornman et al. 1997). This composite genotype involves mutation -889G→T (in linkage disequilibrium with 4845) in the IL-1α gene and mutation 3953C→T (previously numbered 3954) in the in the IL-1β gene (Engebretson et al. 1999). In a recent study performed by Agerbaek et al. (2006), it was shown that a lower bacterial load is required in persons with the mutated composite IL-1 genotype to develop the same level of periodontitis as in mutation-negative individuals.

Studies are in progress to determine the impact of the IL-1 genotype on the periodontal status of the Xhosa population of South Africa. Research in different population groups is necessary as data from Caucasian populations cannot always be extrapolated across ethnic groups owing to population differences in allele frequencies and socio-demographic backgrounds.

Periodontitis and diabetes

Detection of variation in genes encoding the proinflammatory cytokines IL-1, IL-6 and tumour necrosis factor-α (TNF-α) may be particularly important in patients at risk of both periodontitis and diabetes, as cytokine production could be favourably modulated by supplementation with omega-3 fatty acids (Meydani et al. 1991) and vitamin E (Devaraj and Jialal 2000).

Grimble et al. (2002) have demonstrated that fish oil reduced TNF-α production to a greater extent in individuals with at least one A-allele of the TNF-α-308G→A polymorphism, which is associated with a 2-fold increase in transcription levels, compared with the more common G-allele. Co-existence of the –308A allele of the TNF-α gene and the –174CC genotype of the IL-6 gene demonstrated a significant decrease in insulin secretion and is highly predictive of conversion from insulin resistance to type II diabetes (Kubaszek et al. 2003). Persons with the -308A TNF-α gene variant have a 23% increased risk of developing obesity compared with controls and they showed significantly higher systolic arterial blood pressure and plasma insulin levels (Sookoian et al. 2005).

Genetic testing for risk management

DNA testing is not recommended for diagnosis of periodontitis, but may be useful to facilitate clinical management of patients with chronic inflammatory disease. Identification of persons at increased risk of aggressive periodontitis and peri-implantitis may predict general deregulation of the inflammatory response, with concomitant increased risk of other chronic disorders such as coronary heart disease, type II diabetes, dementia and certain types of cancer. A family history of any of these diseases would strongly suggest that genetic testing combined with medical and nutritional therapy may be appropriate (Kotze and Badenhorst 2005).

Conclusion

For multi-factorial diseases such as chronic periodontal diseases, no single gene mutation will allow a definitive diagnosis or certain risk prediction. In such a complex disease model, a single functional gene polymorphism can modulate disease progression over time but is not solely sufficient to cause periodontal disease. Genetic testing would therefore be most useful for subjects with periodontal disease as one component of a spectrum of diseases which might be targeted for intervention for risk reduction at the gene-environment level. At this level the information gained from genetic testing could assist health professionals to personalise the treatment of their patients.

Acknowledgements

Emeritus Professor Peter H Beighton, University of Cape Town, Professor John Lemmer at the University of Limpopo, and Dr Tim Winstanley at the University of Pretoria, are thanked for critical appraisal of and comments on the manuscript. Dr Hein Badenhorst is acknowledged for initiating the process of incorporating periodontitis as one of several risk factors to be considered as part of a comprehensive Cardiovascular Genetic Screen.

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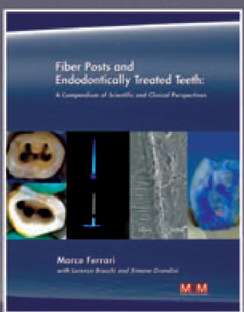

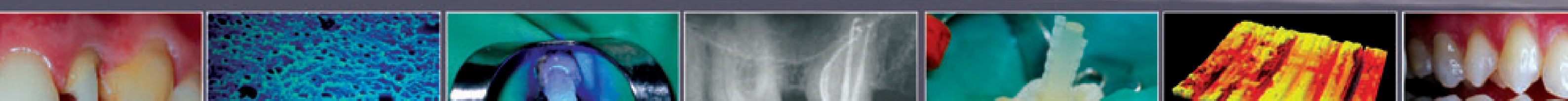

Long-term follow-up of an immediate functional loading implant in a single-tooth replacement

Mauro Donati[1]

For many patients, early or immediate functional loading of implants is an obvious advantage, especially in anterior regions when the need to restore the esthetic appearance has high priority. In recent years, an increasing concern regarding the possibility to shorten the healing period in cases of single-tooth replacement by implants in esthetic areas, has become evident. Here is reported a clinical case where the patient's concern of shortening the rehabilitation time met the criteria for challenging the immediate functional loading protocol for a single tooth restoration. A three-year follow-up is presented.

Figure 1a

Patient presentation

The patient is a 40-year-old female in good general health, presented with the goal of changing her appearance in the maxillary anterior area. The patient had a congenital missing of the left lateral incisor with consequent occlusion problems. A well-planned orthodontic therapy re-established a normal occlusion and created a proper space to rehabilitate the left lateral incisor (Figure 1). To meet the patient's desire to reduce the time of rehabilitation, an immediate functional loading protocol was applied.

Figure 1b

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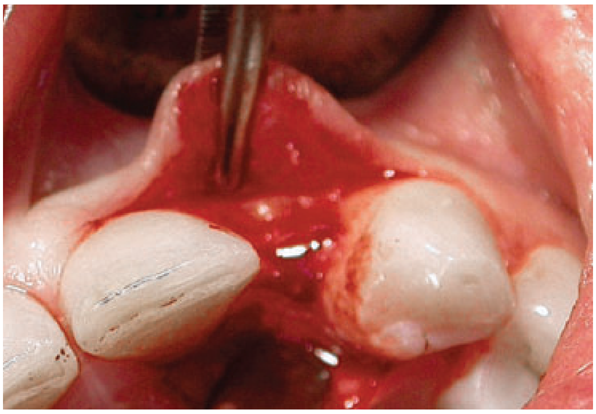

Figure 2a

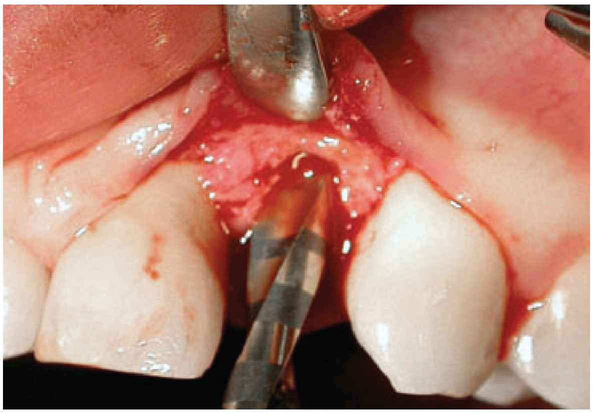

Figure 2b

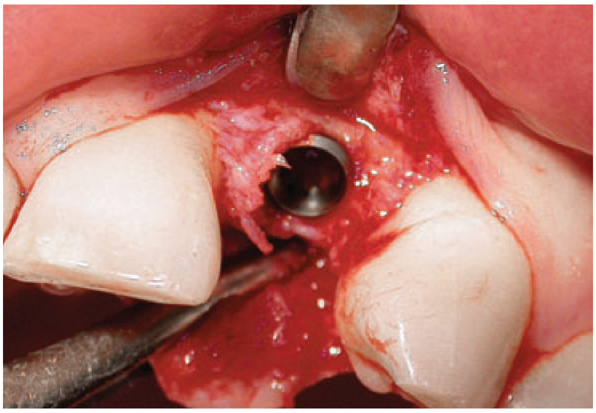

Figure 2c

Figure 3a

Figure 3b

Figure 3c

Surgical procedures

The patient received an antibiotic prophylaxis one hour prior to surgery. Following local anesthesia, sulcular incisions were made at the neighboring teeth and connected by a crestal incision over the edentulous area. Full thickness flaps were elevated to expose the bone ridge (Figure 2). For the installation of the implant, the preparation of the implant bed was performed according to the standards described in the surgical manual specific to the implant system (Astra Tech Dental, Mölndal, Sweden).

Figure 4a

Figure 4b

Prosthetic procedures

Following the completion of the surgical procedure of the site, the prosthetic procedures were initiated. The position of the implant was transferred to a model using an implant pick-up, which was attached to the surgical stent with an autopolymerizing resin (Figure 3). The implant was then protected with a healing abutment during a 12–24 hour interval until the custom-made abutment and the temporary crown were placed. The flaps were adjusted and secured around the abutments with interrupted sutures.

A custom-made abutment (preparable abutment, Astra Tech Dental, Mölndal, Sweden) and a temporary crown were produced within 24 hours of implant installation (Figure 4). The healing abutment was removed and the custom-made abutment was placed and tightened to 20 Ncm. The temporary acrylic crown was cemented with a temporary cement (Temp Bond, Kerr Co., USA). The crowns were in contact in centric occlusion (Figure 5). An X-ray (baseline, Figure 6) was taken with a standardized intraoral radiograph (Kodak Ektaspeed Plus, Eastman Kodak Co., Rochester, NY, USA) obtained using a parallel technique with custom-made film holders. Suture removal was performed 10 to 14 days after implant surgery.

Six months after implant installation, new impressions were taken and a gold-ceramic crown was produced and cemented (Figure 7).

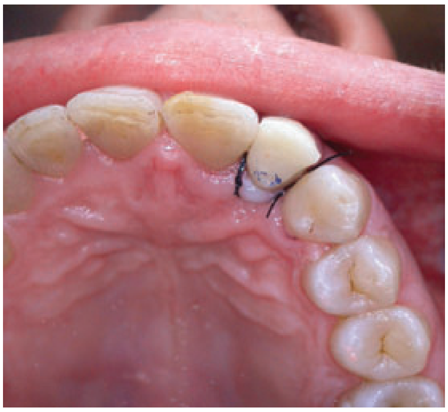

Figure 5a

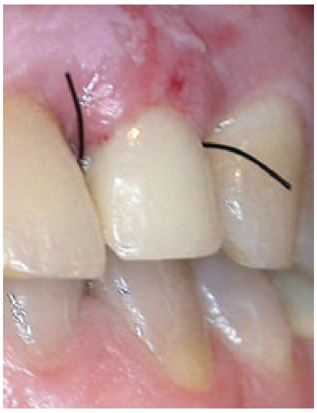

Figure 5b

Figure 5c

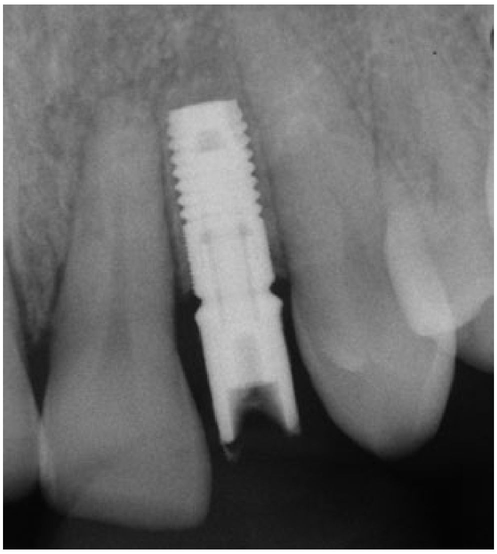

Figure 6

Figure 7a

Figure 7b

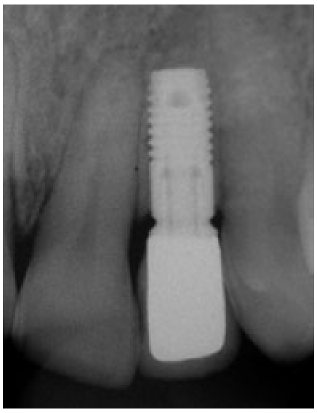

Figure 7c

Figure 8

Follow-up

The patient has been followed for three years. The clinical and radiographic pictures reveal long-term stability of the soft and hard peri-implant tissues, maintaining a successful esthetic outcome that met the patient's expectations (Figure 8). This clinical case is one of the cases included in a recently published study (Clinical Oral Implant Research 19, 2008, 740-748) on immediate functional loading of implants in a single-tooth replacement. The Astra Tech Implant System™ provides a good and reliable protocol when reduction of the rehabilitation time is requested.

Clinical

Coronectomy: an alternative therapy for the symptomatic, impacted third molar report of 9 cases

Nika Vafaei,[1] Carlo Ferretti[2]

Key words: impacted third molar, coronectomy

The mandibular third molar remains the tooth most prone to impaction and interestingly, the incidence of impaction appears to be increasing.[1] Mechanisms for impaction of third molars remain unproven supposition,[2] but the result is the failure of eruption into a normal functional position.[2] Problems which may arise due to tooth impaction (be it partial or full) include pericoronitis, cheek biting, pressure on adjacent teeth causing pain, food impaction in the area, buccal or lingual eruption, pericoronal infection, caries, periodontal problems with associated teeth, and association with pathological lesions such cysts and tumours.[2] Thus, the obligatory surgical removal of wisdom teeth remains a common procedure in dental practice. Prophylactic removal to avoid the aforementioned problems is often performed but it is a persistent source of discussion. Adding to the controversy is the proposed association between third molar impaction, anterior incisor crowding and atypical facial pain.[2, 3]

Irrespective of the motive, the surgical removal of wisdom teeth may be associated with several post-operative complications. The most commonly observed complications include pain, edema, acute alveolar osteitis, infection, mandibular fracture, damage to adjacent teeth, and haemorrhage.[1, 4-7] Possibly the most concerning complication is temporary or permanent sensory nerve damage.[1, 2,4,6,8]

The development of a post-operative complication is influenced by operator, patient, and tooth associated factors. There is a strong correlation between the degree of impaction, the type of impaction (i.e. vertical, mesioangular, distoangular and horizontal), and the anatomical relation of the roots to the inferior alveolar nerve canal and postoperative complications. A preexisting infection or a pathological lesion in or around the tooth also increases the risk.[7,9] An important iatrogenic factor is surgeon experience. Several studies have confirmed the inverse relationship between surgeon experience and complications.[9-13] Surgical technique as well as the use of certain instrumentation are potential risk factors, in particular with regard to nerve damage.[9-13]

Lingual nerve (LN) and inferior alveolar nerve damage (IAN) is largely attributed to the anatomical proximity of the impacted third molar to these nerves. Both the IAN and the LN arise from the posterior branch of the mandibular nerve which in turn is a branch of cranial nerve V, the trigeminal nerve. The IAN consists predominantly of sensory fibres with only a few motor fibres (distributed via the mylohyoid nerve to the mylohyoid muscle and the anterior belly of the digastric muscle). The lower molar and premolar teeth and adjacent parts of the gingiva are supplied by the IAN, and its terminal branches supply sensation to the ipsilateral lower lip via the mental nerve. The course of the IAN within the mandibular canal proceeds anteriorly from the medial aspect of the mid-ramus (at the lingula) along with the inferior alveolar artery (together they are referred to as the inferior alveolar neurovascular bundle) in the intraosseous inferior alveolar canal. It is here that its course approximates the third molar to varying degrees. The nerve proceeds anteriorly in its bony canal within the body of the mandible just apical to the lower molars and

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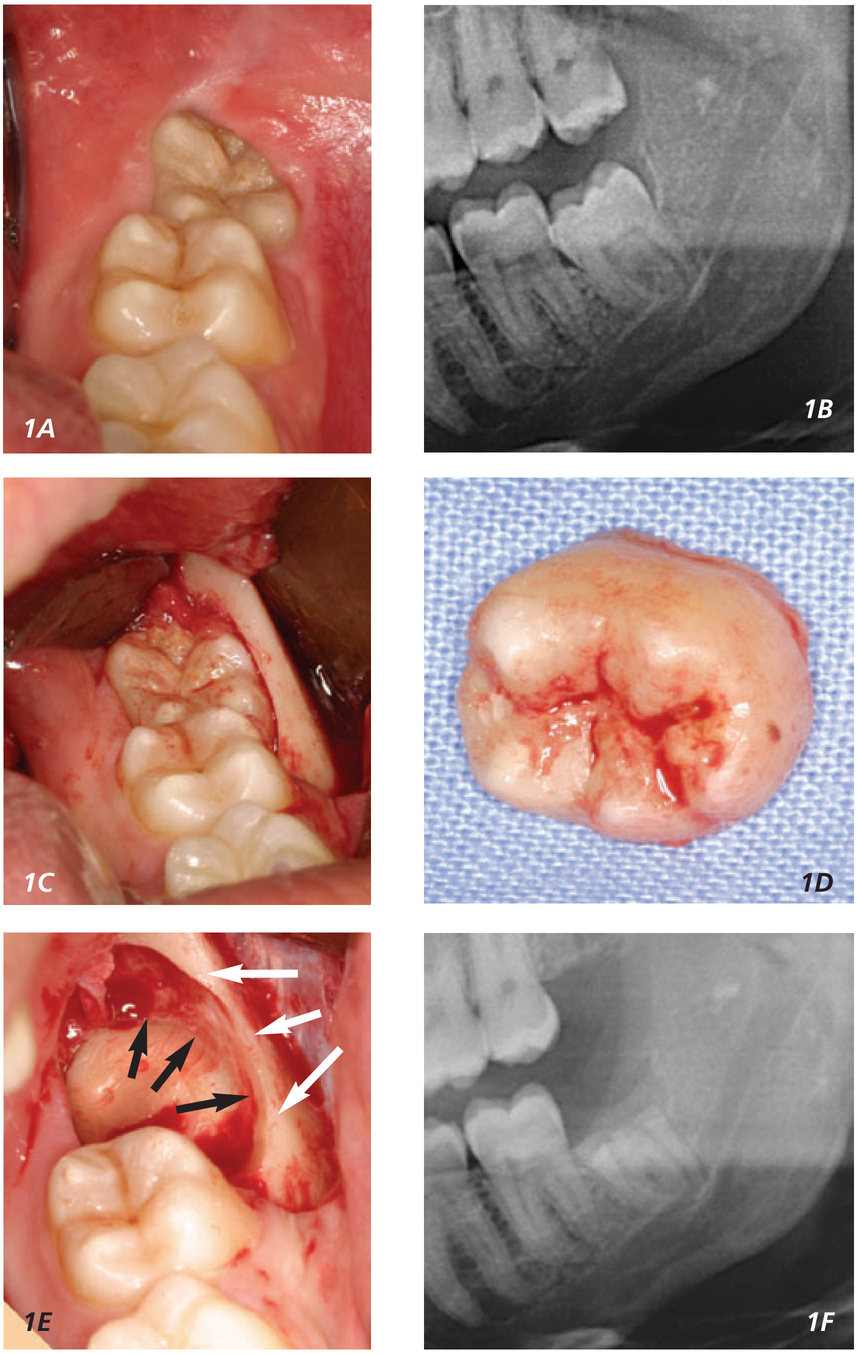

Figure 1 – 32 year old male patient with partially erupted, vertically impacted 38 (A) which on panoramic radiographs demonstrates an intimate relationship of the root apices to the inferior alveolar canal (B). The crown is exposed by means of a mucoperiosteal flap (C) and the crown resected (D). The retained roots (black arrows indicating the tooth margin) are reduced to a sub-crestal level (white arrows indicate the osseous socket margin). This leaves undisturbed, retained root fragments below the socket margin allowing for bone formation above the roots.

premolars to emerge from the mental foramen as the terminal mental nerve branch which innervates the skin of the ipsilateral chin and the lower lip. The smaller incisive branch is the intraosseous anterior continuation of the nerve and supplies the canine and incisor teeth.[14] The lingual nerve runs its course anterior to the inferior alveolar nerve, proceeding anteriorly in the soft tissues lingual to the third molar and supplies the mucous membrane of the anterior two-thirds of the tongue.[14]

Important predictors of neural injury include the use of lingual retractors, particular surgical techniques such as vertical tooth sectioning and ostectomy, anatomical variations of nerve, and lingual root angulation. The mechanism of nerve injury (compression, stretching or

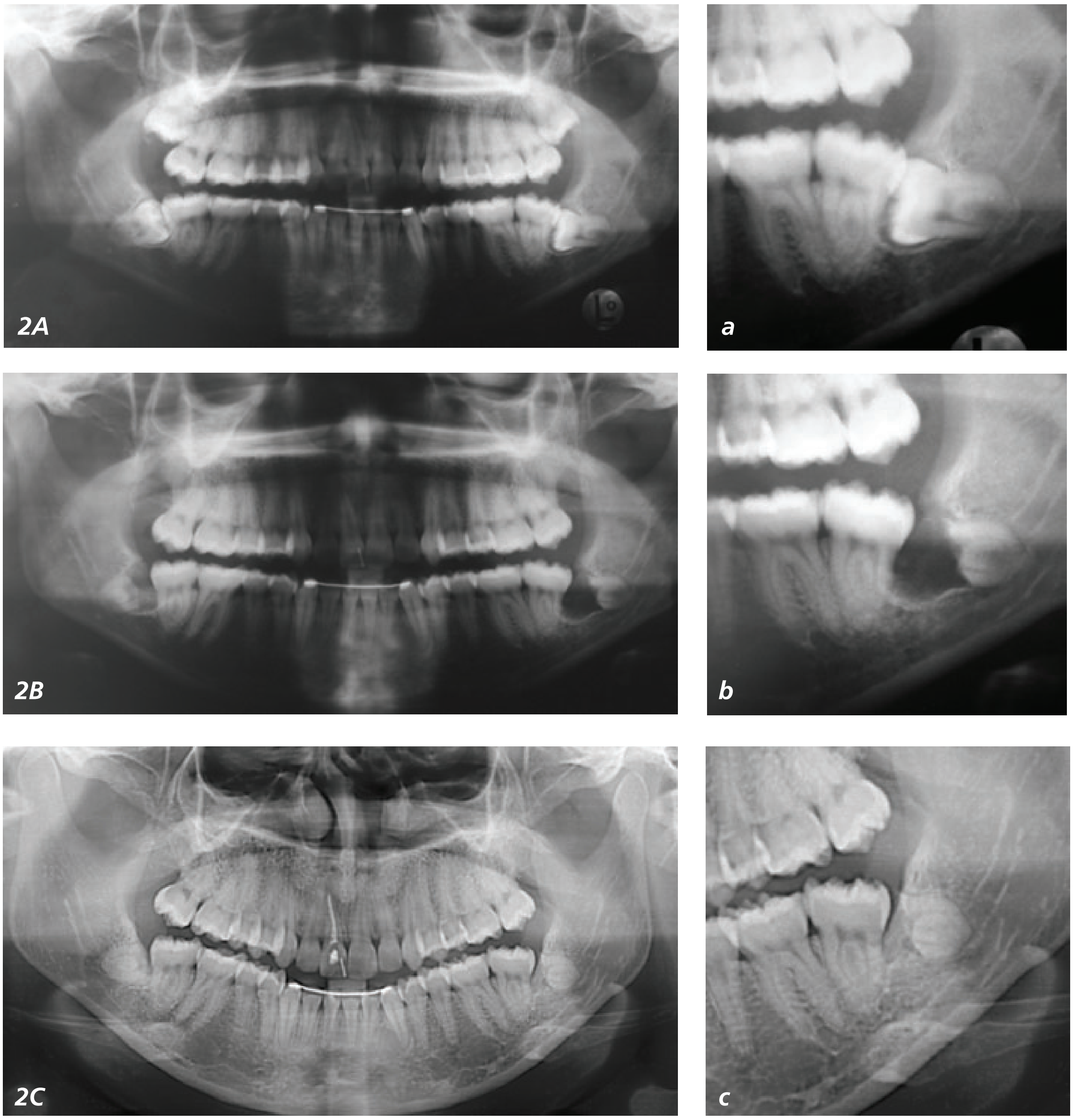

Figure 2 – Panoramic radiograph of 22 year old female patient presenting with persistent pain associated with horizontally impacted teeth (A, a). Due to high risk of IAN injury (note darkening of canal as it crosses the roots) bilateral coronectomy was performed (B, b). 1 year follow-up (C, c) shows significant root fragment migration away from the IAN, ossification anterior to the roots and absence of periapical pathology.

complete transsection) is a strong determinant of sensory alteration and recovery[15], as is increased patient age. The latter is due to the increased difficulty of surgery and the decreased potential for repair and regeneration in older patients.[15,16] The reported incidence of LN and IAN damage following third molar extraction ranges between 0 and 23 %.[11] More recent data has however reported the incidence to be in a lower range of 0-3.6%. [10-13, 16, 17] Whether temporary or permanent, iatrogenic nerve damage following extraction of the lower third molar is a common cause of litigation and patient dissatisfaction in dental practice.[10] This complication can be mitigated to some degree by preoperative risk assessment. The three most common radiographic features suggesting close proximity of an impacted third molar to the IAN include diversion of the canal, interruption of the canal walls, and darkening of the root. [12, 18, 19] The advent of cone beam computed tomography has significantly increased the accuracy of preoperative assessment but its expense precludes it from widespread availability and routine use.

The decision to remove impacted third molars is the culmination of a complex algorithm which must evaluate the reasons for removal and weigh these against the potential risk factors. The fundamental tenet of surgical exodontia is that the prophylactic removal of any tooth which has a high risk for complications (whether due to local conditions or systemic factors) cannot be condoned. Once a decision has been made that the benefits of surgical removal of a tooth outweigh any potential complications it is incumbent upon the practitioner to select a surgical technique with the lowest potential complication rate. Ecuyer and Debien [20] first described a technique, which they termed coronectomy, involving the resection of the crown of a tooth with deliberate retention of the roots.[18,19] This technique may be considered when an impacted lower third molar must be removed and key radiographic findings show close relation of the tooth roots with the inferior alveolar nerve canal, in order to mitigate the risk of IAN damage during tooth extraction.[18,19] The procedure requires transection of the tooth just below its crown and reduction of the remaining root fragments below the lingual and buccal plates (Figure 1), allowing for bone formation superior to these roots.[21] Following retention of vital roots all pulps survive[18], however root mobility must be avoided during the coronectomy procedure as these will become a source of infection.[18,21] Exclusion criteria for coronectomy include a tooth with active infection extending to its roots, periapical pathology associated with the tooth, and mobile teeth. Postoperatively, although retained root movement is unpredictable, they appear to migrate away from the canal (Figure 2) allowing removal at a later stage (if required) with substantially lower risk of nerve damage.[21] Complications associated with coronectomy include osteitis, unintentional root mobility with subsequent infection, and temporary sensory disturbance of the lip related to the technique and damage caused by inappropriate burr usage.[18]

Recently this technique has been subject to closer scrutiny and several studies have been published on the topic. In a study by Pogrel et al [21], forty-one patients had 50 lower third molars treated by coronectomy. There were no cases of inferior alveolar nerve damage; there was however one case of transient lingual nerve involvement, probably due to lingual retractor use. One patient required subsequent removal of the roots of both lower third molars because of failure to heal, and one patient required subsequent removal of a root because of subsequent migration to the surface. Root migration was noted in approximately 30% of patients over a 6 month period.[21] O'Riordan[18] conducted a retrospective study of 52 patients who were operated over a 10 year period. 3 of 52 patients had to have the roots removed subsequent to the coronectomy procedure due to pain or infection. Neural complications included 3 cases of temporary sensory disturbance of the lower lip which the author attributes to pressure transmitted to the nerve when splitting the crown from the root, or a slight elevation of the root when splitting. One case of prolonged anesthesia of the lip was noted, due to bur damage.[18] Finally, a prospective randomized study by Renton et al[19] of 128 patients requiring operations on mandibular third molars which had radiographic evidence of proximity to the inferior alveolar canal nerve. Patients were randomly assigned to either the extraction [n = 102] or the coronectomy [n = 94] group. Some roots were dislodged during intended coronectomy and were therefore removed, resulting in two subgroups (successful coronectomy n = 58, and failed coronectomy n = 36). Nineteen nerves were damaged (19%) after extraction, none after successful coronectomy, and three (8%) after failed coronectomy (p = 0.01). The incidence of dry socket infection was similar in the three groups (10/102, 10%, 7/58, 12%, and 4/36, 11%, respectively). The incidence of acute localized osteitis was found in 10–12% in all groups. Follow up of the coronectomy procedure after 13 months showed five root segments had started to migrate.[19]

Case reports

To the above mentioned cases we add our own experience with a further 9 patients. All patients were offered coronectomy if clinical examination revealed an impacted third molar which has been repeatedly symptomatic and radiographic examination suggested a high risk of inferior alveolar injury. All patients (4 male and 5 female with ages ranging from 19 to 36 years of age) were given a detailed account of all the treatment options and the principles of coronectomy, and were operated by the same surgeon. 3 of these patients had both lower wisdom teeth treated by coronectomy; the remaining 6 patients had a single wisdom tooth treated by coronectomy. This resulted in 12 teeth planned for coronectomy, of which one tooth required complete removal due to inadvertent dislodgement of the roots during surgery. Post operative follow-up period ranged from 3 months to 1 year. None of the patients developed post surgical lingual and labial anaesthesia and thus far none have developed infection requiring subsequent root removal. Long term radiographic follow-up demonstrated considerable root migration away from the inferior alveolar canal (Figure 2)

Discussion

Justifiably, the new technique of coronectomy is advocated with caution and some surgeons have expressed resistance to the adoption of this treatment alternative as it is contrary to the dogma of exodontia. Given its recent emergence, a significant limitation is the lack of long term follow up, in particular with regard to the potential risk of an intentionally retained root. It is proposed that the roots may become a source of infection, leading to an apical periodontitis following pulp necrosis, which could spread to the inferior alveolar canal given the root proximity.[22] Questionable outcomes also include the variable rate of root migration, periodontal status in the region, and the need for repeated radiographic and clinical evaluation, and a possible second operation to remove symptomatic roots.[23] Though not justifying the routine use of this procedure, Garcia-Garcia mentions that following breakage of the apex during conventional wisdom tooth extraction in close proximity to the IAN, the roots should probably not be removed.[24] It must be said that these contrarian views are anecdotal and no well structured study we are aware of has supported these views. On the contrary, the aforementioned studies and our experience corroborate that coronectomy is a treatment alternative with a very low complication rate. Should root removal subsequently become necessary, the root migration that follows coronectomy may decrease the risk of neural injury as the retained roots are no longer intimately associated with inferior alveolar neurovascular bundle.

Given the unpredictability of lower third molar removal, it is not always possible to avoid potential injury. However, awareness of the various associated risk factors makes it possible to minimize consequences, if not prevent them all together.

IAN involvement during lower third molar extraction is a cause for concern as it is both a clinical and medico legal issue.[21] The coronectomy technique diminishes the possibility of nerve injury thus avoiding patient dissatisfaction, and also offers a less traumatic approach than conventional third molar removal. Whilst widespread acceptance of coronectomy rightly awaits the results of longer term follow-up studies, the preliminary results are encouraging, and the practitioner who routinely removes impacted wisdom teeth should consider this surgical option in selected patients.

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Dry mouth: a clinical problem for children and young adults

Laurence J. Walsh[1]

Introduction

The subjective sensation of dry mouth, xerostomia, is a well recognized problem in adults, however relatively little attention has been paid to this issue in children. Because infants drool and young children always seem to have an excess of watery saliva, there is an unfounded belief in the dental profession that children cannot or do not suffer from salivary hypofunction, i.e. xerostomia or dry mouth. Regrettably, this is not so. Many children with special needs or complicating medical factors can suffer significant impairment of salivary function (Table 1).

A normal child will show a stimulated salivary flow rate of greater than 1·0 mL/min, somewhat higher than the value for an adult (0·7 mL/min).[39] Dry mouth occurs when the resting salivary flow rate is less than the rate of fluid loss from the mouth - either by evaporation or by absorption of water through the oral mucosa. By definition, evaporation can only occur during mouth-breathing, and it has been estimated that it could reach a maximum rate of 0.21 mL/min, although normally, even in a mouthbreathing patient, it would be much less.[40] Saliva in the residual volume is present as a thin film, which varies considerably in thickness with site, being thinnest on the hard palate. Symptoms of oral dryness may be due to localized areas of mucosal dryness, notably in the palate. Unstimulated salivary flow rates >0.1-0.3 mL/min may be necessary for this condition to be avoided.

Prompted by the sensation of mucosal dryness, individuals seek fluids to drink. It is interesting that two important determinants of mouth wetting are temperature and acidity. Cold or acidic beverages are more likely to be regarded as "thirst-quenching".[41] Because beverages can differ in their satiating ability, there is a risk that the frequent use of cold acidic drinks (such as cordials and softdrinks) in children conditions them to seek these in later life, in the same way that frequent exposure to sugar can establish a pattern for the later years. A particular concern is that children may be able to readily access caffeine containing beverages such as cola drinks, which have an addictive component (the caffeine) leading to a pattern where the drivers of caffeine, sugar, cold and acid all operate together, albeit subconsciously, to affect behaviour. As the mouth becomes drier, gustatory sensitivity declines,[42] and higher concentrations are needed to sustain the same level of stimulation. This can drive high levels of intake of such beverages. The dental consequences of high cola drink intakes in children are catastrophic in terms of dental caries and dental erosion.

As has been well documented in adults,[43] depressed resting flow and pH at rest is associated with lower plaque pH, increased numbers of lactobacilli and Candida species, and greater caries risk.[44,45] The factors which contribute to salivary dysfunction in children are, in broad terms, no different from those in adults. In short, any factor that reduces body fluids, affects the gland's parasympathetic innervation, or directly damages the glands, will reduce salivary output. This will have consequences for caries activity, and will also increase the risk of tooth loss via dental erosion.[33]

Thus, the most at-risk children for salivary hypofunction are those with medical conditions affecting salivation either directly or indirectly, those using medications which have xerostomic effects, and those whose pattern of school and extra-curricular activities places them at risk of negative fluid balance. Normal salivation, by buffering and clearing acids, contributing to pellicle formation, and providing the ions needed for remineralization of demineralized enamel, protects the teeth from both the bacterial-derived organic acids that cause caries, and the extrinsic and intrinsic acids that initiate dental erosion.[5]

The initial presentation of the child with salivary

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hypofunction may be triggered by symptoms of oral dryness or impaired oral function, the development of oral mucosal pathology such as oral thrush, or pain from carious teeth. In children with severe and long standing oral dryness, recurring infections of the salivary glands themselves (e.g. by Staphylococci) and of the oral mucosa (e.g. herpes labialis and tonsillitis) have been reported.[34] Patients who complain of oral dryness typically have additional symptoms of oral dysfunction indicative of a reduced resting flow rate,[46] and thus the assessment of the patient in the first instance must be thorough or this information will be overlooked. Labial lesions of decalcification on maxillary incisor teeth are a classic sign in young patients with salivary dysfunction, and the location of these is explained by the nature of plaque accumulation cervically and the low pH, slow moving nature of the salivary film at this particular location within the oral cavity (Figures 1-4). Once stimulated saliva samples have been collected to assess flow rate, pH and buffer capacity, the sample can also be tested for the presence of *Streptococcus mutans* bacteria using chairside immunoassays (Figure 5).

Diagnostic approach

Approaching the subject mainly by taking a symptomatic approach, which relates to the presenting complaint or oral dryness, is a useful first step when salivary dysfunction is noted in a child.[44] Chairside salivary diagnostic tests (Figures 5 and 6) and careful assessment of lifestyle factors should be undertaken, and the results from these used to assess the need for referral to specialists in oral medicine, paediatric dentistry, or special needs dentistry, as appropriate. These individuals will work towards firming the diagnosis and designing a home care plan to achieve stability.

Reaching a firm diagnosis of the underlying causes of salivary gland hypofunction may not be straightforward. Acquisition of samples of saliva for complex biologic, microbiological, immunologic and or chemical analyses is difficult in infants and young children due to lack of cooperation and motor skills necessary for expectorating adequately.[48] Use of absorbent tips has proven useful for collecting defined volumes of saliva at rest, and this technique has been used successfully in infants only days old.[49]

In the very young, complex imaging using ionizing radiation is neither safe nor practicable, and ultrasound provides a safe alternative approach. In older children, a range of imaging modalities can be used, including plain radiography, sialography, computed tomography (CT), magnetic resonance imaging (MRI),a nd radionuclide imaging (scintigraphy). In the latter, a radioactive (gamma emitting) label, generally technetium (Tc 99m) pertechnetate, is injected into the patient and its uptake across various tissues of the body measured in a gamma camera. The label binds to the Na-K-Cl membrane transport system of the acinar cells of the salivary glands.

Table 1 Potential contributing factors to salivary hypofunction in children

Negative fluid balance from
• insufficient water intake • intake of caffeine (e.g. black cola drinks) • Type I or Type II diabetes mellitus[4,8,24,28] • haemodialysis for renal disease[13] • eating disorders[10]
Medication effects
• decongestants • caffeine in asthma medications • amphetamines for attention deficit hyperactivity disorder[16] • anti-anxiety medicines for obsessive compulsive disorder[20] • antihistamines for allergic rhinitis • chemotherapy for childhood cancers[12,21,22]
Salivary gland injury
• Paediatric HIV infection[9] • Graft-versus-host disease in bone marrow transplant recipients[7,12,14,25] • Early onset Sjogren's syndrome and autoimmune disorders [6,17,19, 23] • Radiotherapy for solid tumours or leukaemias[14]
Uncommon causes
• Salivary gland agenesis (lack of gland formation)[1,5,11,15] • Salivary gland duct malformations[27] • Ectodermal dysplasia (hypodontia with syndromal associations)[2,3] • Oligodontia (with syndromal associations)[3]

Contributing factors to salivary hypofunction

1. Excessive fluid loss

This can occur from multiple lifestyle factors (such as exertional sporting activities), or from persisting GIT fluid loss, for example from diarrhea in children with Chrohn's disease and food intolerances, or in children with eating disorders, such as anorexia nervosa with restricted oral intakes or binge/purge disorders. Such eating disorders can occur in both males and females, before the age of 10 years. In patients with eating disorders, xerostomia is a common finding, and the salivary deficit greatly compromises the potential for repair after the erosive challenges.[49]

Mouthbreathing is a potential factor which could contribute to oral dryness, however in studies which have

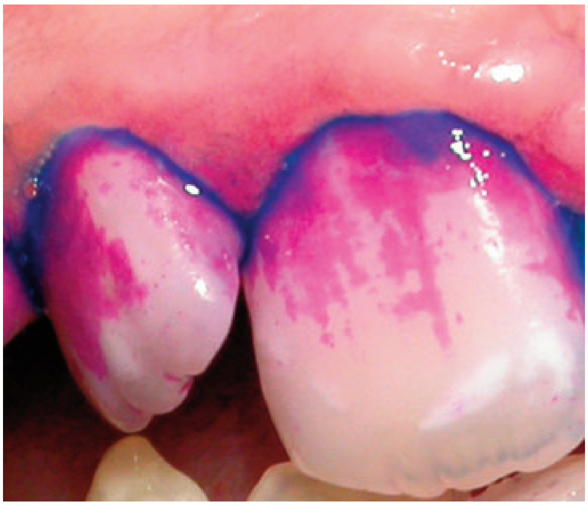

Figure 1: The development of mature aciduric biofilms occurs rapidly on maxillary incisor teeth in children with low resting salivary flow rate and pH. In this example, the plaque has been stained using a 2-tone dye (GC Corporation) which shows the mature biofilms (purple) cervically, while thin, aerobic plaque (pink) extends up the labial surface.

Figure 2: In this patient extensive white spots have developed on the maxillary incisor teeth. The mandibular incisors gain the most protection from saliva and are the last teeth affected by caries in both adults and children, even when the assault is intense and prolonged.

Figure 3: The decalcified surface has now cavitated, while the lower incisors have white spot lesions.

Figure 4: In this patient in the late teenage years, pharmacological desalivation by illicit drugs (amphetamines) has resulted in catastrophic destruction of the dentition, within two years after the completion of orthodontic treatment. Note that in this case the presence of cavitations in the lower incisor teeth signals the extreme caries activity.

compared microbiological and salivary factors in treated and untreated children with mouthbreathing syndrome, no significant differences have been found in caries risk between these groups, although the level of IgG antibodies to S. mutans was higher in the treated group. [50] Similar studies which have compared adolescents aged 10-19 years who were mouth-breathers or nose-breathers failed to find differences in flow rates or buffering capacities of resting and stimulated saliva.[51] Overall, there is little evidence to suggest that mouthbreathing is a risk factor for dental caries in children. Nevertheless, some patients who mouthbreathe may report that their mouth is dry. As already noted, this does not mean they have a complete lack of fluid in the mouth; rather, they may have localized areas of dryness on the hard palate, where the salivary film has become thin from evaporation because of mouth breathing.[52]

2. Medications

Medications used for a number of childhood diseases and conditions can adversely affect salivary output. The clinician must be alert to the fact that medications used to manage serious medical disorders, such as attention-deficit/hyperactivity disorder (ADHD) or obsessive-compulsive disorder (OCD), can cause profound xerostomia. If appropriate prevention is not in place to combat this greater challenge, the resulting dental caries

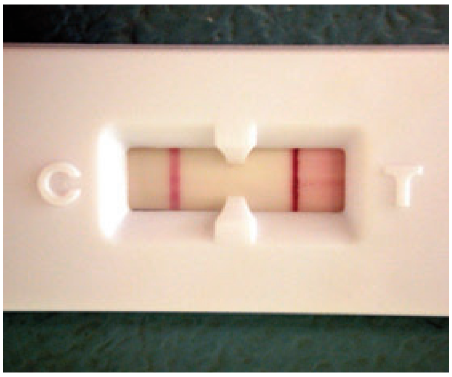

***Figure 5:** Sample of stimulated saliva from a child tested for the presence of Streptococcus mutans bacteria using the Saliva Check SM test kit (GC Corporation). The positive result is indicated by the line on the test (T) well, signifying 500,000 bacteria per mL. The control result (C) indicates correct function of the direct immunoassay.*

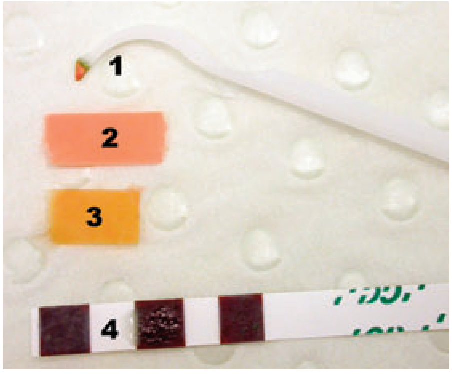

***Figure 6:** Plaque and saliva test results obtained using the GC Plaque Check+pH and Saliva Check Buffer test kits, in a 10 year old child which should raise the alarm. The plaque sample taken from the cervical aspect of the maxillary central incisor has a high level acid production when challenged with sucrose, giving a red colour for final pH (less than 5.5) (1). The resting saliva pH is low (2) and the stimulated pH is only slightly higher, suggesting a structural cause of the hypofunction rather than lifestyle factors. This is confirmed by the low buffering capacity (4). The child suffered from graft-versus-host disease following an allogeneic bone marrow transplant, with immunologically mediated salivary gland injury despite immune*

will compound the management of the child.

ADHD is the most common neurobehavioral disorder affecting school-age children. In many cases, symptoms persist into adolescence and adulthood, causing significant lifelong impairments in academic, career, and social functioning.[53] Children with ADHD have significantly more caries in the primary and permanent dentitions when compared to controls.[54] One reason for this could be a reduction in resting salivary pH, since to control severe hyperactivity and impulsivity, stimulants such as methylphenidate and amphetamines have been used for many years. More recently, non-stimulant therapies have been explored including atomoxetine, alpha-adrenergic agents, antidepressants, guanfacine and modafinil.[53] Impaired salivary production at rest is a side effect of almost all drugs used in the management and treatment of ADHD.

Similar comments apply to OCD, where supportive medications used such as selective serotonin reuptake inhibitors (SSRIs) (paroxetine, fluoxetine, fluvoxamine, and sertraline) and clomipramine have the potential to impair resting salivary flow and pH. [55,56] The suppressive effects of SSRI and tricyclic antidepressants are profound, and extend beyond suppressing resting parameters to reducing stimulated salivary flow. [57] Rampant caries has been linked causally with tricyclic antidepressants and other anticholinergic psychoactive drugs, yet mental health professionals may not be fully cognisant of the dental health risks of long term use of such medications.[58]

Antihistamines are commonly used in children, and their effects on salivary flow is deserving of further comment. Terfenadine is an antihistamine formerly used for the treatment of allergic conditions. It was marketed under the brand name Teldane in Australia. Resting saliva flow has been shown to be unchanged by terfenadine despite the fact that it induces mild drowsiness in nearly one third of patients.[59]

Careful studies of children with asthma have documented that they have suppressed salivary flow rate and pH compared with healthy controls, together with, not surprisingly, a higher caries prevalence compared with healthy controls at the same age. Longer use of anti-asthma medications has been linked with greater reductions in salivary pH, and higher salivary levels of *S. mutans* in asthmatics.[12] These indicate that asthma pharmacotherapy adversely affects risk factors for dental caries, and may directly contribute to salivary dysfunction in children.

3. Diabetes mellitus

Both insulin-dependant and non-insulin-dependant forms of diabetes can occur in children, with documented reports for children from the ages of 5 years onward. [9] Xerostomia is a common occurrence in such patients because of polyuria and its associated fluid loss, as an attempt to reduce blood glucose levels. Diabetic children have higher DMFT rates, with mandibular first molar teeth being particularly affected by caries in the deciduous and permanent dentitions. Screening for diabetes mellitus should be considered for all patients exhibiting asymptomatic parotid enlargement, regardless of their age.[6]

4. Chemotherapy and radiotherapy

Cytotoxic chemotherapy is used to treat a range of solid tumours and haematological malignancies in children. This directly damages salivary gland acinar cells, thereby reducing salivary outputs at rest and when stimulated. Local field or total body irradiation impairs salivary outputs, although the effects of the latter are less severe and recovery can be expected over several months.[21]

5. Graft-versus-host disease

With the increasing number of children receiving bone marrow transplants, it is likely that these patients may appear for care in a general dental practice setting. Despite the use of immune suppressants such as cyclosporin and tacrolimus, patients who receive marrow, cord blood or stem cells from a non-genetically identical donor develop graft-versus-host disease (GVHD), an inflammatory condition which damages the skin, gastrointestinal tract, liver, oral mucosa and salivary glands in particular, and other body sites to a lesser extent. Patients with moderate to severe GVHD suffer profound xerostomia, while in mild GVHD symptoms of oral dryness may be less apparent, even though salivary parameters are below the normal range.[24,26] Rampant caries is a major risk in the post-transplant years.

6. HIV infection

Salivary gland disease is a very common manifestation of HIV infection in children, with the parotid glands being the most frequently affected of the major glands. These glands may be visibly enlarged. Salivary gland involvement in HIV disease leads to dramatic reductions in saliva parameters, the effects of which account for significant morbidity during the progression of HIV disease.[22]

7. Sjogren's syndrome

While the typical presentation of Sjogren's syndrome is in a female in the 5th decade of life, there are reports of children with multi-focal autoimmune disease which has manifested in the first year of life, going on to develop glandular and extraglandular manifestations, including arthralgia and arthritis. Such patients experience severe caries which affects all teeth as soon as they erupt into the oral cavity.[30] The diagnosis should be considered, however, in children with a gritty sensation in the eyes, long standing dryness of the eyes or mouth, or recurrent salivary gland enlargement.[28]

8. Ectodermal dysplasia

This inherited condition is manifested as malformations of all tissues originating from the ectoderm. Impaired function of the sweat glands, hair, or nails is common in this condition. From the dental perspective, this means severe hypodontia, dental malformations, hypoplasia of the alveolar process, and xerostomia. In such patients, almost invariably, all third molar teeth are missing, however ignoring their contribution, common missing teeth are maxillary lateral incisors, mandibular central incisors, and mandibular second premolars.[37,38] While maxillary central incisors are unlikely to be missing, these teeth are often affected by severe malformations. The need for many of these patients to wear removable partial dentures and undergo orthodontics makes it essential that their salivary risk factors are addressed comprehensively. Often one third of patients with ectodermal dysplasia have severe xerostomia (unstimulated salivary flow rate of <0•1 mL/min and/or stimulated salivary flow rate of <0•7 mL/min).[38]

9. Oligodontia

Oligodontia, which is defined as the congenital absence of six or more permanent teeth, can be divided into two broad groups: isolated oligodontia, and oligodontia that is part of a syndrome. A recent study identified that more than 140 syndromes have been described where a component was oligodontia. Testing of salivary flow parameters is strongly recommended in individuals with oligodontia as most children with depressed salivary flow rates will not subjectively perceive dryness of the mouth.[38]

10. Salivary gland agenesis (lack of gland formation)

Partial or total agenesis of salivary glands can occur, and the classical presentation of this is the 'non-drooling infant'. Salivary gland agenesis is, fortunately, a rare disorder, and it can appear singly (e.g. from a spontaneous mutation), or in combination with other genetic disorders.[34] As well as causing profound xerostomia, and being linked causally with aggressive caries, recurring candidal infections, and ascending sialadenitis, salivary gland agenesis has also been linked with tonsillitis, laryngitis and pharyngitis, as well as with abnormalities of the tear-producing lacrimal glands.[32,35]

A key management point with children where salivary gland agenesis is suspected is that symptoms may not be reported. In a series of six cases, where the children had been referred for treatment of rampant dental caries, none complained of excessive thirst or difficulty with mastication or swallowing. The presence of carious lesions in the lowest risk site, i.e. lingual surfaces of mandibular incisors, should alert the clinician to the possibility that salivary glands may be absent.[31]

In addition to complete or partial agenesis of major salivary glands, congenital malformation of portions of the salivary ducts may occur, resulting in recurring infections (ascending parotitis). This can manifest from as early as 3 months of age. As in Sjogren's syndrome, dehydration of the oral cavity and loss of salivary antibacterial defenses appear to be major contributing factors.[36]

Home care programs

This should be based on a "common risk factor" approach, addressing dietary factors, lifestyle choices, salivary factors, and plaque factors.[60]

In the child with ongoing salivary dysfunction, lifelong therapy utilizing salivary substitutes, CPP-ACP, fluoride varnish applications, intermittent chlorhexidine therapy, strict adherence to diet, and regular dental reviews are essential to prevent the early loss of both deciduous and permanent teeth and potential difficulties downstream in coping with dentures.

For children who are old enough to expectorate properly, the use of products in gel or mouthrinse forms is appealing, for example GC Tooth Mousse, chlorhexidine gels, and toothpastes. In high risk patients above age 7, daily mouthrinses using 0.05% NaF could be used, or the fluoride delivered using a fluoride dentifrice in combination with GC Tooth Mousse Plus, which contains 900 ppm fluoride. In older children and young adults, high fluoride toothpastes are effective, and compliance is generally excellent since these can substitute for conventional dentifrices.[61]

If mouthrinsing solutions are recommended, care must be taken that in patients of any age with dry mouth, compliance problems will surface if the rinse has irritant or desiccant properties in terms of the oral mucosa. Ethanol containing products must not be recommended to children for long-term use, and all products containing high concentration of detergent components should be avoided as these may reduce the substantivity of some therapeutic agents and will worsen the symptoms of oral dryness.[62]

Early detection of salivary gland hypofunction in children is important for preventing the deleterious oral affects which follow the absence of salivary protection in the oral cavity.[34] It is critical that any materials used to augment or replace saliva have a neutral pH, so that acidic conditions are not sustained in the oral cavity for any length of time. Somewhat surprisingly, most saliva substitutes have not been designed with this parameter in mind. In healthy patients, the mean pH of all sites in the mouth at rest is 6.78, with typical values being 7.34 for the palate, 6.5 for the floor of the mouth, 6.28 for the buccal mucosa, and 6.8 for the tongue.[63] With a neutral pH, contemporary products such as GC Dry Mouth gel provide effective symptomatic relief, whilst preserving oral pH.

Where functional salivary gland tissues remain, stimulation of these using a sugar-free gum is an essential oral health measure. Gums which contain both CPP-ACP and xylitol would be preferred, because of the remineralizing capabilities of the CPP-ACP and the simplicity of this mode of delivery. Xyitol, which is a naturally occurring sweetener, cannot be fermented by cariogenic bacteria, and its incorporation into gums leads to impressive reductions in caries incidence in children, when these are used on a regular basis. Advantageously, xylitol is compatible with and complementary to other home care products and strategies.[64] Prolonged use of xylitol or xylitol containing chewing gum reduces *Streptococcus mutans* counts in plaque and saliva, the acidogenic potential of the plaque, and the adhesiveness of plaque, whilst increasing its mineral content. No adaptive changes in plaque metabolism occur, even after long term, regular use.[65]

Patients must be carefully instructed not to suck citrus-flavoured sweets to stimulate saliva flow. If they wish to use a product, sweets based on xylitol or isomalt should be sought, which are non-cariogenic and have a low glycaemic index. Another alternative are lozenges which include CPP-ACP and other preventive materials. By carefully selecting appropriate products, both dental health and nutritional aspects can be optimized.

Disclosure

The author contributed to the development of the chairside diagnostic kits for saliva and dental plaque produced by GC Corporation, and has a commercial interest in the latter.

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Compromised nonsurgical treatment of a patient with a severe Class III malocclusion

Eric B Lowenhaupt[1]

Abstract: This case report describes the orthodontic diagnosis and treatment of a 13y10m Caucasian female who presented with a severe Class III malocclusion, maxillary arch crowding with a crossbite of the posterior and anterior teeth. Treatment options included orthognathic surgery, extraction of maxillary first premolars, extraction of a lower incisor tooth, non-extraction, and or a combination of the above. For numerous reasons a limited non-extraction treatment was selected.

Introduction

The frequency of Class III malocclusions has been reported to be from 1-4% in the Caucasian population.[1] The etiology of Class III malocclusions may involve heredity factors,[2] environmental influences[3] and even pathology. Additionally, Class III patients typically have more, longer and more unpredictable facial growth.[4] However, irregardless of the etiology all Class III malocclusions are not the same. Class III patients can have varying degrees of dental and skeletal abnormalities. An accurate diagnosis is important in revealing the underlying components of the malocclusion in order to insure that the treatment plan is directed at correcting these various components. Critical areas of concern include the sagittal position of the maxilla and the mandible relative to each other and to cranial base, vertical skeletal and dental components, the positions of anterior teeth and the warping of the dentoalveolus, and the presence or absence of a centric slide (centric relation to centric occlusion). Careful evaluation of these factors can produce a detailed diagnosis which provides the clinician with the best treatment alternatives.

Diagnosis and Etiology

A 13y10m Caucasian female presented for orthodontic evaluation. She had no other siblings and her parents were divorced. There was no history of familial Class III growth. She did not have a general dentist of record and reported only one or two previous dental visits in her lifetime. She had recently seen another orthodontic practitioner who stated that there was nothing he could do for her and that she would require orthognathic surgery when she was older. A second opinion was being sought.

After reviewing the health history (the patient presented with no medical problems, allergies, or prescription drug use) and after completing an initial clinical examination, complete orthodontic records were recommended for the patient and her father accepted this recommendation. Examination of the patient revealed no signs or symptoms of any temporomandibular joint dysfunction. The patient's chief complaint was that she was unhappy with the appearance of her teeth and smile to the point of being introverted and embarrassed.

Evaluation of the orthodontic records revealed the following:

Extraoral analysis (Figure 1) revealed a straight profile with moderate facial asymmetry. The lower facial third appeared to be shorter than the upper facial thirds. Intraoral (Figure 2) and model analysis (Figure 3 & Figure 4) revealed an anterior crossbite of teeth #7-#11 and a left side posterior crossbite. There was a 100% overbite with the patient in maximum occlusion. Teeth #7 and #10 were palatally positioned to teeth #6 and #11 and tooth #10 was rotated at 90 degrees. The lower arch had spacing in the bicuspid area. The right side molar was an Angle Class I in maximum occlusion and the left side was Class III. The patient also had a severe (+5mm) curve of Spee of the lower arch. Centric relation (Figure 5) revealed that the patient was able to get her anterior teeth to an end to end relationship which produced approximately a 10mm bilateral posterior openbite. When the patient went from centric relation to centric occlusion (maximum intercuspation) she demonstrated an anterior slide of approximately 6mm, a lateral slide of approximately 2mm and a vertical slide of approximately 10mm. Gingival tissues were healthy with the exception of a very thin zone

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Figure 1: Pre-treatment facial photographs.

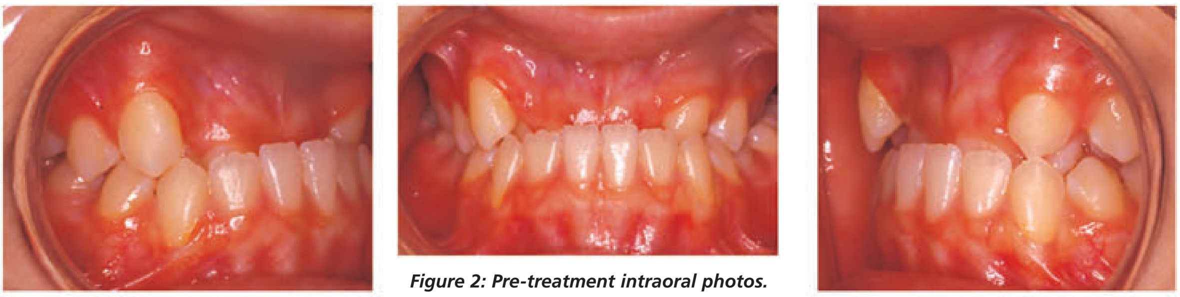

Figure 2: Pre-treatment intraoral photos.

Figure 3: Pre-treatment models trimmed to centric occlusion.

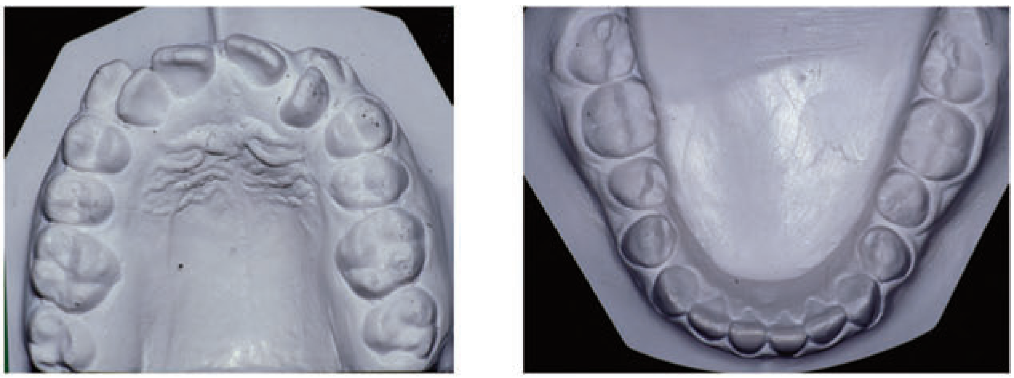

Figure 4: Occlusal photos of pretreatment models.

Figure 5: Pre-treatment centric relation.

of attached tissue on the lower anterior teeth. Oral hygiene was considered adequate. There were no sign of any dental decay or other pathology.

The panorex revealed the presence of all teeth including third molars. Condyles appeared normal, no bone or dental pathology was present and the airways appeared normal. Some mandibular asymmetry was noted.

Due to the magnitude and directions of the patient's centric slide the decision was made to record her lateral head film in both the centric position and centric occlusion position. This would then allow a better analysis of how much the skeletal and dental components contributed to the malocclusion. A modified Ricketts analysis[5] was done on each lateral head film (Figure 6 & Figure 7). The results of this analysis (Table 1) revealed the following: 1) meisocephalic facial type; 2) slight skeletal Class III based on a slightly retrognathic (to cranial base) maxilla (by one mm) and a slightly prognathic mandible (by 2 mm) resulting in a convexity of -1mm; 3) recline

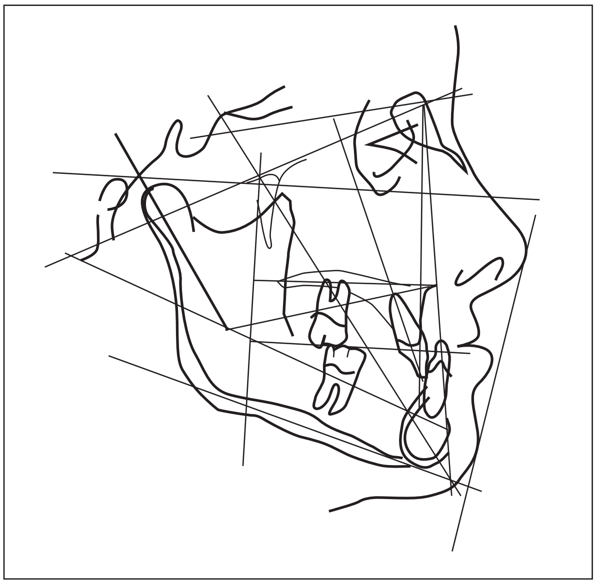

Figure 6: Pre-treatment centric occlusion tracing.

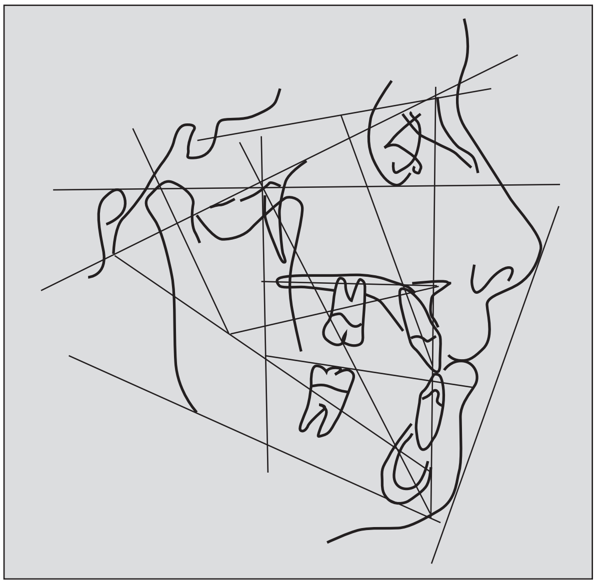

Figure 7: Pre-treatment centric relation tracing.

Table 1 Initial Ricketts analysis

	* Norms for Meso-Facial Caucasian : 9y0m		I	II	
1	Facial Axis	$90^0 \pm 3.5^0$ No △	99	90	Effected by slide
2	Low Facial Ht	$45^0 \pm 4^0$ No △	37	46	Effected by slide
3	Tot Facial Ht	$60^0 \pm 3^0$ No △	48	60	Effected by slide
4	Mand Plane	$26^0 \pm 4.5^0$ △- 1^0 q2y	17	24	Effected by slide
5	Mand Form (Arc)	$26^0 \pm 4^0$ △+ 1^0 q2y	35	34	
	Vertical Indicators				
6	Palatal Plane	$+1^0 \pm 3.5^0$ No △	+1	0	
7	F. Occ. Plane	$-11^0 \pm 2^0$ △+ 3^0 total	+1	-7	Effected by slide & vertical closure
8	Mand Arc	$26^0 \pm 4^0$ △+ 1^0 q2y	35	34	
9	Mand Plane	$26^0 \pm 4.5^0$ △- 1^0 q3y	17	24	
10	Post. Facial. Ht	55mm ± 3mm △+ 1.8q1y	65	67	
	Class II & III Skeletal Factors				
11	Convexity	2mm ± 2 - 1mm q3y	-6	0	Effected by slide
12	Mand Arc	$26^0 \pm 4^0$ △+ 1^0 q2y	35	34	
13	Ramus position	$76^0 \pm 3^0$ No △	82	76	Effected by slide
14	Cranial Deflec	$27^0 \pm 3^0$ No △	26.5	26.5	
15	Cranial Length	55mm ± 2.5 + 0.8qy	55	56	
16	Corpus length	65mm ± 2.7/△+ 1.6 qy	73	72.5	
17	Porion Location	-39mm ± 2.2mm	-42	-42	
18	Facial Depth	$86.5^0 \pm 3^0$ △+ 1^0 q3y	96	89	Effected by slide
19	Max Depth	$90^0 \pm 3^0$ No △	89	89	
	Dental Factors				
20	1 to A Perp	5mm ± 2mm	+2.5	+2.5	
21	FMIA	$65^0 \pm 3.5^0$	83	76	
22	IMPA	$90^0 \pm 4.5^0$	80	80	
23	1 to A Pog	1mm ± 2mm	+5.5	+1	Effected by slide
24	6 to 6 width	34mm ± 3.0mm	34	34	
	Soft Tissue Factor				
25	Lower lip to 'E'Plane	-2mm ± 2 △- 1^0 q5y	-2	-6	

* All measures must be adjusted for age, race and facial type
I Initial centric occlusion
II Initial centric relation

lower anterior teeth; 4) severely reclined upper anterior teeth; 5) skeletal facial height in centric relationship was normal (i.e. the patient was not hyper- or hypo-divergent). Overall, the analysis revealed that the patient did not exhibit any severe Class III skeletal discrepancies and appeared to have more of a dental problem.

Treatment Objectives

The main treatment objective for this patient was to align her severely malposed upper anterior teeth and correct her occlusion (primarily her anterior crossbite). Since her skeletal problem appeared to be minimal a dental correction of her malocclusion was considered the primary goal. Esthetics, function and stability were all goals in establishing as ideal an occlusion as possible. Establishing an esthetic smile to improve overall facial esthetics and improve the patient's attitude was also a primary concern.

Treatment Plan and Alternatives

Since the patient did not have a significant skeletal discrepancy (based on the diagnostic records) the initial plan was to attempt to improve her severe dental malocclusion by utilizing fixed orthodontic appliances in a non-extraction approach. If orthognathic surgery was going to be needed at sometime in the future the dental arches would have to be aligned and the non-extraction approach was deemed the most conservative starting approach. Whether the alignment of the upper anterior teeth could be accomplished without extractions and whether the alignment of these teeth would eliminate the anterior crossbite was uncertain. Other options considered were: 1) possible extraction of a lower incisor to provide space to further retract the lower anterior dental arch and establish overjet; 2) maxillary expansion to correct the posterior crossbite and possibly aid in gaining upper arch length for alignment of the malposed teeth; 3) a combination of dental alignment of the upper and lower arches and evaluation for orthognathic surgery once facial growth was completed.

Treatment Progress

Both the patient and parent (father) had very little experience with any dental procedures. Additionally, the family's finances prevented any consideration of orthognathic

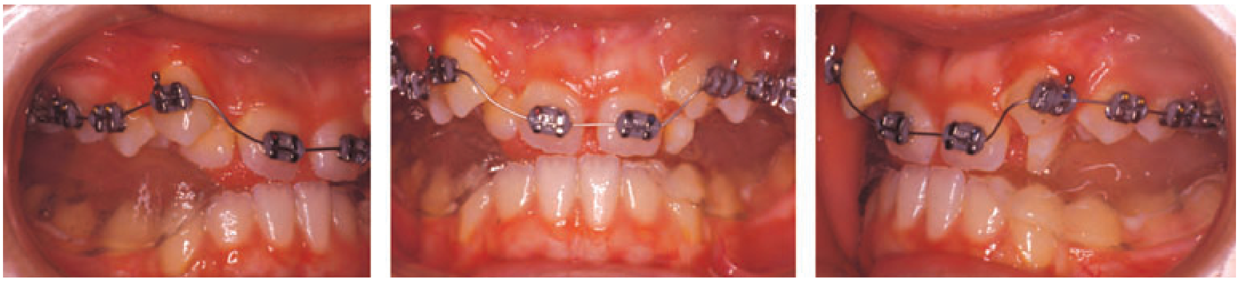

Figure 8: Initial wire with posterior acrylic bite block.

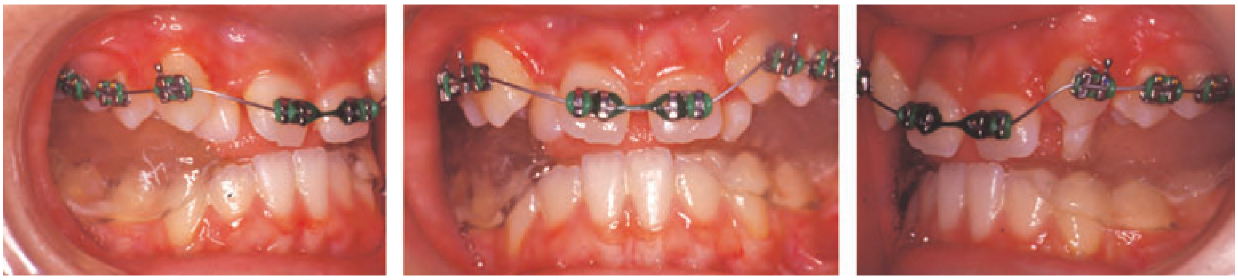

Figure 9: 8 weeks of treatment.

Figure 10: 8 weeks treatment without posterior bite block (patient is now end to end).

surgery and they could only afford the minimum of any dental or orthodontic treatment. For these reasons the simplest and most conservative treatment would begin with the attempt to align the upper anterior teeth.

Treatment was begun with the placement of upper .018 edgewise brackets and bands (Victory series MBT prescription 3M Unitek, Monrovia, California) on the upper arch (skipping over the severely malposed lateral incisors). The real problem was how to address the patient's severe anterior and vertical slides which would produce massive

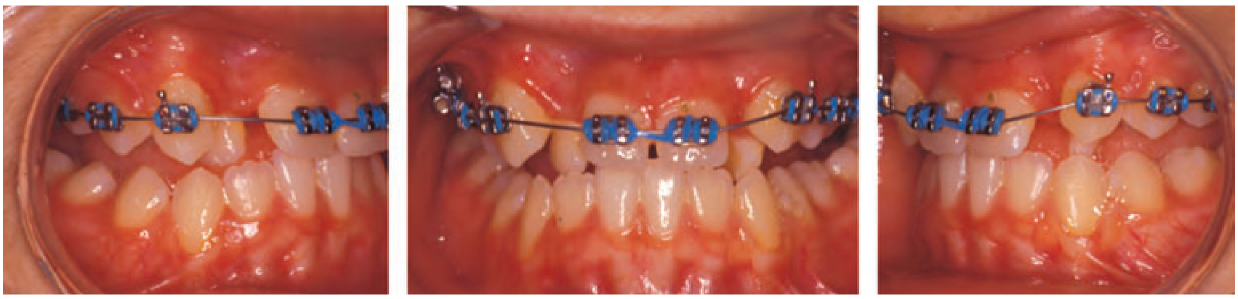

Figure 11: 16 weeks treatment.

Figure 12: 12 months treatment time.

Figure 13: 14 months treatment time.

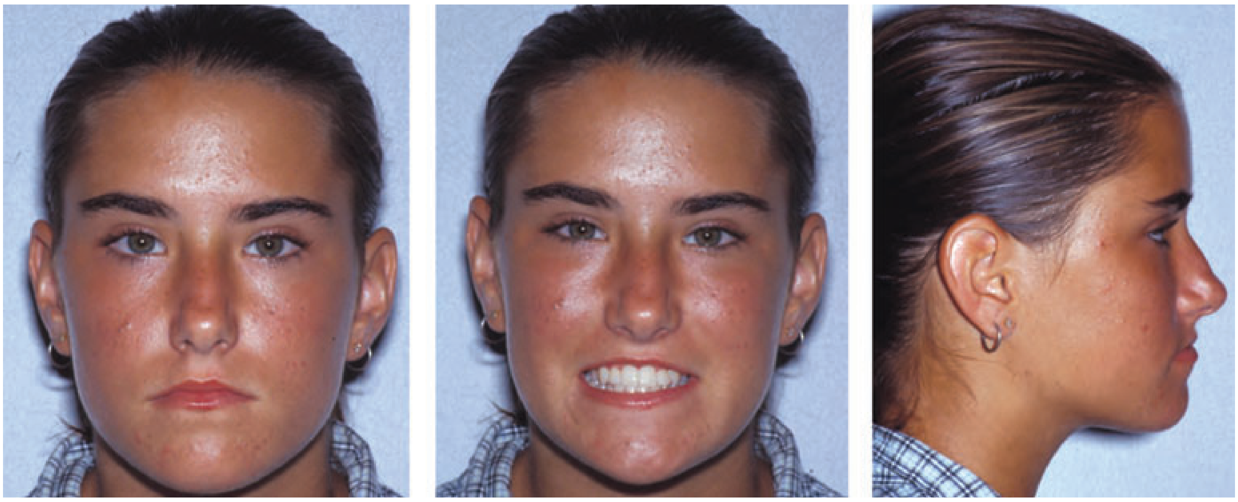

Figure 14: Finish facial photographs.

Figure 15: Finish intraoral photographs.

interferences with the brackets and make jumping the anterior bite impossible. Several options were considered but the best solution was the use of a removable posterior bite block. This bite block was made intaorally with the use of a plastic base arch (3mm thick hard plastic formed on a vacuum machine in the lab) to which cold cure acrylic was added. This appliance was then placed in the mouth to establish the proper vertical height then the appliance was cured in a pressure pot and trimmed and polished (Figure 8). Care was taken to avoid covering the lower anterior teeth so the upper anterior teeth would have room to advance without interference. This appliance would have to be worn full time including eating (remove to brush). The initial wire that was placed was a flexible .016 CuNiti wire. The patient was seen eight weeks later (Figure 9) and at that time elastic chain was placed between the upper central incisors. The occlusion was also checked without the bite block in place (Figure 10) and slight overjet was noted. The posterior bite block was reduced to reflect this new vertical position. The archwire remained the same. At 16 weeks (Figure 11) more overjet had been established, space was opening for the maxillary lateral incisors and the bite block was once again adjusted for the new vertical position. The arch wire remained the same. At 18 weeks the maxillary lateral incisors were bonded and a series of sectional wires and elastomeric chains were utilized to position these teeth and bring them out of cross bite. These brackets were also placed on the teeth upside down to reverse the torque of

Table 2 Finish Ricketts analysis

	* Norms for Meso-Facial Caucasian : 9y0m		
	Facial Type Indicators		
1	Facial Axis	$90^0 \pm 3.5^0$ No △	92
2	Low Facial Ht	$45^0 \pm 4^0$ No △	44
3	Tot Facial Ht	$60^0 \pm 3^0$ No △	57
4	Mand Plane	$26^0 \pm 4.5^0$ △- 1^0 q3y	20
5	Mand Form (Arc)	$26^0 \pm 4^0$ △+ 1^0 q2y	35
	Vertical Indicators		
6	Palatal Plane	$+1^0 \pm 3.5^0$ No △	0
7	F. Occ. Plane	$-11^0 \pm 2^0$ △+ 3^0 total	-8
8	Mand Arc	$26^0 \pm 4^0$ △+ 1^0 q2y	35
9	Mand Plane	$26^0 \pm 4.5^0$ △- 1^0 q3y	20
10	Post. Facial. Ht	55mm ± 3mm △+ 1.8q1y	67
	Class II & III Skeletal Factors		
11	Convexity	2mm ± 2 - 1mm q3y	-2.5
12	Mand Arc	$26^0 \pm 4^0$ △+ 1^0 q2y	35
13	Ramus position	$76^0 \pm 3^0$ No △	79
14	Cranial Deflec	$27^0 \pm 3^0$ No △	27
15	Cranial Length	55mm ± 2.5 + 0.8qy	57
16	Corpus length	65mm ± 2.7/△+ 1.6 qy	74
17	Porion Location	-39mm ± 2.2mm	-41
18	Facial Depth	$86.5^0 \pm 3^0$ △+ 1^0 q3y	93
19	Max Depth	$90^0 \pm 3^0$ No △	90.5
	Dental Factors		
20	1 to A Perp	5mm ± 2mm	+7
21	FMIA	$65^0 \pm 3.5^0$	81
22	IMPA	$90^0 \pm 4.5^0$	79
23	1 to A Pog	1mm ± 2mm	+2
24	6 to 6 width	34mm ± 3.0mm	34
	Soft Tissue Factor		
25	Lower lip to 'E'Plane	-2mm ± 2 △- 1^0 q5y	-4
	* All measures must be adjusted for age, race and facial type		

the brackets to aid in obtaining better root torque (facial root torque). At 12 months of treatment all anterior teeth were out of cross bite and the patient discontinued her bite splint at that time (Figure 12). The patient and parent decided that they were very happy with the results obtained to date but due to financial constraints were unable proceed any further with treatment. Some second order and torquing bends were placed in the wire (Figure 13) and the decision was made to discontinue treatment. After 17 months of treatment the patient was debanded (Figure 14 and Figure 15) and an upper circumferential Hawley was delivered for night time wear. At no time during or after the treatment did the patient complain of any TMJ problems.

Treatment Results

At the time treatment was discontinued the following had been accomplished: 1) the severe upper dental malalignment had been corrected: 2) the anterior and posterior cross bite had been corrected: 3) positive overbite and overjet had been created: 4) a stable posterior occlusion with minimum centric slide was established: 5) an esthetic smile was established. The soft tissue facial profile remained straight. The lateral head film (Figure 16 and Table 2) at the end of treatment demonstrated that (as suspected) most of the correction was the result of tooth movement and the dentoalveolar change of the upper anterior teeth. Superimposition of the maxilla shows that the angulations of the upper incisors were increased. Facial convexity (-2.5mm) continued to indicate a slightly Class III skeletal relationship. The skeletal changes seen would be consistent with what would be expected from facial growth. The correction of the posterior crossbite was the result of eliminating the patient's anterior dental slide. No expansion appliances were utilized in this case. The resultant dental correction would then result in a camouflage of this slight skeletal discrepancy. Clinical examination did not reveal and the patient denied any signs or symptoms of TM joint dysfunction.

Discussion

Treating Class III malocclusions requires an accurate diagnosis in order to isolate the various components of the malocclusion. Patient age, a familial history of Class III skeletal growth, and the skeletal and dental components of the malocclusion all play a role in determining the proper treatment direction. For non-growing patients or for patients approaching the end of their skeletal growth options for treatment narrow to various extraction scenarios, orthognathic surgery, or some type of dental camouflage procedure. Additionally, patient's and parent's concerns regarding the type and amount of treatment must be addressed.

Most practitioners agree that the most efficient timing for Class III skeletal problems is in the early mixed dentition.[4] Unfortunately, this is not always the time that the patient presents themselves. Patients who present

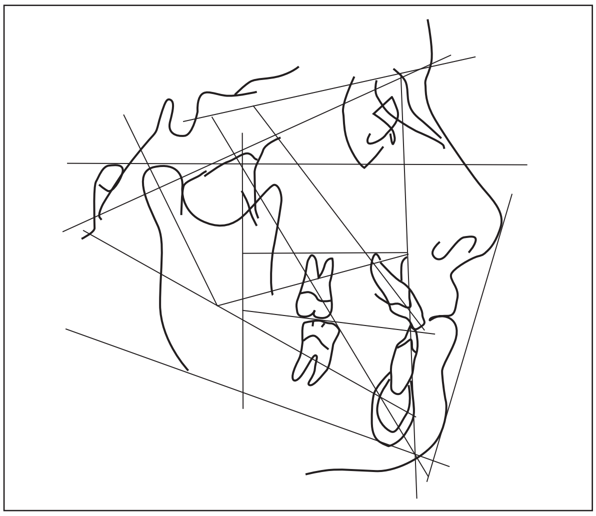

Figure 16: Finish lateral headfilm tracing.

with Class III malocclusions with anterior crossbites can benefit from the correction of the anterior crossbite and establishment of overbite and overjet.

The treatment for this patient represents a compromise. Obviously, ideal results were not obtained. The upper lateral incisors do not have ideal facial root torque and the curve of Spee was not addressed. Additionally, despite the fact that the lower arch was not treated, the lower cuspids and incisors continue to show a very minimal (thin) zone of attached gingiva. Though this tissue level has remained fairly stable throughout treatment the need for future mucogingival periodontal treatment (including the possibility of grafts) exists.

This patient's orthodontic treatment was completed as she approached her sixteenth birthday. Though the exact age that facial growth is completed for females and the relationship between facial growth and skeletal growth is not well established, what is known is that Class III skeletal growers tend to grow longer and more unpredictably than Class I growers.[4] Whether this patient will undergo a latent period of mandibular development is not known. However, the fact that there does not appear to be any familial history of Class III skeletal growth and the establishment of a more normal overbite and overjet relationship may help to inhibit further Class III skeletal changes and maintain her correction. Future treatment could involve orthognathic surgical procedures and the patient and parents would be informed of these possibilities.

The long term health and function of the TM joint is always a consideration for patients. This patient did not report any TM joint dysfunction before, during or after treatment. Egermark[6] reported that no single occlusal factor (malocclusion) is associated with a higher incidence of TM disorders. However, no patient is immune from developing TM disorders, especially (as often reported) in female patients who seem to have a higher incidence than male patients. As always patients and parents need to be aware of the potential for the development of future TM joint dysfunction and appropriate treatment for such problems may be indicated.

Overall, this was a compromise treatment with a reasonable final result. The occlusion is functional and stable and the patient's chief complaint was met in establishing a pleasing and esthetic smile. The patient's self image was greatly improved.

Conclusions

In all the 'noise' of today's orthodontic marketing the practitioner is bombarded with many different claims of appliance efficiency and effectiveness. Often these claims come accompanied by glowing clinical reports or research findings that have been vetted by the supposed experts who as it turns out are often sponsored by the same company whose products they are touting. The bottom line is that orthodontics is still about change and all orthodontic treatment involves causing a change. While many advances in technology have eased the burden of orthodontic treatment on both the practitioner and the patient it is still the process of utilizing accurate diagnosis and treatment planning based on this diagnosis that allow the orthodontic practitioner to navigate through the complex cases. Relying on a 'magic' appliance system is not necessary if the basic principals of diagnosis and biomechanics are followed. This would then explain why so many different 'systems' seem to work well and it relieves the practitioner of the worry that his or her particular 'orthodontic system' does not perform as well as some other newly marketed appliance system. The use of high quality orthodontic appliances and materials is important, however, orthodontic treatment and systems can and should be individually tailored for each patient.

The purpose of this case is to demonstrate the diagnostic criteria used to diagnose and treatment plan what (at least initially) appears to be a very serious and debilitative Class III malocclusion. With the proper diagnosis a systematic treatment plan can be formulated which then makes the actual appliance used to accomplish the treatment goals a secondary consideration. In the 'real world' ideal is not always possible. In this case the limited treatment provided produced a result that was satisfying to the patient, parent and practitioner.

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When esthetics matter

Stefen Koubi,[1] Hilal Kuday[2]

One of the major issues leading to unsatisfactory results when fabricating several ceramic restorations in the anterior region is the integration in terms of shade. The situation found in patients is often a combination of discoloured prepared teeth, metal constructions and teeth showing no discolouration. Achieving a harmonious overall appearance in such situations is a challenge.

Nowadays, the use of glass-ceramic materials, such as the IPS e.max® Press lithium disilicate (LS2) material, is the textbook approach in terms of the esthetic integration, for two good reasons:

- These materials offer the possibility of creating unique translucent restorations which mimic the dental enamel.
- The wide array of cementation possibilities facilitates the creation of lifelike results.

In the past, severe discolouration was often a reason why glass-ceramics could not be used to fabricate restorations. The constant improvement of the materials, however, has led to the development of a comprehensive system: IPS e.max. This system offers the advantages of press ceramics – such as accuracy of fit and esthetics – while eliminating the drawbacks that existed previously – i .e. restricted use on dark preparations.

Figure 1: Initial situation.

Figure 2: Clinical view of the initial restorations.

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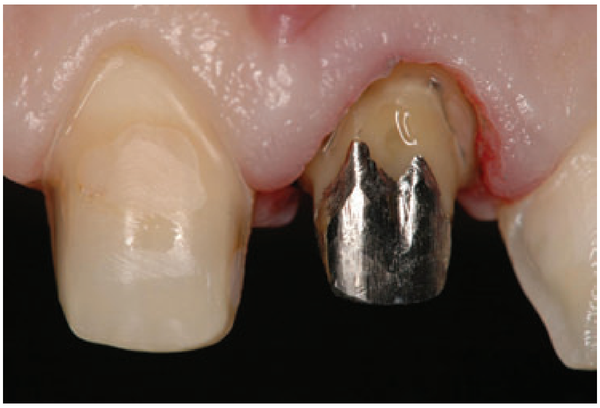

Figure 3: Different preparations depending on the type of underlying structure.

Figure 4: Preparations.

Figure 5: Variable opacity according to the selected ingots.

Figure 6: Translucent and opaque frameworks after pressing.

Figure 7: IPS e.max Press HO (high opacity).

Figure 8: IPS e.max Press HT (high translucency).

The fact that we have glass-ceramic materials in various levels of opacity and translucency at our disposal thus opens up a whole range of new possibilities. We can now cover the entire spectrum of single-tooth and small bridge restorations with glass-ceramics – regardless of the underlying tooth structure.

Discoloured teeth or metal structures are also no longer a reason for avoiding lithium disilicate glass ceramics.

Case study

The use of frameworks and restorations in different levels of translucency is presented here on the basis of a multi-disciplinary case study. The objective in this case was to recreate the esthetics of the patient's anterior teeth on a

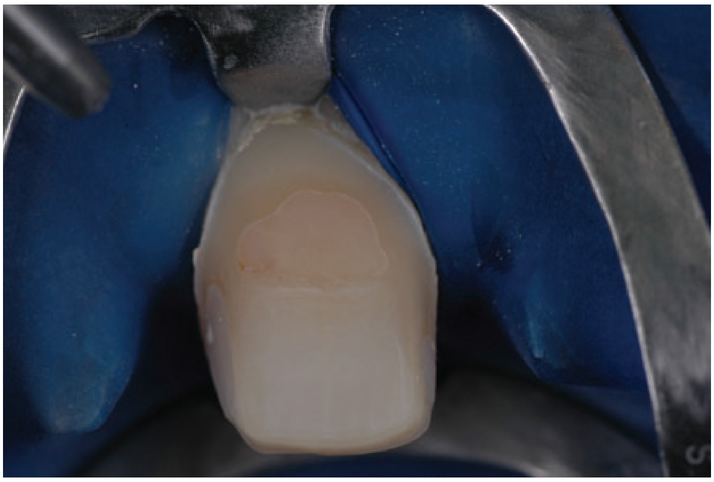

Figure 9: Tooth isolation with a rubber dam.

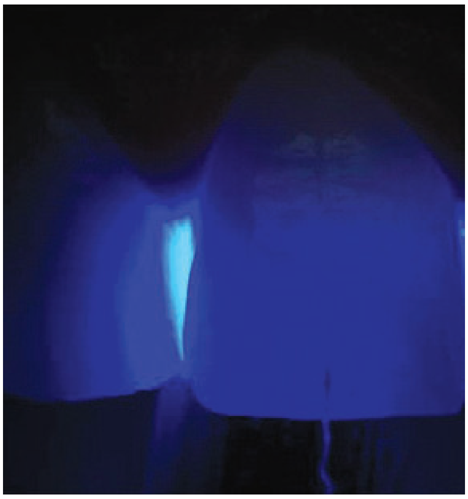

Figure 10: Even light scattering in the translucent frameworks.

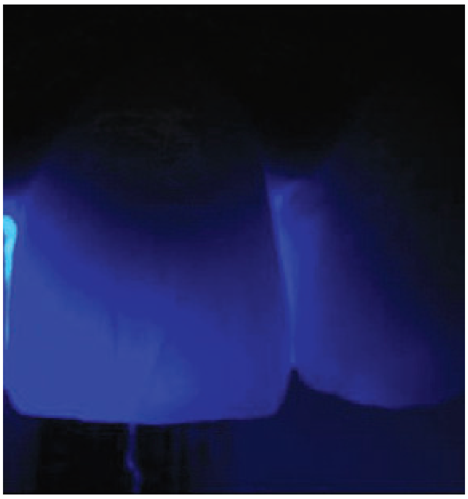

Figure 11: IPS e.max HO framework with metal substructure.

natural tooth and a metal core build-up.

The patient expressed the wish to improve the appearance of his anterior teeth. The initial examination revealed that the periodontal tissue was inflamed and in generally poor condition (Figures 1 and 2).

After the initial treatment, the condition of the periodontal tissue had improved enough to allow the restorative rocedure to be conducted with adhesive cementation.

An analysis of the situation presented by the patient from an esthetic point of view revealed that older ceramic restorations and numerous composite root canal posts were responsible for creating an inharmonious appearance.

An esthetic concept which was based on the existing tooth shapes was drawn up to help preserve the individual characteristics of the patient. Subsequently, the necessary preparations were carried out (Figures 3 and 4). IPS e.max Press ceramic restorations (veneers and crowns) were fabricated for the entire upper jaw (Figures 5 to 8).

The IPS e.max Press frameworks were layered with one layering ceramic (IPS e.max® Ceram) regardless of their translucency level. The result was thus a balanced look.

The restoration design was dictated by the underlying tooth structure. For crowns which were placed on metal substrates, press ingots with a higher opacity (HO = high opacity) were used. In addition, the thickness of the restorations was increased in order to mask the metal colour and achieve lifelike layering.

Figure 12: Visualization of the surface structure with gold powder.

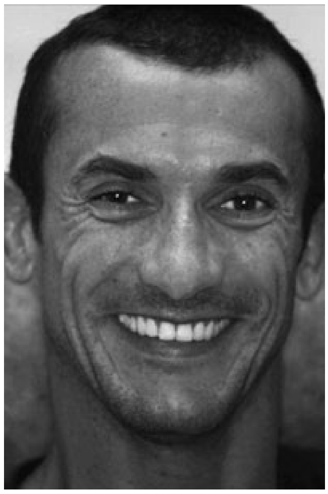

Figure 13: A happy patient.

Figure 14: View from the side: excellent shade match.

Figure 15: Final result.

The veneers were considerably smaller and LT (low translucency) ingots with a translucency higher than that of MO or HO ingots were used. A thickness of approx. 0.5 mm was sufficient in order to allow the dentin shade to shine through the translucent framework and thus create the desired chameleon effect.

Clear communication between the dental practice and the laboratory is indispensable to ensure that both the clinician and the laboratory have the same information about the preparations in the situation at hand.

The view of the pressed opaque and translucent frameworks illustrates the versatility of the IPS e.max system (Figures 7 and 8).

The optical properties are harmonized by layering IPS e.max Ceram onto the pressed frameworks (Figures 10 and 11).

Particular attention was paid to the surface treatment and the design of a macro- and micro-pattern in order to achieve natural-looking light effects (Figure 12). After try-in and adjustment, the restorations were cemented with Variolink (transparent) while using a rubber dam, in order to ensure that every restoration was isolated (Figure 9). By using a versatile ceramic and cementation system and by imitating the light effects, lifelike restorations were fabricated in spite of the suboptimum initial situation (Figures 13 to 15).

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Case Report on the use of a bone level implant to replace a congenitally absent lateral incisor

Johann Lochner,[1] Andy Effting[2]

Introduction

Hypodontia is a very common pleomorphism in man and is associated with congenitally missing teeth. The term Anodontia is used where all teeth are absent.[1, 2, 3] The aetiology could be hereditary, but sometimes no familial history can be identified. Systemic conditions such as Down's syndrome and Ectodermal Dysplasia also show a higher incidence of hypodontia. Developmental conditions like cleft lip or palate could also result in hypodontia due to the lack of alveolar development.[3] The prevalence of hypodontia is between 3.5 – 6.5 % in a normal population with a Male:Female ratio of 2:3.[3] Except for missing third molars the most common congenitally absent teeth are maxillary second premolars followed by maxillary lateral incisors and thereafter mandibular second premolars.[4]

Missing lateral incisors as well as peg shaped lateral incisors present the clinician with unique and very challenging aesthetic demands. It is helpful to determine from an early stage which final treatment modality would be utilised. Treatment options include space closure, re-establishment of the space or no treatment at all. These cases are best identified and managed at an early age and usually require a multi-disciplinary approach. If implants are utilised it is important to choose an implant system that is versatile so that any restorative requirement can be addressed. In young patients it becomes important to choose a strong implant design and a system that offers a cone connection and horizontal offset.[2] With modern treatment modalities a very satisfactory outcome can now be achieved.

The patient and parents should be counseled about the complexities of this unfortunate anomaly as soon as it is identified. All the available long-term treatment options need to be discussed as well as the considerable cost implications of each.

Most patients are diagnosed with hypodontia between the ages of 6 – 12 years. The general dentist is well positioned to manage the case and to make necessary referrals at the appropriate stages of

Figure 1: Panoramic radiograph at the age of 12 years.
Figure 2: Periapical radiograph showing the 23 in the position of the congenitally absent 22.

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Figure 3: Clinical appearance at the age of 16 years. Note the midline shift and crowding.

Figure 4: Peg shaped 12.

Figure 5: The 23 has erupted into the 22 position and the 63 is retained.

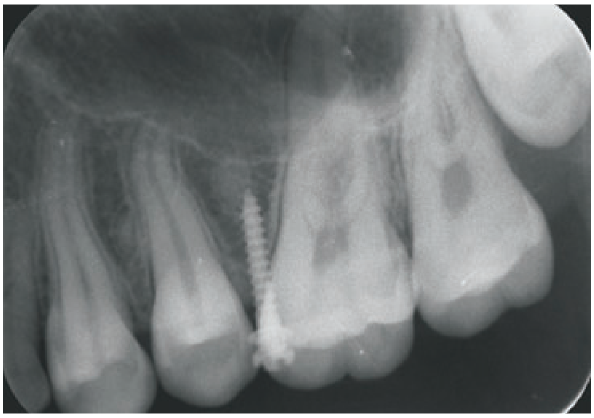


Figure 6: Micro screw inserted for anchorage.

development. Regular consultation visits are thus highly recommended and routine maintenance and restoration of the dentition is important as part of the overall management of the patients.[5]

Case Presentation

An 18 year old male with a congenitally missing lateral incisor (22) with retained deciduous predecessor (62) and a peg shaped lateral incisor (12). (Figures 1, 2)

The patient was diagnosed 8 years earlier and followed up annually during subsequent years for monitoring of development as well as prophylactic measures to maintain and improve his oral hygiene. At the age of 16 he was referred to the orthodontist.

The patient exhibited a class I malocclusion with a class III skeletal pattern, an anterior open bite tendency, a slight midline shift and crowding of both dental arches. The 22 is congenitally absent with tooth 23 in the 22 position and the 12 is a peg-shaped lateral incisor. (Figures 3, 4, 5)

It was decided to utilise fixed appliances to correct the malocclusion. This included distalising the 23 to create space for an implant to replace the missing 22. A compromise treatment plan using the canine as a lateral incisor would have resulted in a poor aesthetic outcome as the canine is usually of a darker chroma, has a bulbous shape, the gingival margin being more apical leading to asymmetry and to the loss of canine guidance.[1] The 12 would be retained and the shape corrected with a full coverage veneer.

Preliminary Treatment

Tooth 63 was extracted and a Jeil® micro bone screw 14mm length (Jeil Medical Corporation) was inserted interproximal of teeth 25/26 to provide the anchorage for distalising the 23. (Figure 6)

Sufficient space had been created for implant placement

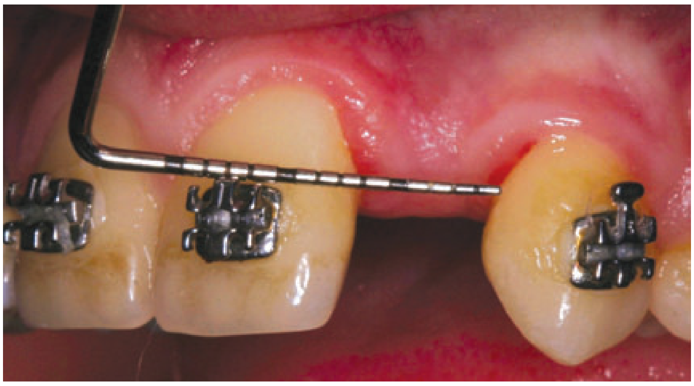


Figure 7: Pre-operative view showing 6mm interdental space.
Figure 8: Pre-operative Radiograph. Note the Radiolucent appearance where the implant is likely to be placed.

in the 22 position.[4] The buccal-palatal bone width was adequate but for the absence of a normal root prominence. It was decided to place a Straumann® 3.3 narrow connection bone level implant of 12mm length with simultaneous labial contour augmentation. Adolescents should have completed growth before implants are placed, particularly in areas of cosmetic concern.[6]

Surgical treatment

Prophylactic antibiotics were given one hour before surgery. The patient rinsed with Corsodyl® for one minute pre-operatively. The surgical phase was performed under local anaesthetic in the dental operatory after the dentist removed the arch wire to facilitate access. (Figure 7, 8)

Radiographically it is apparent that there is a more radiolucent appearance at the site where the implant is planned, due to poor bone structure. The interdental bone forms a straight line between the 21 and 23 due to the absence of a tooth. The clinical picture demonstrates a lack of root prominence and a lack of normal gingival contour. The space between the 21 and 23 measured 6mm.

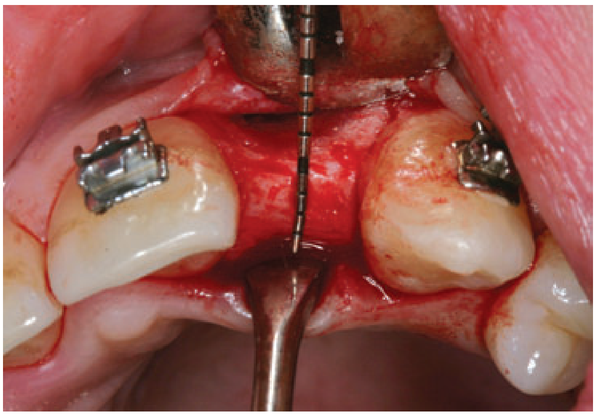


Figure 9: The bucco-palatal dimension is 4 mm. Please note the buccal dip.

A palatal line angle incision was made in the event that poor primary stability would be obtained and primary closure necessitated. In addition, this type of incision makes it possible to improve soft tissue contour by moving the tissue to a more favorable position. The use of punching techniques is strongly discouraged, because it removes keratinised gingiva, which could otherwise have enhanced the site. The palatal extent of the incision mimics the shape and position where the palatal part of the healing abutment is likely to fit. This design also creates the possibility to provide a thicker labial tissue by using a roll flap. The full thickness flap was carefully elevated with minimal pressure onto the bone surrounding the teeth without relieving incisions. Relieving incisions are avoided as far as possible as they always cause some scarring, more postoperative pain, bruising and swelling. If a perforation occurs during the osteotomy preparation, or if bone grafting is required, relieving incisions and flap mobilisation would be needed to gain proper access and to achieve tension free closure. (Figure 9)

The 3-dimensional position of any implant is crucial for long-term aesthetic stability. A slight buccal dip was evident and the bucco-palatal dimension was only 4mm. The plan was to place a definitive cement retained crown, therefore the angulation of the implant was planned through the imaginary incisal plane of the missing tooth. The mesio-distal position was planned in the middle of the edentulous

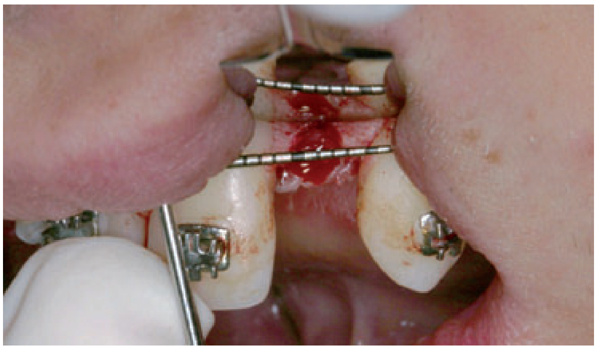


Figure 10: The probe is aligned with the CEJ of the adjacent teeth and ostectomy was done to 2 mm below this line.

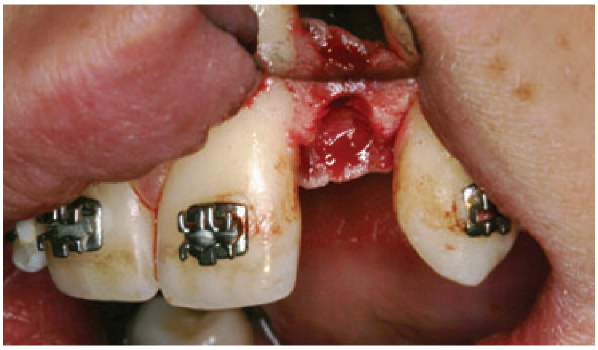


Figure 11: The morphology after the ostectomy mimics that of an area where a tooth is present.

space. The vertical position of an implant is crucial. With bone level implants the vertical position could be sub-crestal. It was planned to place the implant 2mm below the CEJ of the adjacent teeth, 1mm sub-crestal.

A 3.1mm diameter round burr was used to do an ostectomy in the implant position. This was to establish a bony contour, similar to that around a tooth, to a level of the CEJ of the adjacent teeth. Three millimeters of bone was removed. By removing this excessive bone a crown of the correct length and shape was possible. When bone is removed in such a manner the width of the crest becomes wider and the ridge width, initially 4 mm was now 5,5mm. (Figure 10, 11)

A small diameter (2.3mm) round bur was used to create a purchase point. Whilst working in close proximity to adjacent tooth roots it is preferable to use osteotomy preparation techniques that do not damage the adjacent roots. A sharp osteotome was pushed into the alveolus in the correct 3-dimensional orientation and a favourable position verified radiographically. A 2mm twist drill was used to prepare the osteotomy to the desired length to allow for a 12 mm implant 1mm subcrestal. Thereafter the 2.8mm twist drill was used to prepare the final osteotomy. The verification radiograph confirmed the correct position. (Figures 12, 13, 14)

There were no palpable perforations, as such there was no need to expose the buccal bone further and relieving incisions were not required. The final profile drill for the 3.3mm bone level implant was used in the crestal part only and because the bone was of a poor quality bone tapping was not done. A Straumann® bone level 3.3mm narrow connection (NC) implant 12 mm long was placed 1mm sub-crestal. Primary stability was adequate and a NC conical D3.6/H 5mm healing abutment was inserted. It is important to verify the final position of an implant so that comparisons can be made in the future. (Figure 15, 16, 17)

Small granule (0,25-1mm) Bio-Oss® was mixed with a

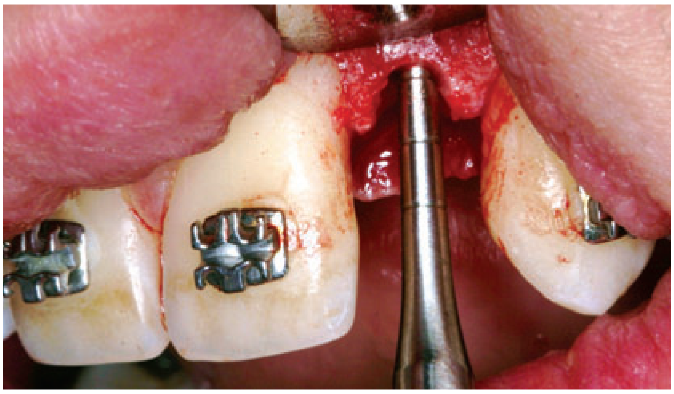
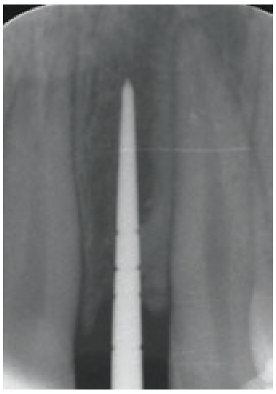


Figure 12: Osteotome in the correct 3-Dimensional orientation.



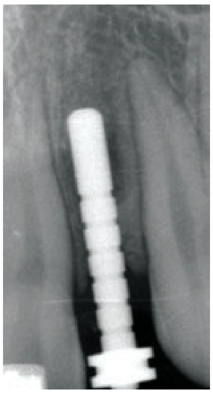


Figure 13: Radiographic verification of osteotome position.
Figure 14: Final position verification with the 2.8mm direction indicator.

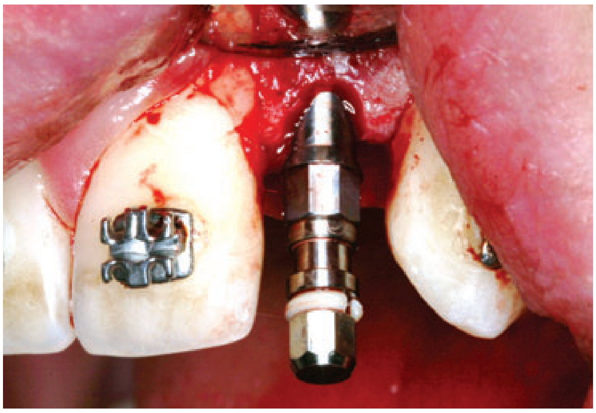


Figure 15: Final implant position before the placement mount is removed.

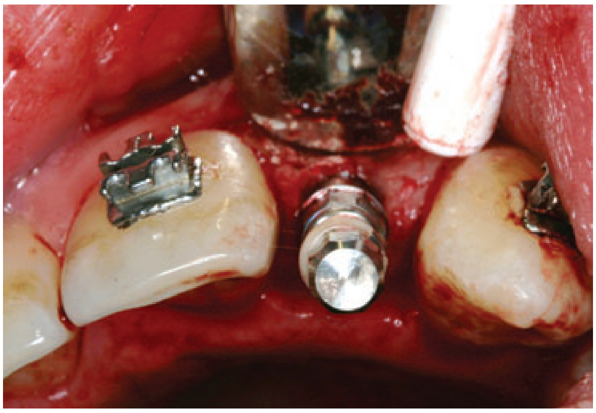


Figure 16: Note the correct 3-dimensional position with the angulation of placement through the incisal plane for provision of a cement retained final crown.

little blood and pushed into a pouch prepared buccal of the implant to create a root prominence. Bio-Oss® was only applied over the bone, apical to the healing abutment. The implant was contained completely within a bony envelope and the Bio-Oss® material was not used as a bone graft, but purely as a contour augmentation to create a root prominence. The Bio-Oss® will become encapsulated in soft tissue. Due to the extremely slow resorption rate of the Bio-Oss® it would help to stabilise soft tissue on the buccal aspect. (Figure 18)

The excess tissue elevated was shaped by removing a half moon piece of epithelium and connective tissue to facilitate better adaptation around the healing abutment and rolled in buccally of the healing abutment. Visyn® 6-0 sutures were used to the mesial and distal aspect of the healing abutment to approximate the soft tissue. (Figure 19, 20)

The arch wire was replaced immediately after surgery and the sutures removed one week later. Healing was uneventful with minimal post-operative pain. (Figure 21)

The fixed orthodontic appliance was removed shortly afterwards and a Hawley retainer incorporating a prosthetic 22 was fitted.

Restorative Treatment

Six weeks after surgery the patient returned for the restorative phase of treatment. The healing abutment on the implant was then modified to create a better emergence profile. This was achieved with air abrasion of the healing abutment, application of metal primer, bonding agent and flowable composite. The desired effect was

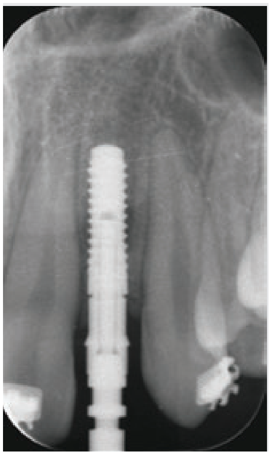


Figure 17: Final implant position.

Figure 18: Bio-Oss mixed with a little blood.

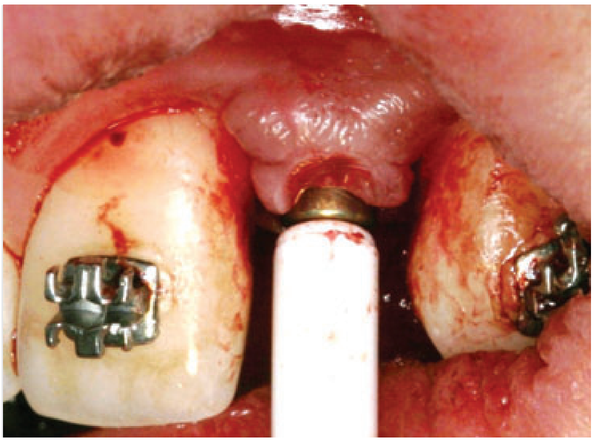


Figure 19: Removal of a half moon of epithelium to facilitate better adaptation of the roll flap around the healing abutment.

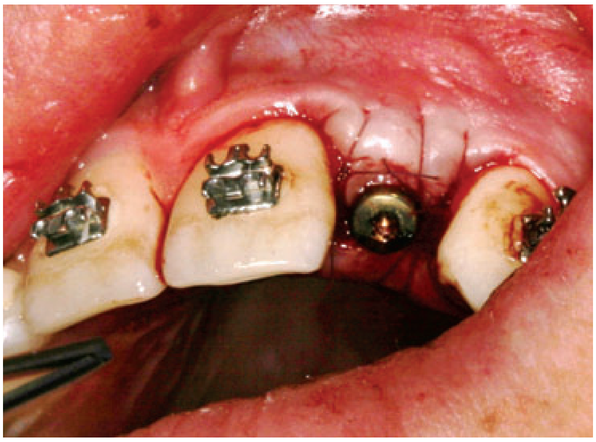


Figure 20: Immediately post surgery after suturing of the roll flap. Note the excess buccal tissue created by utilising the bone filler and roll flap.

achieved in that the soft tissue moved in a bucco-apical direction creating a more labial emergence profile. A harmonious gingival contour with the adjacent teeth was established. (Figure 22)

It was suggested from the outset that a crown lengthening procedure on the peg shaped lateral would create a longer crown length and a more symmetrical gingival contour in relation to the contra-lateral incisor. The patient decided to keep treatment simple and avoid further surgery and cost.

An open tray NC impression coping was connected to the implant and verified radiographically. The 12 was minimally prepared for a full coverage veneer. A polyether impression compound was used to take the final impression, taking great care to record the soft tissue emergence profile.

A customised final abutment was cast accordingly and torqued to 35 Ncm. The porcelain fused to metal crown was cemented with Tempbond®. The Emax® full coverage veneer was luted with transparent Rely-X® veneer cement, and the upper Hawley retainer adjusted to fit. (Figures 23, 24, 25)

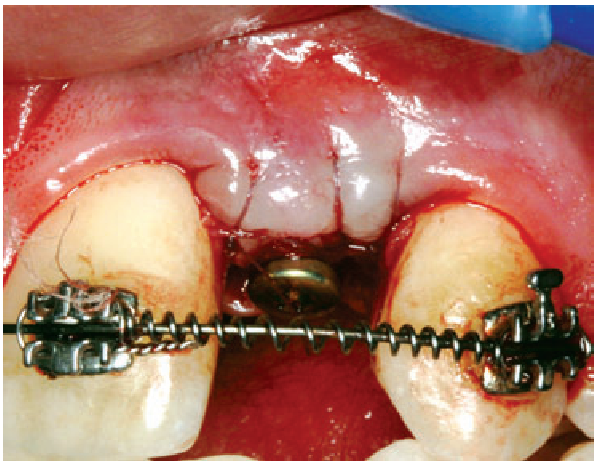


Figure 21: Replacement of the arch wire to prevent tooth movement during the integration period.

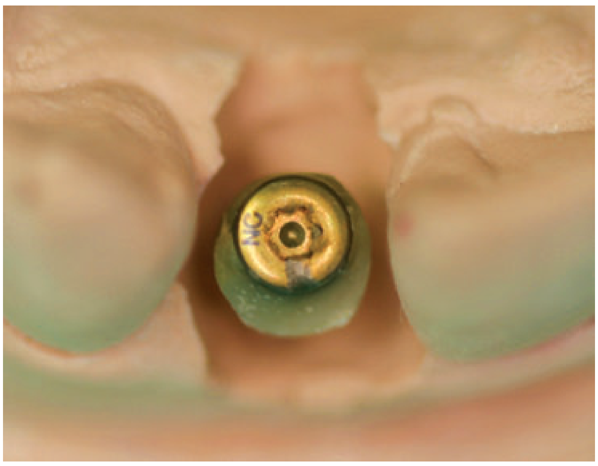


Figure 22: Modified NC healing abutment to create the correct emergence profile.

Figure 23: Frontal view on the day of cementation.

Figure 24: Final. Note the beautiful fill of papillae on both sides and the correct gingival contour due to ostectomy provided during implant placement.

Figure 25: Final radiograph showning seating of the final crown.

Acknowledgements

Philipe Seha (Hout Bay Dental Laboratory).
Dr Andre De Villiers (Orthodontist).

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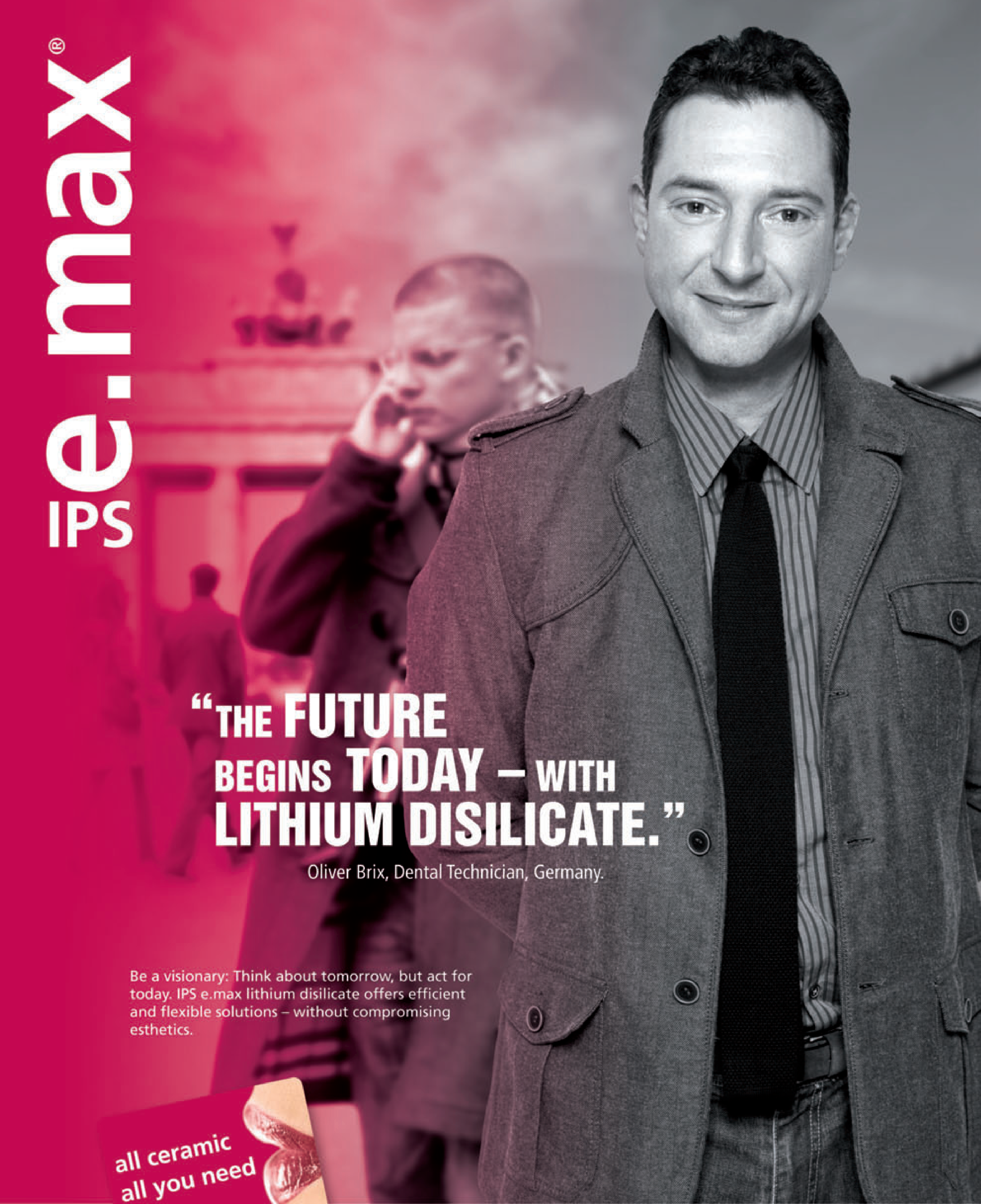
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