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3-D Virtual Planning Concepts: Maxillary Implant Supported Removable or Fixed Prostheses

case report
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Without questions, Cone Beam Computed Tomography has provided clinicians with an amazing imaging modality to assess our patient’s individual anatomy. In fact today, many clinicians will not place a dental implant without a CBCT scan prior to any surgical intervention. While this alone is a powerful statement, there are still questions that need to be asked with regard to how the technology is utilized. Are we seeing what we need to see? Having a CBCT scan does not in itself mean that clinicians are able to clearly visualize all aspects of the bone, soft tissue, teeth, and adjacent vital structures. The implication is that if clinicians cannot see everything that we need to see, are we able to diagnose properly? In my opinion, diagnosis is a key.

The data that is derived from a CBCT is invaluable for certain, but it does require software intervention to convert that data into information that can be used for diagnosis and treatment planning for a variety of different purposes. Managing the DICOM data from the CBCT device perhaps the most important consideration that can define the clinicians’ ability to visualize everything necessary for proper diagnosis. One example of the impact of the software capabilities is how the data is revealed on our computer screen. The software should easily allow for each cross-sectional, axial, coronal, and 3-D reconstructed volume to be enlarged without distortion for careful inspection at high levels of magnification. The ability to change the opacity of various anatomical structures, as I have previously termed, “selective transparency” is essential to provide clinicians with very powerful tools to visualize relationships between these structures.

When the software attempts to create beautiful and visually pleasing three-dimensional reconstructed volumes, problems often occur when there are existing crowns, or metal within the field of view resulting in scatter artifact. This scatter can mask underlying anatomy in critical regions that clinicians need to analyze, making the scan useless for diagnosis. Therefore, the software must have an ability to help remove or diminish scatter artifact, and this may require ancillary superimposition of intra-oral scans or optical scans of stone casts to improve surface accuracy, as an aid for planning and the eventual fabrication of surgical templates via stereolithography, 3-D printing, or CAD/CAM processes.

In the pages of CBCT International Magazine, we continue to strive to provide our readership with information that will help inform and educate about state-of-the-art tools as utilized by world-class authors who have taken the time to document their cases and concepts. The information will illustrate that there are vast differences in how data is used from various CBCT devices and software applications. The underlying and most important goal for our publication is to deliver the “clarity of vision” to help clinicians make the best decisions for our patients.

Please enjoy our latest issue!

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"Pre-surgical prosthetic planning" can be defined as the process of accumulating diagnostic information to determine which course of treatment should be considered for the fully edentate patient. The first step in patient evaluation should include conventional periapical radiographs, panoramic radiographs, oral examination, and mounted, articulated study casts. In the completely edentulous patient it is essential for the clinician to assess several important aspects of the individual anatomical presentation including vertical dimension of occlusion, lip support, phonetics, smile line, over-jet, overbite, ridge contours, and a basic understanding of the underlying bone structures. The accumulation of preliminary data afforded by conventional diagnostics provides a foundation to prepare a course of treatment for the patient. However, if the review of findings is based upon a two-dimensional panoramic radiograph, it may not be accurate in appreciating the true spatial positioning of vital structures such as the incisal canal, the floor of the nose, or the maxillary sinus. To fully understand each individual patient’s actual bone anatomy, it is essential that clinicians adopt an innovative set of virtual, three-dimensional tools. Through the use of advanced imaging modalities new paradigms have been established that in the author’s opinion will continue to redefine the process of diagnosis and treatment planning dental implant procedures for years to come. Without the application of computed tomography (CT) or lower radiation dosage cone beam computed tomography (CBCT), an understanding of the three-dimensional anatomic reality cannot be accurately determined, potentially increasing surgical and restorative complications.

The utilization of 3-D imaging modalities as part of pre-surgical prosthetic planning can take several paths. The first involves acquiring a three-dimensional scan directly, without any prior planning or ancillary appliances. The scan process can be accomplished at a local radiology centre, mobile imaging company, or via an in-office CBCT device. The scan itself can be completed within several minutes. Once the data is processed, it can be viewed on the native software of the CBCT machine itself, evaluated for potential implant receptor sites, followed by the surgical intervention, or with a third party interactive treatment planning software. A second path requires the fabrication of a radiopaque “scannographic” appliance that incor-
technique _ virtual planning

porates vital restorative information that will be worn by the patient during the acquisition of the scan. In this manner, the desired tooth position can be evaluated in relation to the underlying bone and other important anatomic structures such as the maxillary sinus or the inferior alveolar nerve. Certain proprietary methods incorporate the use of fiducial markers to help with the registration process for planning based directly upon the restorative needs for the patient.

The use of interactive treatment planning has expanded dramatically in the past ten years as computing power has increased exponentially. As defined by the author, guided surgery can be divided into three distinct categories once a "virtual" plan has been established based on 3-D scan diagnosis (Ganz-Rinaldi Classification of Guided Implant Surgery Protocols). The first allows the information to be assessed, providing important information to the clinician who will perform the surgical intervention free-hand based upon the software plan, termed "Diagnostic-Freehand". The second category involves the fabrication of a surgical guide or template that is remotely constructed from the digital plan usually through rapid prototyping or

Figs. 4a–c. Cross-sectional slice reveals tooth position in relationship to the bone (a) and the extension of the labial vestibule (red arrow) (b). The relationship to the maxillary sinus is essential for planning in the posterior region, where thin cortical plate can be clearly visualized (arrow) (c).

Figs. 5a & b. Evaluating a potential receptor site within the cross-sectional view (Slice 63) (a). The positioning of the implant(s) need to fall within the envelope of the teeth (b).
Technique: Virtual Planning

Stereolithography, CAD/CAM, or laboratory fabricated, termed CT-derived “Template-Assisted”. The drilling process is started and can be completed within the template helping to control trajectory and depth with the proper instrumentation. The third category requires a specific template design that allows for accurate drilling and osteotomy preparation, and with the proper manufacturer-specific carriers the implants can then be accurately delivered through the template, termed, “Full Template Guidance.” The use of advanced imaging modalities for pre-surgical prosthetic planning is essential for any type of implant surgical and restorative intervention, from the single tooth, multiple tooth restoration, full arch fixed and removable overdenture reconstruction. However, it is the correct use of three-dimensional tools that provides clinicians with the power to diagnose and treatment plan with the highest degree of acuity and accuracy.

3-D Planning Concepts:

Full Arch Maxillary Overdenture

Due to anatomical variations related to the maxillary sinus, the floor of the nose, the incisal canal, the facial trajectory of the anterior segment, thin cortical plates, and diminished overall bone density when compared to the mandible, the completely edentate maxilla offers additional diagnostic challenges for clinicians. The axial view provides insight into the global topography of the maxilla (Fig. 1). The position of the incisal canal can be visualized, along with thin facial and palatal cortical plates. The volumetric rendering aids in the inspection of the bone, but does not offer any information regarding tooth or ultimate restorative position (Fig. 2). In order to achieve the concept of “true restoratively driven implant dentistry” pre-surgical prosthetic planning should start prior to any scan being taken. A scanning appliance can be fabricated from a duplicate of a patient’s existing well-fitting denture, or a new diagnostic set-up which positions the teeth at the ideal vertical dimension of occlusion, centric relation, and functional/aesthetic components (Fig. 3a). The patient wears the scannographic appliance during the scan, ideally held in place with a pre-determined bite registration to minimize movement. The scan reconstruction will then contain both the tooth position and the underlying bone (Fig. 3b).

The combination of the anatomical scan data with the radiopaque template allows unprecedented diagnostic potential. The template reveals the tooth position (red arrows) in relationship to the underlying
bone in the cross-sectional slice (Fig. 4a). The thin cortical plates can be clearly visualized, along with the extension of the labial vestibule (red arrow, Fig. 4b). The relationship to the maxillary sinus is important when deciding if implants might be an option in the posterior region (Fig. 4c). In this example the pneumatization of the sinus has resulted in extremely thin lateral cortical plate (see red arrows). The radiopaque template is helpful when evaluating other receptor sites, and positioning a simulated implant within the cross-sectional view (Slice 63, Fig. 5a). For an over-denture application the positioning of implants need to fall within the envelope of the teeth, and it is even more practical to visualize the abutments that might be utilized (Fig. 5b). For this example a realistic stock "ball type" abutment was utilized on the virtual realistic implant. In order to provide some guidance, it is the author’s preference to place the implant within a defined zone of available bone (Figs. 6a & b). This zone has been previously defined as the “Triangle of Bone” (TOB) that also acts as a decision tree to connect the implant placement to the restorative outcome (Fig. 6c). Positioning the implant within the zone of the TOB, or actually bisecting the triangle, allows for the most bone volume to surround the implant. Following this formula, the implant and abutment will be positioned in a favourable restorative position.

Further inspection through the utilization of additional views can be extremely enlightening with regard to the final positioning of the implants. The occlusal view of the volumetric reconstruction aids in the implant-to-implant positioning within the bone (Fig 7a). However, without a complete understanding of the tooth position, the implants may not be ideally located based upon the prosthetic plan.

Superimposing a translucent scannographic template over the maxilla provides the important information to position the implants within the restorative envelope (Fig. 7b). The prosthesis design can be evaluated to determine whether to fabricate a complete denture that would extend to incorporate a conventional post-palatal seal, or an open-palate horseshoe type prosthesis. To aid in the final positioning, it is helpful to visualize the outline of the occlusion using the author’s concept of “selective transparency”, and extend the abutments above the occlusal plane (Fig. 8a). “Selective transparency” is a software tool which can help separate one anatomical structure from another by adjusting the opacity of the various objects. Once the implants are placed, the ball abutments can then be positioned at the proper tissue cuff height (Fig. 8b). Rotating the views can substantiate the plan to place the implants where they will be support the removable prosthesis (Figs. 9a & b).

It is important to assess the clearance within the denture to allow for sufficient thickness of acrylic within the over-denture abutment housing avoiding potential fracture of the prosthesis. This “prosthetic space” requirement may be different depending upon the type of attachment used. Using the power of digital technology and selective transparency, the realistic implant and ball abutment can be seen through the prosthesis and the underlying bone (Figs. 10a & b). These illustrations reveal that the two right implants are parallel, while the left implants are seen to follow the natural trajectory of the implant-abutment complex can be visualized within the virtual plan.
The top of the implant (red line) serves as the foundation for the abutment at a specific tissue cuff height (green line) (a); the metal housing represented in gold also has a vertical component (yellow line) (b).

Once the implant position has been confirmed, the software will generate the virtual design of the template. 

Eight implants positioned to support a fixed restoration (a) to fit within the framework of the desired tooth position (b); using “selective transparency” the underlying bone can be visualized (c).

Frontal view of the scanning template with yellow abutment projections seen above the occlusal plane (a); semi-transparent scanning template (b); and all three objects translucent to visualize the position of the implants within the bone (c).

Another 3-D view showing the emergence of the abutment projections through the scanning template.

The ball-abutment is only one potential stock abutment choice for an overdenture application. Another widely used abutment is the Locator attachment (Zest Anchors). The use of realistic Locator attachments allows for a precise understanding of the implant-to-implant relationship, and spacing around the arch which is necessary to gain maximum retention of the prosthesis to resist dislodgment during mastication (Figs. 12a & b).

In addition, the utilization of virtual abutments aids in determining the correct tissue cuff heights of the abutments above the bone, and through the soft tissue (Fig. 13). The vertical distance can be evaluated within the framework of the prosthetic design (Fig. 14a). The new digital tools allow for new paradigms to be established assessing the relationship of the implant position, abutment position, and prosthetic prior to the scalpel ever touching the patient. Crown-to-root ratios and the trajectory of the implant-abutment complex can be visualized within the virtual plan, providing valuable surgical and restorative information during the planning phase (Fig. 14b).

In addition to the axial, panoramic, and three-dimensional reconstructed volume, the importance of the cross-sectional image is critical to fully appreciate the relationship between the implant position within the bone, and the emergence through the tooth. One area that has not been emphasized however, is the ability to determine the prosthetic space required for the abutment as it relates to the thickness of soft tissue supporting the overdenture (Fig. 15a). The realistic ball abutment can be clearly visualized sitting on the coronal aspect of the implant (red line), and the tissue cuff height of the abutment (green line). One component that is not easy to determine is the metal housing that will be processed within the denture. This component part is not yet available within the software libraries to the author’s present knowledge. Therefore an approximation was digitally represented (gold), so that the extra height can be visualized (yellow line), revealing the thin palatal aspect of the overdenture (Fig. 15b). Once the virtual plan has been established a surgical template can be designed by the software and then fabricated through 3-D printing, stereolithography, or a CAD/CAM process to assist in the placement of the implants within the anticipated restorative needs of the patient (Fig. 16).

3-D Planning Concepts: Full Arch Maxillary Fixed Prosthesis

There are few differences between 3-D planning concepts for an overdenture prosthetic design, or a fixed prosthetic rehabilitation supported by implants. All aspects of the patient’s bone and soft tissue anatomy must be carefully evaluated. After a proper assessment of the available bone, key implant positions are identified, and simulated within the 3-D reconstructed volume as seen in Figure 17a. However, it is important to once again evaluate the potential implant receptor sites based upon the envelope of the occlusion (Fig. 17b). Using “selective transparency” helps to provide an enhanced perspective of how the implant abutment projections (yellow) are spaced within the desired restoration (Fig. 17c). The frontal view clearly illustrates the importance of the implant abutment projections, revealing for this example a nearly parallel placement of the implants (Figs. 18a & b). “Selective Transparency” can be applied to multiple structures, to help visualize the entire complex of the implant, abutment projection, radiopaque template, and the underlying bone (Fig. 18c). By rotating the 3-D reconstructed volumes, it is apparent how powerful these interactive software tools can be (Figs. 19a & b). Once the final positions of the im-
Plants are confirmed for the edentulous presentation, a mucosal-supported template can be designed and fabricated through 3-D printing, stereolithography, or a CAD/CAM process. The mucosal-supported template should be fixated to the bone, to insure accuracy of the drilling sequence. The template with the blue screws can be visualized in Figures 20a–c.

**Conclusion**

The advent of complete denture fabrication evolved into the adoption of over-denture concepts for both natural and implant supported restorations. Conventional prosthodontic protocols were developed to aid in the diagnosis, treatment planning, and laboratory phase of the reconstruction. These included conventional periapical radiographs, panoramic radiographs, oral examination, and mounted, articulated study casts. The clinician was then expected to assess several important aspects of the patient's anatomical presentation including vertical dimension of occlusion, lip support, phonetics, smile line, overjet, overbite, ridge contours, and a basic understanding of the underlying bone structures. The accumulation of preliminary data afforded by conventional diagnostics provided a foundation to prepare a course of treatment for the patient. However, the conventional review of findings was based upon a two-dimensional assessment of the actual patient's bone anatomy. To fully understand each individual patient's presentation, this article provided clinicians with an appreciation of various innovative virtual, three-dimensional tools based upon the use of advanced three dimensional imaging modalities for both removable and fixed prosthetic treatment alternatives.

The application of CBCT and interactive treatment planning software, empowers clinicians with an accurate understanding of the three-dimensional anatomic reality for our patients as an aid in providing state-of-the-art treatment. Implants will be better positioned, with fewer surgical and restorative complications, and reduced laboratory remakes based upon these improved diagnostic tools. The benefits will enable clinicians to better understand the relationship between patient anatomy and the desired restorative outcomes, in the process of achieving true restorative driven implant reconstruction. The ability to utilize digital imaging and treatment planning technology is now within the reach of most clinicians through the various software products that are on the market. In addition there are many third party outlets through internet portals that enable clinicians to upload their DICOM data for evaluation, processing, treatment planning, and even surgical template fabrication without actually owning the planning software. New paradigms have been established that in the author's opinion will continue to redefine the process of diagnosis and treatment planning dental implant procedures, both removable and fixed alternatives for years to come. Please remember though that the “template is only as good as the plan”.

Figs. 20a–c. The template design revealing the guide tubes (a); three blue fixation pins (b); and the entire complex on the 3-D reconstructed volume (c).

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**About the Author**

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Dr Ganz delivers presentations worldwide on both the surgical and restorative phases of implant dentistry, and has published extensively on these topics. He is considered one of America’s leading experts in the evolution of computer utilisation and interactive software for diagnostic and treatment planning applications using CT and newer-generation CBCT imaging modalities.
**Lateral maxillary incisor implant – Key issues for aesthetic success**

**Introduction**

Faced by a missing lateral incisor, practitioners often consider a wide range of issues and are also faced by numerous treatment options:

- in a young patient, faced with a unilateral or bilateral agenesis, he has to choose between an orthodontic treatment that either opens up the spaces or closes them. This decision, when taken early in the overall treatment, will affect both the patient and their caregiver for a long time (Fig. 1);
- in an adult patient, this is a consequence of bone, physiological, traumatic or infectious resorption, which will result in a decision whether or not to recommend a bone reconstruction or a gingival augmentation.

In every situation, the results will be judged by the patient and those around him. Since the lateral maxillary incisor is an integral part of the smile, aesthetic expectations are generally very high and, if the results do not meet the expectations, disappointment can be powerfully felt.

When describing the different treatment stages, a number of pitfalls and difficulties will be highlighted and advice and clinical protocols will be given, in order to ensure that the results of this implant/prosthetic treatment are predictable and as aesthetically attractive as possible. This first article is concerned with these issues as regards the preprosthetic stages; the second will consider the most important aspects of the prosthetic stages as well as aesthetic outcomes and their evolution over the long term.
Anamnesis

Once the usual contraindications for oral and implant surgery have been eliminated, particular attention should be given to the patient’s answers concerning their smoking habits. Indeed, meta-analysis give an accurate picture of the consequences of smoking, with increases of:

- peri-implantitis\(^1\)\(^2\) and bone loss\(^3\);
- failure rates\(^3\).

The conclusions of Snider et al.\(^4\) can provide recommendations for the practitioner faced with a patient who is a smoker:

- the best is to ask the patient to stop smoking...;
- if this approach is not acted on, then the patient must be warned of the increased risk of failure and of postoperative complications.

This last issue is important, as smoking can be considered a lost opportunity as far as implant treatment is concerned.

“It is preferable to avoid patients that are smokers.”

Clinical examination

The smile line

When replacing a tooth in an aesthetic region, understanding the location of the smile line is one of the determining issues during the clinical examination. There are two factors to consider: the exposure of papillae and visibility of the collar of the lateral incisor, and there is one significant problem: any aesthetic deficit experienced by the patient tends to make them change their smile line, which can happen more or less as a conscious process and this can be a source of significant errors. Analysis of gingival composition is also a determining issue in positioning the collar of the lateral incisors in a location that is aesthetically optimal. The gull-wing profile, where the collar of the lateral incisors is slightly more coronal than that of the front teeth or the canine teeth, is considered to be more attractive according to Chiche\(^5\) (Fig. 2).

Dental aesthetics

As regards dental aesthetics, the proportions of the proposed implant supported tooth can reflect two different scenarios:

According to Levin, following the golden ratio, the width of the lateral incisor \(y = 0.62 \times\) and, for Preston, it is \(0.66 \times\) (images from Papathanassiou).\(^6\)
there is a unilateral missing tooth and the contralateral incisor has normal and aesthetically pleasing proportions. The objective will be to create a lateral incisor implant that is a mirror image; with the same situation but where the contralateral incisor is small; this is a situation that occurs frequently in unilateral agenesis where the incisor that is present is riziform or, if there is agenesis of both lateral incisors, the clinical examination should gather the information required to decide on the dimensions and coronal axes of the proposed lateral incisors. An analysis of the occlusion and the dimensions of the central incisors are the clinical parameters that make it possible to establish the characteristics of the planned prosthetic teeth.

The anatomy of the lateral incisor has been the subject of various publications, including, notably, by Panpathanassiou who defined average dimensions and a typical form (Fig. 3a) and also presented numerous morphological variants affecting these dimensions and also other characteristics such as the crown/root ratio and the coronal and root axes (Fig. 3b). These morphological criteria, which can now be found using 3-D imaging, have had a significant influence on the location of implants in all spatial planes in order to achieve the goal of harmony of form and dimension. Other publications, such as those by Levin and Preston make it possible to estimate the width of absent lateral incisors on the basis of the central incisors (Fig. 4).

“Establish the ideal width and orientation of the planned prosthetic crown.”

**Implant location**

A clinically significant deficit signals the need for reconstruction of hard tissue but, conversely, a site without a tooth with no loss of volume should be subjected to a three-dimensional X-ray, as thick soft tissue can hide a lack of hard tissue (Fig. 5). A thin tissue biotype or a lack of attached gingiva can be a sign that gingival augmentation surgery will be required, particularly if a bone graft needs to be performed.

**Oclusion**

For orthodontic treatments, the anterior guidance should be analyzed carefully. It can be tempting to increase the perimeter of the maxillary arcade in order to obtain, at the least, implant corridors that are sufficiently wide at the level of 12 or 22. However, an overjet will make it very likely that the natural teeth will move in relation to the implant prosthesis with highly negative consequences for the sustainability of the cosmetic outcome.

**Documentation**

Taking photographs at the start of the treatment will make it possible to maintain a record of the initial condition, which is always useful if there are medical/legal problems at the end of the treatment. In addition, the images often make it possible to see problems relating to width, axis or asymmetry that sometimes go unnoticed during a clinical examination.

“Check anterior guidance and absence of overjet.”
Complementary tests

2-D imaging

Panoramic X-rays or retroalveolar radiography make it possible to check the depth of implantable bone in relation to the floor of the nasal cavity, the bone level in relation to that of adjacent teeth and the parallelism of the central incisor and canine.

3-D imaging

3-D imaging is required to check the vestibular palatal dimensions of the bone crest. There are three possibilities:

- The crest is sufficiently wide to take an implant without any bone augmentation;
- The crest is narrow, bone augmentation is required prior to siting the implant (Fig. 6);
- Intermediate situations where the siting of the implant will be accompanied either by bone splitting or by guided bone regeneration.

Orthodontic preparation

When the adjacent teeth present apical convergence, the orthodontic preparation should create a mesio-distal dimension at the level of the root that allows the implant to pass with a margin of at least 1 mm of bone (Figs. 7 &8). Where there is a controlateral incisor of a normal size, the rule for the orthodontist is to measure the width of that tooth carefully and to recreate the same width in the crown of the planned implant. Where the controlateral incisor is riziform, the orthodontist should plan the future face of the tooth in order to achieve two laterals with the same shape.

Diastemas around the riziform tooth make it possible to achieve a smile that, in the end, is almost symmetrical (Fig. 9). The riziform incisor does not have to be in the centre of the space but should be positioned in such a way that the papillae and the future zenith of the tooth are optimized. The zenith should be located 0.4 mm distal from the centre of the tooth for a lateral incisor, according to Chu et al.2 (Figs. 10a & b).

Figs. 11 & 12. Papillary view (b), X-ray view (a), 2 years after the insertion of the implant.

Cortical graft in place, shaped to support future papillae (case as shown in Fig. 1).

X-ray result, compare with Fig. 6.

Clinical outcome 5 months after the graft. Compare with Fig. 11.

3 mm diameter Nobel Active implant.
I technique — first part of an implant treatment

Som etimes, a zenith situated more than 1 mm from a line between the collars of the central incisor and the canine should be surgically altered by coronal lengthening as a lateral incisor that is too short can also be aesthetically unacceptable.

“The orthodontist should anticipate the future prosthetic morphology of the riziform incisor.”

Hard tissue augmentation

Where a bone reconstruction is indicated, this should take into account one of the key factors for the overall cosmetic outcome: restoration of papillary support in order to avoid any unsightly black triangles between the lateral incisor and the adjacent teeth or any concave area above the implant crown that would create an ugly shadow.

The cortical graft, taken from the chin or the external oblique, should be formed in such a way as to provide support for the gingival papillae (Fig. 11). Gaps under and around the graft should be filled with cortical bone particles, crushed from the chin block or lateral mandibular area using a bone mill.

The attachment must be reliable. This is done using two 1.6 mm diameter osteosynthesis screws (Fig. 12). Autografts take about 5 months to heal. Ideally, the implant should be inserted between 4.5 and 5.5 months after the graft (Fig. 13).

“Fully reconstruct papillary support.”

Insertion of implant

Choice of implant

The mesio-distal dimension of the gap will determine the choice of the implant. When this is close to or less than the average size of 6.5 mm, the bone and papillary volume around standard size implants will be limited. According to Hasan et al. and Bourael et al., the disadvantage of small diameter implants is that they transmit higher stresses to the crestal bone than do standard implants. When replacing a lateral maxillary incisor, it is possible to arrange both the anterior guidance and the deduction in such a way as to make them largely affect the natural teeth, in the absence of any significant malpositioning, and in this way reduce the stresses applied to the implants. Under these conditions, small diameter implants have the advantage of increasing surrounding residual bone volume as well as space available for papillary healing.

In a forthcoming study of 120 Nobel Active 3 mm diameter implants, one of the conclusions confirmed the importance of these small diameter implants as regards the additional height of the papillae, resulting in an improvement in the Fürhauser pink aesthetic score (Figs. 14, 15a & b).

“Favor small diameter implants.”

Fig. 16 Mobile Anyray 2 (Vatech) X-ray generator.

Fig. 17 Intraoperative X-ray, Precision Drill inlay (left on picture) and in situ (right on picture).

Fig. 18 Clinical outcome 5 months after the graft. Postoperative X-ray Nobel Active 3/0 implant and 15° abutment in place.

Fig. 19 Initial situation.

Fig. 20 De-epithelialisation of a palatal flap into a diamond shape.

Fig. 21 Unfoldment of palatal flap, vestibular edge.
3-D positioning

As regards replacement of a lateral maxillary incisor, the tolerances for the location of the implant are very small because of the narrow width of the implant corridor. Two recent meta-analysis concerning the precision of surgical guides resulting from 3-D imagery, even if these do not apply specifically to the lateral incisor replacement, has found a deviation in the order of a millimetre at the point the implant emerges and 4 to 5 degrees as regards the drilling axis. For Van Assche et al., the average imprecision at the apex of the implant is 1.24 mm.

Since these measurements are incompatible with a 12 or 22 implant corridor, it is important to check the first drill hole(s) during the operation, whether the surgery is guided or being carried out freehand. If the implant clinic does not have retroalveolar X-ray equipment, portable generators such as the Anyray 2 (Vatech) are available on the market, which allow you to produce intraoperative images (Fig. 16).

In this context the Precision Drill from the Nobel Biocare kits is particularly helpful. Its sharp point provides considerable precision at the point of entry and its small dimensions make it possible to correct any deviations from the ideal axis occurring during the first drilling (Fig. 17).

In the vestibular palatal plane, it is essential to prepare a prosthetic treatment plan before inserting the implant because the positioning requirements differ:
First part of an implant treatment

Technique

For a screwed prosthesis, the axis of the implant is very strictly determined by the point in the cingulum where the screw emerges; with a cemented prosthesis, the tolerance is slightly greater as it is possible to make a correction to the axis by an abutment angled up to 15 degrees or by a Procera type individualized abutment (Fig. 18).

“Position the implant under X-ray monitoring.”

Soft tissue management

Whether the soft tissue management is carried out at the time the implant is put in place or when it is exposed, the choice of surgical technique depends on an examination of the initial situation:

- horizontal deficit of soft tissue that could result in the underlying titanium being visible;
- vertical deficit in the papillae that could result in unsightly black triangles.

Different surgical techniques can be used, depending on these deficits, which are taken from three publications: the roll flap developed by Abrams, the envelope technique of Peter Raetzke and Carl Misch's split-finger.

If there is just a horizontal deficit, a modified rolled flap can be carried out, without separation of papillae and without vestibular incisions, the palatal flap being folded into an envelope flap (Figs. 19 to 25). The attraction of this technique for the patient is that a second operation site to take a graft is not required. In addition, it makes it possible to recreate a root eminence, considered already 20 years ago by Silverstein and Lefkove to be an important factor for the aesthetic outcome (Figs. 26 & 27a to c).

Where there is a vertical deficit, a crestal W-shaped incision as described by Carl Misch is indicated. This makes it possible to recreate an anatomical gingival architecture while, as a first step, creating two vestibular neo-papillae (Fig. 28). After separating the sections, the palatal tissue (finger) is divided into two to make two palatal half-papillae, joined one on one with their vestibular counterparts (Fig. 29).

Where there is a combined deficit, the same incisions are combined with a buried connective vestibular graft. Provided that there is sufficient volume, the graft is taken from the maxillary tuberosity, since this area has the advantage of providing graft tissue that is more dense, opaque and less adipose than the palate and, in addition, results in less postoperative pain. If the graft is transferred in a V- or Y-shape, it can support the newly formed papillae. The shape of the palatal incision can be modified to a Y-shape to assist rotation of the palatal half papilla (Fig. 31).

If the thickness of the buccal gingival tissues has not been augmented or if collagen substitutes are used that do not have the opacity characteristics of tuberosity connective tissue, the aesthetic outcome can be compromised. If there is recession of the external table or the titanium abutment under thin con-
connective tissue, the grey titanium colour can be seen through the gum as a grey halo above the crown collar, which is detrimental to the aesthetic appearance (Figs. 32 & 33).

“Systematically augment the thickness of buccal connective tissue.”

Conclusion

The aesthetic fundamentals for an implant are in the preprosthetic surgical stages of the treatment. Any approximation in the location of the implant in such a narrow implant corridor, any lack of support for papillae or any deficiency in the thickness of hard or soft tissues, will result in aesthetic problems. The prosthetic stages allow optimisation of the result as regards the gingival context but any error in the surgical stage will often be impossible to correct during the prosthetic stages. For this reason it is vital to approach this first part of the implant treatment for a lateral incisor with thoroughness and precision.

Editorial note: A complete list of references is available from the publisher.

This article was originally published in the Éditions Cdp prosthetic journal, No 167, September 2014 and the Clinical Masters Magazine No 1/2015.

Fig. 31 Insertion of connective graft buried under the papillae.
Fig. 32 Clinical outcome in a case of gummy smile.
Fig. 33 Insufficient soft tissue thickness alters the chromatic outcome.

Dr Philippe Russe, former assistant at the Reims University and Hospital. He runs his private practice in Reims, France.

Dr Patrick Limbour, MCU-PH, Head of department of oral surgery, Pontchaillou University Hospital, Rennes, France.
Small-diameter implants for single anterior restorations

Author_ Dr Richard Marcelat, France

Case 1: Small vestibulo-palatal bone volume

A 42-year-old patient presented with bilateral agenesis of the maxillary lateral incisors (Fig. 1). The smile line analysis indicated a low smile line associated with toned lips. The oral examination showed small mesiodistal spaces in regions #12 and 22, as well as a rather thick gingival biotype.

The patient’s reason for consultation was aesthetic. After discussing alternative solutions with the patient—orthodontic space closure, replacement with fixed prostheses (bridge or crowns)—the patient ultimately chose implant-supported prostheses. We worked in close collaboration with an orthodontist colleague, Dr Frédéric Chalas, who took responsibility for adapting the mesiodistal spaces, which were required for the placement of the endosteal implants in regions #12 and 22. We saw the patient again after 14 months of orthodontic treatment (Figs. 2a & b), which consisted of wearing a multi-bracket appliance to open up the spaces at

---

**Fig. 1** Baseline panoramic radiograph.

**Figs. 2a & b** The clinical situation at the end of orthodontic treatment.

**Figs. 3a-d** CT scan cross-sections showing the small exploitable volume on the vestibulo-palatal plane.
regions #12 and 22, while aligning the apices of the adjacent teeth.

**CT scan analysis and choice of implants**

The CT scan cross-sections of regions #12 and 22 showed a limited bone volume on the vestibulo-palatal plane, which would not have allowed for standard-diameter implants to be placed without the use of a bone augmentation technique. The cortical bone, however, was preserved (Figs. 3a–4).

Narrow implants (Axiom 2.8, Anthogyr) were used for this restoration. Axiom 2.8 has been designed exclusively to replace mandibular incisors and maxillary lateral incisors. It is equipped with a three-degree Morse taper connection system with an integrated switching platform. The special feature of the system is that the abutment is impacted without a transfixation screw. Abutments are available in several gingival heights and angulations, making Axiom 2.8 adaptable for any prosthetic situation.

**Placing the implants and fabricating the prostheses**

Placement of the implants in regions #12 and 22 was done during the same procedure. Under local anaesthesia, two 2.8 mm x 10 mm implants were placed 0.5 mm sub-crestally (Figs. 5a–d). Very light drilling enabled bone condensation of the specific sites. The correct 3-D positioning of the implant was vital for the final aesthetic result. Temporary crowns were attached to the orthodontic arch wire and left in place for the three months of osseointegration in order to ensure post-orthodontic fixation of the teeth.

Three months postoperatively, the patient’s brackets were removed by the orthodontist and the temporary crowns fabricated directly on the PEEK healing plugs (Fig. 6). The basal surface of the temporary crowns was carefully polished.

After a period of two months of gingival maturation, which was put to good use by performing dental whitening in an outpatient setting, the prosthetic phase could begin. The implant impressions were taken with the pop-in technique (Fig. 7) using an individual impression tray fabricated in the laboratory. The choice of the most suitable abutment by means of the planning kit by the laboratory was a vital step. In fact, the abutments required only very slight adjustments or none at all. Having the option of four gingival heights and four angulations enabled us to adapt to any clinical situation.

The laboratory prepared the metal–ceramic crowns (Figs. 8a–9). The prostheses were verified in the mouth and then the crowns were fixed to the abutment with Fuji PLUS cement (GC) outside of the mouth (Figs. 10–13b). This allowed for perfect control of excess cement and guarded against any risk of gingival inflammation.

The abutment together with the crown was impacted with the Safe Lock system, mounted on the chair unit. The Safe Lock system made it possible to control the impaction. The recommended five impactions were applied to seat the prostheses permanently (Figs. 10–13b). The good aesthetic results were related to the symmetry of the emergence profiles. The narrow diameter of the implant was perfectly adapted to this clinical situation.
**Case 2:**

**Limited mesiodistal space and proximity to the apices of the adjacent teeth**

A 20-year-old male patient presented with unilateral agenesis at region #12. This patient had just finished his orthodontic treatment. His brackets had been removed several months before. He was wearing a removable partial denture while waiting for the placement of an implant. The periapical radiographic examinations and CT scan cross-sections showed an extremely small mesiodistal space, especially at the level of the apices of the adjacent teeth (Figs. 14–16).

The treatment of this small space required great precision during the surgical phase. The insertion axis was visualized on the 3-D reconstruction of the CT scan cross-sections using SIMPLANT software (DENTSPLY). Preoperative periapical radiographs were performed at each drilling sequence.

The treatment of this very small mesiodistal space was only made possible by the use of an implant of 2.8 mm in diameter (Axiom 2.8), without which it would have been necessary to resume orthodontic treatment in order to align the apices of the adjacent teeth. That was not what the young patient desired (Figs. 17 & 18).

**Cases 3 and 4:**

**Small antero-posterior volume**

**Case 3**

A 25-year-old female patient at the end of orthodontic treatment presented with unilateral agenesis at region #22. The smile line was moderately high, associated with right-left asymmetry of the positioning of the anterior teeth in relation to the midsagittal plane. The analysis of the CT scan cross-sections showed a small bone volume on the vestibulo-palatal plane (Figs. 19 & 20).

A narrow 2.8 mm × 12 mm implant was placed (Fig. 21a). The orthodontic arch wire served as fixation during the osseointegration phase and was removed three months postoperatively. A temporary crown was fabricated on a PEEK healing plug in order to shape the peri-implant soft tissue. The permanent crown was to be fabricated four months after surgery (Fig. 21b).

**Case 4**

A 59-year-old patient came to our clinic with tooth #31 missing, which had been managed for
years with a glued metal brace. Owing to frequent detachment of this prosthesis, the patient desired a fixed prosthetic solution. The periodontal condition of the surrounding teeth was stable, but the available bone volume around region #31 on the vestibulo-lingual plane was small. There were two surgical options: (a) augment the bone and place a standard implant, or (b) use a narrow implant. A 2.8 mm × 10 mm implant was placed. After a healing period of three months, a standard metal–ceramic prosthesis was fabricated (Figs. 22–24).

Discussion

The Axiom 2.8 implant makes it possible to restore single teeth in the incisal area using implant-supported prostheses in cases in which there is a small mesiodistal space. Having narrow implants available
case report  _ CBCT in diagnosis  

Small space, proximity to the apices of the adjacent teeth and small bone volume present surgical difficulties in the ideal positioning of implants. We believe it is important to use abutment teeth that integrate platform shifting, including on implants with a small diameter. The large choice of abutments, in terms of gingival height and angulation, makes it possible to adapt to any clinical situation.

Conclusion

Although we do not have the clinical retrospection to offer our opinion on the strength and long-term durability of implants with small diameters at this point, the average success rate of these narrow implants is comparable to that of standard implants. The use of narrow implants for the management of single anterior restorations, especially for the replacement of mandibular incisors and maxillary lateral incisors, constitutes an important option that makes it possible to simplify the surgical approach, sparing patients from more invasive techniques and securing the surgical procedure in relation to the roots of adjacent teeth.

Acknowledgements: Many thanks to Laurent Bougette from Laboratoire Créadent in Grabels and Dr Frédéric Chalas in Montélimar in France for the orthodontic treatment of Case 1.
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Diagnosis and management of a rare case of a maxillary second molar with two palatal roots

Supported by conventional radiography and CBCT

Author: Ass. Prof. Katarina Beljic-Ivanovic, Serbia

Case report

A 26-year-old male patient sought treatment at the Department of Restorative Odontology and Endodontics at the University of Belgrade with the following chief symptoms, which had persisted for several weeks already:

- spontaneous dull, mild and intermittent pain in the region of the left maxillary molar;
- moderate sensation of pain when biting hard food.

Additional information was acquired from further anamnesis:

- There were no other symptoms, and no irradiation of existing pain.
- The patient recalled that a root canal therapy had been performed on the same tooth several years before.
- He also recalled that two teeth on the same side of the upper jaw had been extracted at least ten years before.

Furthermore, clinical examination confirmed the following:

- only the second molar, #27, with an extensive amalgam restoration, was present in the left maxilla;
- moderate sensitivity on vertical percussion of the buccal cusps, and painful response to percussion of the mesiopalatal cusp;
- no sensitivity on digital palpation on the vestibular or palatal side;
- both hot–cold and electric vitality tests were negative;
- no pathological mobility of the tooth.

The diagnostic periapical radiograph (bisecting angle technique) showed...

Introduction

Besides adequate knowledge of root canal morphology in general, it is of utmost importance to evaluate each individual case for aberrant anatomy and to identify any morphological variation before performing and during an endodontic procedure on such teeth. In clinical practice, conventional radiography with the assistance of an operating microscope is the most common method for evaluating root canal anatomy. However, it has been shown that their use does not reveal all anatomical details. Recently introduced and developed cone beam computed tomography (CBCT) for dental use has proved to be more accurate in detecting root canal morphology, especially in maxillary posterior teeth. One of the most unusual and rare aberrations of tooth anatomy is a maxillary second molar with two separated palatal roots. This article presents the case of such a patient, who presented ten years after another such patient had been recorded.
partly obturated palatal and mesiobuccal (MB) root canals and an unfilled distobuccal (DB) root canal; slight radiolucency around the palatal root apex; no distinctive border towards the surrounding maxillary bone structure.

The necessity of an endodontic retreatment of the tooth was explained in detail to the patient, who accepted the suggested therapeutic procedure and the general schedule for further appointments.

Treatment procedure

The old amalgam restoration and the phosphate cement base were completely removed, and the cavity walls were additionally prepared to enable clear visibility and straight-line access to all root canal orifices. The orifices of the palatal and MB root canals had been blocked with obturation material, presumably iodine phosphate cement and a gutta-percha cone. Approximately 3 mm distal from the orifice of the obturated palatal root canal, another oval, crack-like orifice could be seen, with the appearance of a perforation. Further assessment of the pulp chamber floor was performed with 4.5x magnifying loupes and the Endodontic Probe Orifice Opener (DENTSPLY Maillefer). Using the probe and a #10 K-file to negotiate the flat oval orifice, the presence of a second palatal (distopalatal, DP) root canal was detected.

The orifice of the DB root canal was hidden under brownish deposits of tertiary dentine, located about 2 mm distal from the obturated MB canal orifice and approximately 2 mm buccal from the DP canal orifice. The DB canal orifice was negotiated and slightly widened with the Orifice Opener, ensuring that it could be easily detected in a further procedure. The second MB root canal could not be found with meticulous searching under loupes and the application of a decalcifying solution (17 % EDTA).

After consultation and receiving the approval of the patient, it was decided to conduct the entire procedure in at least two sessions. First, the root filling material in the MB and mesiopalatal (MP) root canals was removed using rotating NiTi files, ProTaper D1, D2 and D3 files (DENTSPLY Maillefer), and manual H-files (DENTSPLY Maillefer). Further instrumentation of those canals was performed using WaveOne files (DENTSPLY Maillefer) with reciprocating motion: the MP canal with black (#40) and the MB canal with red (#25). The working length was determined and checked throughout the entire procedure using an electronic apex locator (RomiApex A-15, Romidan).

The DP root canal was then negotiated and a glide path was created approximately 1–1.5 mm shy of the apical foramen using #10 and 15 K-files. The coronal portion was flared successively with #3 and 2 Gates-Glidden drills. The same procedure was performed at the DB root canal. Clear visibility and straight-line access were established for all four canals (Fig. 1).

Two intra-oral radiographs were captured from two different horizontal angles with an inserted K-file in each root canal, but only one revealed all four root canals (Fig. 2), showing vague contours of the apical portion of the roots.

A calcium hydroxide dressing was applied at the MP root canal and a paper point, soaked with a 2 % solution of chlorhexidine (R4, Septodont), was left in the MB root canal. A cotton pellet with chlorhexidine...
was left in the pulp chamber and the cavity was then sealed with a temporary filling material.

In the second session, two weeks later, the DP and DB root canals were carefully prepared, applying the same WaveOne technique as used for the MP and MB root canals: the DP canal with WaveOne black (#40) and the DB canal with WaveOne red (#25). The working length was determined and checked using the same electronic apex locator.

Throughout the entire endodontic procedure, 2.2% sodium hypochlorite and 10% citric acid solutions were used as irrigants, successively, in all four root canals. Each of the four canals was finally irrigated with 40 ml of a 2.2% NaOCl solution, dried and obturated using Acroseal (Septodont) and a single gutta-percha cone with an adequate taper (DENTSPLY Maillefer; Fig. 3).

The intra-oral, retro-alveolar radiograph captured post-treatment was of relatively poor quality owing to superimposition and interference of the infra-zygomatic arch and adjacent bone structures, and failed to show the most important apical portions of the roots with the correct root canal fillings (Fig. 4).

In agreement with the patient, a CBCT scan was obtained, primarily to check the treatment outcome, but also to document this extremely rare case with much more accurate and reliable images. The small field of view (50 x 50 mm) was recommended, and the data was acquired by SCANORA 3Dx (SOREDEX) immediately after the treatment and at the six-month recall.

The edited images (OnDemand3D, Cybermed) clearly visualized two distinctive palatal roots, their relation to the two buccal roots, the adjacent anatomic structures and, most importantly, the quality of the obturation of all four root canals (Figs. 5–9, arrows).

**Conclusion and key learning points**

A careful assessment of the internal anatomy of the pulp chamber is essential for detecting all root canals.

A maxillary second molar with two separate palatal roots is a rare anatomical variation and, according to our records, is detected only once in a decade.

CBCT images provide more accurate and reliable information regarding roots and the root canal morphology than conventional radiographs are able to provide. Furthermore, concerning the treatment outcome, CBCT images enable a much more predictable and successful endodontic treatment procedure.

*Editorial note: This article is based on the work presented at the 16th congress of the European Society of Endodontology in Lisbon in Portugal in 2013.*
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Interdisciplinary approach to treatment of maxillary radicular cysts:

Minimization of surgical invasiveness and medication load

Authors: Prof. Galyna Biloklytska, Dr Vasyl Rybak, Dr Iulia Braun & Dr Ievgen Fesenko, Ukraine

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Age (years)</th>
<th>Sex (F/M)</th>
<th>Place of operation</th>
<th>Preoperative preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main (3 patients)</td>
<td>24–55</td>
<td>2 F, 1 M</td>
<td>DSPMC, Kyiv Regional Clinical Hospital</td>
<td>Endodontic root canal treatment with ProTaper, AH Plus 3 days before: Nimessulid powder 100 mg (o.d.) Loratadinum 0.01 mg (o.d.)</td>
</tr>
<tr>
<td>Control 1 (5 patients)</td>
<td>24–55</td>
<td>3 F, 2 M</td>
<td>DSPMC, Kyiv Regional Clinical Hospital</td>
<td>Endodontic root canal treatment with Foredent (SpofaDental), Endomethasone N (Septodont) phosphate cement 3 days before: Nimessulid powder 100 mg (o.d.) Loratadinum 0.01 mg (o.d.)</td>
</tr>
<tr>
<td>Control 2 (4 patients)</td>
<td>24–55</td>
<td>2 F, 2 M</td>
<td>Other city policlinics</td>
<td>Endodontic root canal treatment with Foredent, Endomethasone phosphate cement None</td>
</tr>
<tr>
<td>Control 3 (4 patients)</td>
<td>24–55</td>
<td>2 F, 2 M</td>
<td>Other city policlinics</td>
<td>Endodontic root canal treatment with Foredent, Endomethasone phosphate cement None</td>
</tr>
</tbody>
</table>

Taking into consideration the active lifestyle of most of our working patients with maxillary odontogenic radicular cysts, such patients require more minimally invasive interventions that will not disturb their usual activities, can be provided in outpatient departments (do not require hospitalization), do not lead to typical post-operative complications, do not require additional antibacterial load, and do not disturb the natural contour of the soft periodontal tissue in operated area, leading to postoperative aesthetic complications. With new treatment approaches, such as using autologous plasma rich in growth factors (PRGF-Endoret, BTI Biotechnology Institute), and the development of the Minimally Invasive Surgical Technique, there is opportunity for modification of the standard approaches to the treatment of odontogenic radicular cysts, retaining the basic principles, but minimizing the invasiveness of such an operation. Using modern approaches, including different types of surgical incisions for predictable preservation of periodontal soft tissue post-operatively, cyst cavity preparation with modern devices and choice of suturing technique, it is possible to minimize the typical post-operative complications, the medication load and post-operative gingival recession. The use of autologous plasma has been explored in periodontology and maxillofacial surgery. Since it has a high concentration of biologically active factors and can be used in different forms (liquid, membrane, clot), it can be used in surgeries, including on bone tissue. Based on data on the effect of autologous plasma on inflammatory response, stimulation of osteogenesis and tissue regeneration according to the biological pathway, studies today continue to make supporting findings for the use of autologous plasma. In addition, the use of ultrasonic devices in dentistry is widespread and ultrasonication can be used during surgery on bone tissue.
Material and methods

Sixteen patients aged 24–55 who had been diagnosed with maxillary odontogenic radicular cysts were selected for the study and had undergone etiologic treatment. The patients were divided into four groups depending on the treatment provided and the criteria given in Tables 1–3. All patients in the main and Control 1 groups underwent complete clinical and radiographic examination. Data on patients in the Control 2 and 3 groups was collected from a database of city policlinics in Kiev. All of the patients were divided according to preoperative preparation and surgical method during cystectomy. In the main and Control 1 groups, preoperative endodontic treatment of the involved teeth was performed and temporary splinting was done using orthodontic buttons attached with a light-curing composite (Spectrum TPH, DENTSPLY) and fixed with an elastic ligature without tension. In patients in the main group, venous blood was drawn preoperatively and autologous plasma was prepared using BTI technology. The prepared material was stored in sterile glass vials until needed.

For surgical access, under local anaesthetic, an intrasulcus incision was performed, as well as a horizontal incision, in the area of the interdental papilla base according to the Minimally Invasive Surgical
I researched the treatment of maxillary radicular cysts using the Modified Papilla Preservation Technique, and vertical incisions were made in the area of the adjacent healthy teeth. The mucoperiosteal flap was formed and raised, and a bone window over the cyst was made using a surgical drilling bur. The curettage of the cyst cavity and the roots of the involved teeth was performed using a combination of manual and ultrasonic methods (Cavitron Select SPS, DENTSPLY) until complete cavity degranulation.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Surgical stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incision, shape of mucoperiosteal flap</td>
</tr>
<tr>
<td>Main</td>
<td>Trapezoidal with preservation of interdental papilla and gingival contour</td>
</tr>
<tr>
<td>Control 1</td>
<td>Trapezoidal, semilunar</td>
</tr>
<tr>
<td>Control 2</td>
<td>Trapezoidal, semilunar</td>
</tr>
<tr>
<td>Control 3</td>
<td>Trapezoidal, semilunar</td>
</tr>
</tbody>
</table>

Table 2. Patient division into groups according to type of surgical method.

Table 3. Patient division into groups according to suturing technique and post-operative management.

Figs. 3a & b. A series of radiographs taken during the endodontic stage of treatment. The teeth involved (teeth #11–13) were treated with ProTaper files (DENTSPLY) and AH Plus (DENTSPLY).

Fig. 4. Fixation of orthodontic buttons on the teeth in the future surgical area.

Fig. 5. The mucoperiosteal flap was formed and raised. The bone window over the cystic cavity was made. The apices of the involved teeth were located in the cystic cavity.

Figs. 6a & b. Ultrasonication of the cystic cavity (a) and root surfaces (b).
In the main and Control 1 groups, apicectomy of the involved teeth was performed. Before retrograde root canal filling (ProRoot MTA, DENTSPLY), the resectioned root canal cavities were prepared by ultrasonication (Cavitron Select SPS). In the main group, after antiseptic irrigation of the cyst cavity (Decasan, Yuria-Pharm), an intrafocus, grid-like osteotomy was performed using a small round bur (2 mm) and staggered small perforations were made, achieving removal of 50% of the cortical bone layer surrounding the cyst. The prepared cavity was completely filled with PRGF autologous plasma in the form of a gel-like clot (mixed with blood clots collected during surgery) and a PRGF membrane, which completely covered the vestibular aspect of the defect. In the Control 1 group, the cyst cavity was filled using a xenogeneic bone substitute material (Bio-Oss, Geistlich) mixed with blood.
The flap was then adapted and repositioned coronally with the marginal flap edge advanced 0.2–0.5 mm coronally to cement-enamel junction (CEJ). The suturing technique used in both groups was the same. The wound was sutured using a modified internal mattress suture. The proximal ends of the sutures were knotted on to the orthodontic buttons, the suture in the interdental space was attached to two buttons on the adjacent teeth, which provided additional coronal flap repositioning and complete closure of the previously opened periodontium, as well as long-term blood clot stability. Interrupted sutures were used in the area of the vertical incisions until complete wound closure. The elastic ligature was attached to the orthodontic buttons without tension, providing additional immobilization of the teeth.

The surgical site was then covered with a cellulose dressing (Reso-Pac, Hager & Werken). The pressure bandage was prescribed for patients for a period of three nights. The post-operative medications prescribed are shown in Table 3 for each group. In the
main and Control 1 groups, 0.12% chlorhexidine was prescribed (rising three times per day) for three weeks post-operatively for oral hygiene. The treatment of the Control 2 and 3 groups was provided in other clinics, and the data collection and details regarding the treatment process were obtained from the archives of the respective city clinics. The anamnesis and post-operative description of the soft-tissue condition were done at the Dental Training Centre (DSPMC) at P.L. Shupyk National Medical Academy of Postgraduate Education in Kiev.

_Foreword_

Our preliminary results during observation showed that the healing process in the main group was not accompanied by pain, owing to wound stability due to the suturing technique used. Only 33% of patients in the main group experienced pain on Day 1 and 2 post-operatively, compared with 50–60% of patients in all three control groups who experienced pain for 1–7 days. Also post-operative facial oedema was observed in all patients, but its duration was the shortest in all three patients in the main group, lasting 1–2 days, with a significant decrease on the third day. In patients in all three control groups, general antibiotic therapy was prescribed; in spite of this, in 25–50% of patients, a slight temperature increase was observed (from 37.0 °C to 37.5 °C) 1–2 days post-operatively. In the main group, general antibiotic therapy was not prescribed and the temperature increase was absent in all patients. Patients in all three control groups reported slight discomfort during eating 1–7 days post-operatively, but this was completely absent in patients in the main group.

During examination of post-operative ossification, the preliminary observation three weeks post-operatively was a decrease in the cystic cavity bone defect due to peripheral defect ossification corresponding to physiological mechanisms. Post-operative recession occurred in 40% of patients in the Control 1 group and in 87.5% of patients in the Control 2 and 3 groups after one month. The rate was 20% and 87.5%, respectively, after two months and 20% and 75%, respectively, after three months. In patients in the main group, marginal contour stability was observed and absence of recession after three months post-operatively.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Post-operative manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pain (%)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Main</td>
<td>33% on Day 1–2</td>
</tr>
<tr>
<td>Control 1</td>
<td>60% on Day 1–5</td>
</tr>
<tr>
<td>Control 2</td>
<td>50% on Day 1–7</td>
</tr>
<tr>
<td>Control 3</td>
<td>50% on Day 1–5</td>
</tr>
</tbody>
</table>

_Foreword_

*Fig. 16*. A panoramic radiograph six months post-op. In the area of the defect, new bone formation can be observed. The apical filling with ProRoot MTA can be seen in teeth #11 and 12, and no signs of inflammation can be seen in the surgical area.

*Fig. 17*. A radiograph of teeth #11–13, showing new bone formation and a reduction of the defect contour.

_Figs. 18a–c_. A CT scan of tooth #11 six months post-op in the area of the previous defect. The bone density is 135.685 HU (b). In comparison, the cortical bone density in the area of tooth #21 is 716 HU (c).

Table 4. Details of post-operative clinical manifestations.
Conclusion

The preliminary results showed that using PRGF autologous plasma prepared using BTI technology with its various consistencies (clot, membrane) for filling cystic bone cavities after their ultrasonication during cystectomy can be a useful method to minimize surgery time with quick antiseptic debridement and preparation and to avoid the usual antibiotic therapy if cysts are smaller than 3 cm. In addition, the suturing technique used provides complete wound closure in the interdental space and long-term coronal flap repositioning, minimizing the risk of post-operative recession and other complications. The preliminary data indicates a positive therapeutic effect of PRGF autologous plasma on the maturation and revascularization of the soft periodontal tissue and support of physiological bone tissue regeneration. Further studies are, however, required. Furthermore, this approach minimizes the medication load and maximally decreases patients’ discomfort during healing, which is the very aim of modern dental treatment approaches, being minimally invasive and supporting physiological response.

about the authors

Prof. Galyna Biloklytska, DDS, Honoured Master of Science of Ukraine, is head of the Dental Training Centre at P.L. Shupyk National Medical Academy of Postgraduate Education in Kiev in Ukraine and head of the Department of Therapeutic Dentistry at the same institution.

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Dr Iuliia Braun conducted her PhD research on the combined use of diode laser and Endogain during the surgical stage of treatment in patients with moderate and severe periodontal disease. She is currently a maxillofacial surgeon at the Dental Practical-Scientific Centre at P.L. Shupyk National Medical Academy of Postgraduate Education.

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Figs. 19a–d. Condition of soft tissue six months post-op. The marginal periodontal tissue has healed completely and matured and the interdental papilla fills the interdental space. The recession of tooth #13 has not increased and the amount of surrounding gingival tissue is such that it can be used for covering the recession in the future.
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The field of digital dentistry is rapidly evolving, with new dental technologies emerging as part of a more efficient and comprehensive workflow. By pairing Planmeca CAD/CAM solutions with radiographic units in the Planmeca ProMax 3D family, dental professionals can bring together a wide range of detailed information for treatment planning and diagnostic purposes. This seamless combination of CAD/CAM and CBCT technology presents new possibilities in creating a new standard of care for patients, offering high-quality features for different specialities, all available through one software interface.

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The rise of same-day dentistry

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The new FireCam HD by 3D ISC Imaging, a manufacturer of digital imaging solutions, is an intra-oral camera that rapidly delivers high-definition images during consultations, enhancing chair-side time with patients.

“Advancements in camera technology have allowed us to fit an incredibly high number of pixels into the FireCam HD. With 5M pixels, it is the intra-oral camera with the highest definition image on the market. It enables you to see every little detail while examining patients’ teeth,” said Sigrid Smitt-Jeppesen, CEO of 3D ISC Americas.

Dentists can use the FireCam HD during consultations to show patients a clear image of their dental problems, document patients’ issues before starting treatments and record progress during ongoing treatments. It can be used to motivate patients to initiate further treatment and encourage patients to change their oral hygiene habits, as it enables them to see the problem with their own eyes.

The FireCam HD adjusts images automatically. With auto-focus and auto-brightness, it yields the best image possible. This allows dentists to focus on their patients instead of dealing with hardware settings.

A specially designed heating mechanism prevents the patient’s breath fogging the lens and thus causing images to become unclear. The seamless exterior of the FireCam HD leaves nowhere for bacteria to hide and is easily cleaned with disinfectant liquid. These two features eliminate the need for plastic sheaths, which blur and lower the image quality and detail.

As 3D ISC has designed the FireCam HD to be the size of common dental instruments, the compact design fits naturally into the hand of the dentist. The slim design also makes it a more pleasant experience for the patient.

In March 2015, the company exhibited the FireCam HD at the International Dental Show (IDS) in Cologne in Germany.
RAY introduces new imaging system at IDS

RAY, a specialist in digital radiation technology, introduced its latest extra-oral imaging system, the RAYSCAN α+, at the 2015 International Dental Show (IDS). In addition, the company, formerly a subsidiary of Samsung Electronics, has announced a new initiative to become an independent manufacturer. RAY’s strategic decision to leave the Samsung Electronics venture fund provides the company the freedom to create innovative dental imaging technologies, the company stated.

Recently, Dr Sangchul Lee, the founder of RAY, purchased the main stocks from Samsung to own the company. This founder-owned system allows RAY to make faster decisions and progress toward the global market, the company stated. RAY’s singular focus on the dental market and a significant investment by a investment by BRV Lotus, part of venture capital firm BlueRun Ventures will lead to substantial growth, particularly in the crucial US and European markets, which comprise 70 per cent of all of its dental imaging sales.

According to RAY, Samsung selected the manufacturer as the first subsidiary to start up in the healthcare business owing to its expertise in the field. During the project with Samsung, RAY built an effective quality control system and introduced the first radiographic unit in the medical field. In 2012, RAY introduced RAYSCAN α, and its revenue has almost doubled every year over the last two years.

IDS attendees could visit RAY booth for a demonstration of the new RAYSCAN α+. The state-of-the-art technology allows for faster scanning (4.9 seconds) and real-time CT (reconstruction, 1.5 seconds). Also on display was the new RIOSensor digital radiography system, an intra-oral sensor with dedicated radiographic imaging software._
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After achieving a record result, the 36th International Dental Show (IDS) that was characterised by an excellent atmosphere closed its doors in Cologne after five days. Around 138,500 trade visitors from 151 countries attended the world’s leading trade fair of the dental industry, which corresponded to an increase of almost eleven per cent compared to the previous event. IDS also achieved new records in terms of the number of exhibitors and the exhibition space sold.

2,201 companies (+6.9 per cent) from 56 countries presented a wealth of innovations, product developments and services on exhibition space covering 157,000 square meters (+6.2 per cent). With an over 70 per cent share of foreign exhibitors [2013:
68 per cent) and a 17 per cent increase in the number of trade visitors from abroad the level of internationality of the event was once again significantly increased. At the same time, the number of trade visitors from Germany also increased markedly in comparison to 2013 (+4.3 per cent).

“We succeeded in making the International Dental Show in Cologne even more attractive, on both a national and international basis. It is thus the most successful IDS of all time,” summed up Dr Martin Rickert, Chairman of the Association of German Dental Manufacturers (VDDI). “The quality of the business contacts between the industry and the trade as well as between the industry, dentists and dental technicians was extremely high. The number of orders placed at IDS rose once again and we are reckoning with sustainable impulses for the post-fair follow-up business,” added Katharina C. Hamma, Chief Operating Officer of Koelnmesse GmbH.

Furthermore she said: “In addition to the growth in the number of German trade visitors, the high international response once again underlines the character of IDS as the world’s leading trade fair of the dental industry. The International Dental Show particularly recorded strong growth in the number of visitors from the Near and Middle East, the United States and Canada, Brazil as well as from China, Japan and Korea. The business in the South East European market, especially Italy and Spain, has also increased noticeably.”

_Fantastic outcome of the trade fair and excellent mood

The hustle and bustle in the halls made the high attendance at IDS very apparent. By all accounts, representatives from all relevant professional groups—from dentists’ surgeries, dental laboratories, from the dental trade, but also from the higher education sector—from all over the world had visited the exhibition stands. The exhibitors were especially pleased about the high level of internationality of the trade visitors. In terms of business, IDS was very successful for many companies, because orders were placed—by both national and international customers.

Numerous companies were pleased to announce full order books. Aspects such as grooming contacts, customer bonding, winning over new customers or penetrating new foreign markets were at least equally important for the exhibitors. These goals were also achieved to complete satisfaction at the 36th International Dental Show. The exhibitors evaluated the quality of the visitors very positively. This finding is confirmed by the initial results of an independent visitor survey: 83 per cent of all of the visitors are involved in purchasing decisions at their company.

“The world meets up at IDS in Cologne,” summed up Sebastian Voss, managing partner of Hager &
Meetings

IDS

Meisinger GmbH. "More international customer contacts visited our stand this year than in 2013. Visitors from Latin America were particularly well represented, but also from Asia. "We were able to establish countless new contacts at IDS and also met up with our existing customers." Martin Dürstein, Chairman of Dürr Dental AG, was also extremely satisfied: "The trade fair went very well for us, it was fantastic. We received a high number of particularly qualified trade visitors. We are totally satisfied with the fair, because we were able to welcome many new customers from Asia, Arabia, Latin America and South Africa."

Christian Scheu, Executive Director of Scheu-Dental GmbH also praised the further increased internationality of IDS: "In comparison to 2013, we were able to further increase the number of visitors at our stand, in particular visitors from abroad. The Asiatic region, for instance China and Korea, were especially well represented, but we also registered an increase in the number of customers from Southern Europe." As well as the high frequency of visitors at his stand, Axel Klarheimer, Executive Director of BEGO, also reported, "that the customers were well informed and that they showed great interest in new technologies."

Walter Petersohn, Vice President Sales of Sirona Dental Systems, was also pleased "about the vast numbers of international visitors, the buying interest and as always about the large number of attending German dentists and dental technicians." Michael Tuber, Executive Director of A. Titan also awarded IDS 2015 top marks. "This is the seventh time we have exhibited at IDS and we have optimally achieved the goal we set ourselves, namely further expanding our international sales network. The trade fair offers us the perfect platform for meeting up with our existing customers from all over the world, but at the same time, we were able to establish many new customer contacts. This is why the International Dental Show is an absolute must for every American manufacturer from the dental industry."

IDS 2015 was also a success for Andrew Parker, CEO of Mydent International: "We met up with our international customers here in Cologne and were additionally able to make over 100 interesting new contacts to dental dealers. No other event in the world has such international appeal."

_Satisfied visitors all round

The visitor survey revealed that over 75 per cent of the respondents were (very) satisfied with IDS. The fair’s comprehensive spectrum of products and new products ensured that 81 per cent of visitors rated the product range as being (very) good. 74 per cent of the exhibitors were (very) satisfied in terms of reaching the goals they had set themselves for the fair. Overall, 95 per cent of the visitors questioned would recommend visiting IDS to business partners and 77 per cent also intend to visit IDS 2017.

The International Dental Show (IDS) takes place in Cologne every two years and is organised by the GFDI Gesellschaft zur Förderung der Dental-Industrie mbH, the commercial enterprise of the Association of German Dental Manufacturers (VDDI) and is staged by Koelnmesse GmbH, Cologne.

The next IDS—the 37th International Dental Show—is scheduled to take place from 21 to 25 March 2017.

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