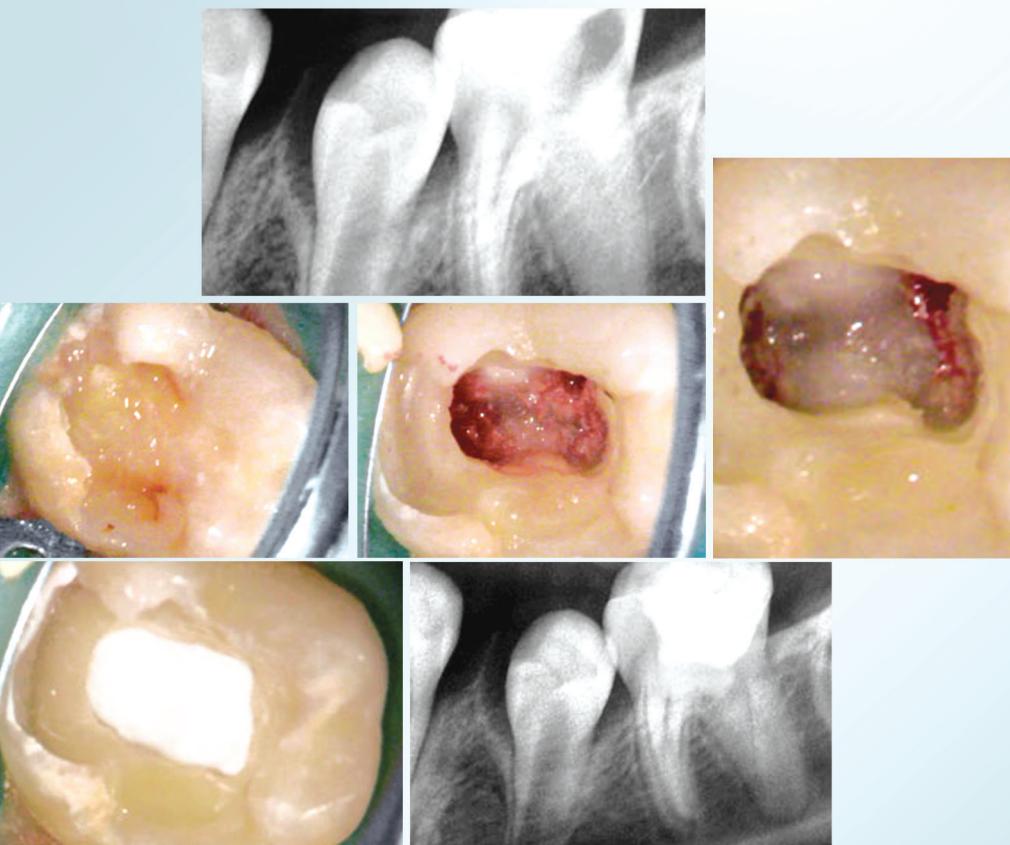


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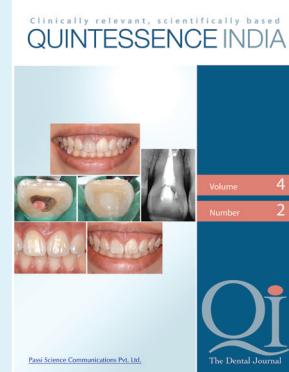
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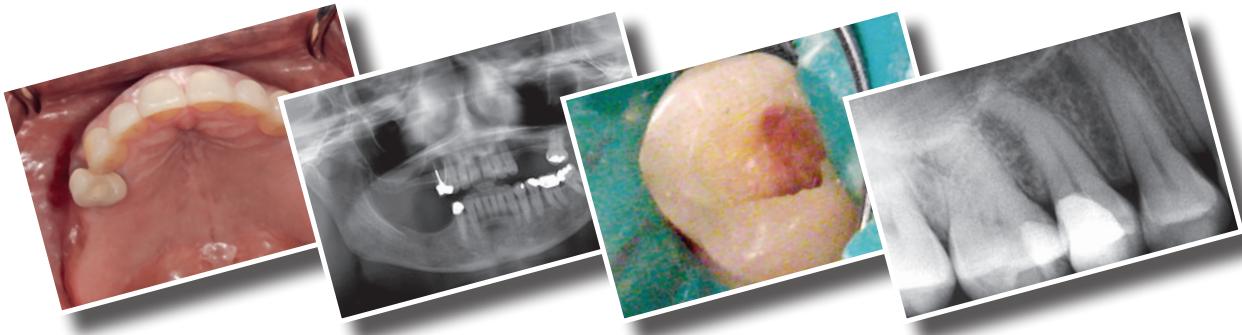
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Faris Z. Jamjoom / Simon D oliveux / Dominique D. Rousson / Bernard Friedland / Adam Hamilton

Block anesthesia for the maxillary division (V2) of the trigeminal nerve is a suitable approach when an entire quadrant of teeth and/or associated structures are involved. The most effective approach to anesthetize the maxillary branch is intraorally via the greater palatine canal. This case report describes the use of a computer-aided design/computer-assisted manufacturing (CAD/CAM) implant surgical template designed with a guide channel to allow for the administration of maxillary nerve block through the greater palatine canal.

Endodontics

- 17** Clinical guidelines for vital pulp therapy

George Bogen

Vital pulp therapy is a minimally invasive procedure designed to preserve the dental pulp when it is affected by dental caries, trauma, restorative procedures or dental anomalies. The treatment can be completed in both asymptomatic and symptomatic teeth, including those diagnosed with reversible or irreversible pulpotitis. Teeth with necrotic pulps should be treated by root canal treatment, otherwise they may have to be extracted. The type of intervention to be used can vary from a direct pulp cap to a pulpotomy depending on the extent of affected tissue and level of inflammatory response; thus, depending on the amount of pulp tissue to be preserved.



Periodontics

- 21** Modified tunnel double papilla procedure for root coverage in the anterior mandible

Alon Sebaoun / Carlos E. Nemcovsky / Ilan Beitzlitz / Ofer Moses

Free connective tissue grafts, barrier membranes, pedicle flaps, soft tissue allografts, and xenografts have been described for root coverage and augmenting the zone of attached gingiva. The present report evaluated a modified tunnel surgical procedure for root coverage of mandibular anterior teeth where a connective tissue graft was combined with a tunnel and double papilla flap. Fourteen patients with 18 consecutive Miller Class I or II gingival recession defects in the anterior mandible were treated with a connective tissue graft combined with a tunnel and double papilla flap procedure.

Prosthodontics

- 29** Effect of molar preparation axial height on retention of adhesively-luted CAD-CAM ceramic crowns

Robert Wake / Richard Buck / Nicholas DuVall / Howard Roberts

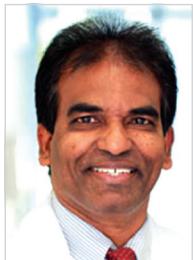
The purpose of this article is to evaluate the effect of axial wall height (AWH) on failure resistance of CAD-CAM adhesively-bonded, all ceramic crowns on molar preparations with a conservative total occlusal convergence (TOC). 60 newly extracted maxillary third molars were divided into 5 groups ($n = 12$) and prepared for all-ceramic crowns with occlusal cervical AWH of 0, 1, 2, 3, and 4 mm, all containing a conservative 10-degree TOC.

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Jayakumar
Jayaraman



Mel Mupparapu

Dental age estimation using radiographs: An unsettling conflict between ethical principles and scientific evidence

The need for age estimation arises from two main circumstances: first, poor birth registration practices, and second, falsified reporting of age. Although world nations have taken efforts to register births, the United Nations Children's Fund (UNICEF) reports that more than one quarter of the global population of children under the age of 5 have never been registered.¹ There is a global increase in cross-border migrations, particularly in the United States. In the first half of fiscal year 2019, around 780,000 people were denied entry while trying to cross the border compared to 521,000 in the entire fiscal year 2018.² Unaccompanied alien children (UAC) alone represent around 10% of total people seeking asylum.² Age becomes disputed when a subject cannot provide an authentic document to prove their age. The falsification of age is mostly noted when a subject claims his or her age to be lower than their true chronologic age to claim the benefits that are commonly reserved for juveniles. The 18-year-old threshold is of particular importance since this age differentiates a juvenile from an adult.

A strong correlation exists between physical growth and chronologic age ascertained from different biologic indicators. Amongst these indicators, age estimated from dental tissues has shown to be more accurate, as these tissues are subjected to the least modification from environmental or nutritional changes. Several methods of dental age estimation have been developed, but radiologic methods have been shown to be the least invasive, and provide

accurate, reliable estimates of age. Panoramic radiography provides an opportunity to evaluate the developing dentition in a single tomographic image. Based on this imaging technique, several investigators have reported standards on dental development for different ethnic groups. Particularly at the 18-year-old threshold, the standards have been reported mainly based on the crown and root development,³ root pulp volume,⁴ and periodontal ligament visibility.⁵ These methods have been tested for diagnostic accuracy through validity and reliability assessments.

Although the scientific literature has clearly favored dental age estimation as a reliable method to estimate age, several concerns have been raised for this procedure, including that it is inaccurate and unethical.⁶ The concerns regarding the ethical aspect of age estimation stem from accuracy of the estimated age due to variability in the rate of dental development, subsequent statistical approaches to determine the age, and exposure of radiation for the purpose of dental age estimation. The most vital part of an age estimation method is the quality and accuracy of the reference data that are used for estimating the age of an individual. Many population-specific dental reference standards have been published in recent years that could narrow the population variability in dental development. This is available for major ethnic populations including white people,⁴ Chinese,³ Africans,⁷ and many more. In addition, newer statistical methods allow calculation



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of the probability of a person "above" or "below" a specific age threshold within specific levels of certainty. Based on a large data of white subjects, Lucas et al⁴ showed that a subject who exhibits complete root development of mandibular third molar combined with stage C or stage D of root pulp volume (RPV-C, RPV-D)⁴ and periodontal ligament visibility (PLV-C, PLV-D),⁵ is indisputably above the 18-year threshold.

The use of radiographs is an integral part of the process of dental age estimation. It is noteworthy that ionizing radiation exposures, even at very low levels, carry some risk. However, an estimated 50% (3.10 mSv) of global annual effective dose (6.20 mSv) are from natural background radiation while the remaining 50% (3.10 mSv) are from other sources including diagnostic medical radiology.⁸ About half of the human-made radiation exposure comes from computed tomography (CT) scanning.⁸ Dental radiography accounts for approximately 2.5% of the effective doses received from all medical radiography and fluoroscopy combined.⁸ The radiation doses in dentistry are minimal and should not be a matter of concern. In addition, a variety of measures are in place to minimize the radiation dose received by patients, including the use of appropriate selection criteria, minimizing re-exposures, appropriate technique, and the use of digital detectors instead of film.⁸

Many countries in the world, including the US, have experienced a rapid increase in the demand for forensic age estimates of unaccompanied alien children. Estimation of the exact date of birth is practically impossible and, to date, no method has been able to achieve this. Age estimation using dental radiographs alone has been extensively analyzed and, based on the best scientific evidence to date, it has shown to be fairly accurate and reliable. Best efforts must be taken to safeguard the rights of children and age estimation must always be used as a last resort when all efforts to ascertain an individual's age fail. The risk of exposure to very low levels of ionizing radiation must be balanced with the benefit of an individual and, perhaps, the society as a whole. Only trained advocates should be allowed to interview and examine the children to elicit information and determine age. When radiographs are exposed, the exposure must be kept to a minimum and the resulting image must be interpreted by a trained and calibrated dental professional and reviewed by a second trained

professional. The report must clearly mention the method of assessment employed, and statistical analysis must be presented along with margin of error. As advocates of children, we have a great role to protect their rights, and any procedure should be conducted in accordance with codes of principles put forth by the medical and dental fraternities. Issues with cross-border migration will not end, and the demand for age estimation will continue to rise. It is time to stop false propagations on age estimation methods and have a fresh look at the empirical evidence.

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REFERENCES

1. Birth Registration. United Nations Children's Fund. 2018. <https://data.unicef.org/topic/child-protection/birthregistration/>. Accessed 3 October 2019.
2. Southwest Border Migration FYI 2019. U.S. Customs and Border Protection. <https://www.cbp.gov/newsroom/stats/swborder-migration>. Accessed 3 October 2019.
3. Jayaraman J, Wong HM, King NM, Roberts GJ. Development of a Reference Data Set (RDS) for dental age estimation (DAE) and testing of this with a separate Validation Set (VS) in a southern Chinese population. *J Forensic Legal Med* 2016;43:26-33.
4. Lucas VS, McDonald F, Andiappan M, Roberts G. Dental age estimation: periodontal ligament visibility (PLV)—pattern recognition of a conclusive mandibular maturity marker related to the lower left third molar at the 18-year threshold. *Int J Legal Med* 2017;131:797-801.
5. Roberts GJ, Lucas VS, Andiappan M, McDonald F. Dental age estimation: pattern recognition of root canal widths of mandibular molars. A novel mandibular maturity marker at the 18-year threshold. *J Forensic Sci* 2017;62:351-354.
6. Moze K, Roberts G. Dental age assessment (DAA) of Afro-Trinidadian children and adolescents. Development of a Reference Dataset (RDS) and comparison with Caucasians resident in London, UK. *J Forensic Legal Med* 2012;19:272-279.
7. Aynsley-Green A, Cole TJ, Crawley H, Lessof N, Boag LR, Wallace RM. Medical, statistical, ethical and human rights considerations in the assessment of age in children and young people subject to immigration control. *Br Med Bull* 2012;102:17-42.
8. National Council on Radiation Protection Measurements. Ionizing radiation exposure of the population of the United States: Recommendations of the National Council on Radiation Protection and Measurements (NCRP Report No. 160). Bethesda: National Council on Radiation Protection and Measurements, 2009. <https://ncrponline.org/publications/reports/ngrp-report-160-2/>. Accessed 5 Nov 2019.

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A modified implant surgical guide for the administration of maxillary nerve block anesthesia intraorally via the greater palatine foramen: Case report

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Block anesthesia for the maxillary division (V2) of the trigeminal nerve is a suitable approach when an entire quadrant of teeth and/or associated structures are involved. The most effective approach to anesthetize the maxillary branch is intraorally via the greater palatine canal. This case report describes the use of a computer-aided design/computer-assisted manufacturing (CAD/CAM) implant surgical template designed with a guide channel to allow for the administration of maxillary nerve block through the greater palatine canal.

Key words: 3D, CAD/CAM, local anesthesia, sinus elevation, surgery, surgical guide

Local anesthesia is described as the loss of sensation in a defined region of the body caused by the depression of excitation in nerve endings or inhibition of conduction in peripheral nerves.¹ Deposition of the local anesthetics very close to the nerve is necessary to allow for optimal diffusion of the solution, ultimately achieving profound anesthesia.² Pain control using local anesthetics is an important element when performing invasive dental and oral procedures, with numerous traditional, advanced, and auxiliary techniques described in the literature.^{1–3}

Blocking the maxillary division (V2) of the trigeminal nerve provides anesthesia for the maxillary teeth, periodontium, palatal mucosa, maxillary sinus, parts of the nasal cavity, upper cheek and lip, and lower eyelid.^{2,4–9} This approach is generally considered when an entire quadrant of teeth and/or associated structures are involved.^{5–10} It is also particularly useful for large procedures, as it can significantly reduce the amount of local anesthetics and number of injections while providing a more profound anesthesia compared with multiple local infiltrations in the maxilla.^{4,10} Furthermore, maxillary nerve blocks can be used for the treatment of painful conditions such as migraines, facial pain, cluster headaches, and trigeminal neuralgia.^{4,11–13}

The most effective approach to anesthetize the maxillary branch is intraorally via the greater palatine canal (GPC).^{2,8} The GPC approach to the maxillary nerve block was first described by Nevin in 1917, but was later modified by Silverman, and Wong and Sved.^{6,10,14–16} To administer the local anesthetics, the greater palatine foramen (GPF) must first be located by palpating the soft depression on the posterior part of the hard palate at the junction of the horizontal palate and the vertical alveolar bone, usually distal to the maxillary second molar.^{2,5,8} The needle is inserted into the GPF through the palatal mucosa, and 0.1 to 0.3 mL

Key Point

In implant dentistry, the use of three-dimensional imaging and virtual implant planning has allowed for the presurgical determination of the most appropriate implant position relative to the planned prosthesis while avoiding vital anatomical structures

of the local anesthetics is injected after negative aspiration to anesthetize the area.^{2,5,16} The GPC can then be gently negotiated using a long needle advanced slowly along the canal at 45 to 60 degrees to the occlusal plane, to a depth of approximately 30 mm.^{2,5,6,16} Aspiration must be performed at multiple stages along the course of the canal prior to dispensing the content of the cartridge to avoid intravascular or nasopharyngeal injection.^{2,16}

Maxillary nerve block via the GPC is contraindicated in the presence of acute infection in the GPF area, which may spread into the pterygopalatine fossa as a result.^{6,16} Difficulty locating the GPF and negotiating the GPC are also considered contraindications of the approach.⁶ Although the GPC approach is effective and efficient, a number of complications have been associated with it.^{5-7,17} The most notable complications reported with varying rates of occurrence include diplopia, epistaxis, intravascular injection, neural injury, anesthesia of orbital nerves, broken needle, and failure of anesthesia.^{5-7,9,13,17} Absence of anesthesia is a frequently encountered problem; this is the result of significant anatomical variability, which can make it difficult to localize the GPF and negotiate the GPC.^{5,7-9,13,18} Different types of image guidance such as x-ray fluoroscopy, ultrasonography, and computed tomography (CT) have been used with various nerve block techniques in order to ensure accurate needle placement and the achievement of the desired anesthetic effect.^{11,12,19,20}

In implant dentistry, the use of three-dimensional (3D) imaging and virtual implant planning has allowed for the presurgical determination of the most appropriate implant position relative to the planned prosthesis while avoiding vital anatomical structures.²¹⁻²⁴ Subsequently, the virtual implant position can be transferred to the surgical field through the use of computer-aided design/computer-assisted manufacturing (CAD/CAM) surgical guides with reasonable accuracy, improving the overall patient experience and reducing morbidity.²¹⁻²⁴ With further advancement of CAD/CAM technologies, planning software, and rapid prototyping, clinicians have been able to expand their use beyond guided implant placement to include procedures such as local anesthetics administration and outlining the access for lateral approach sinus augmentation.^{20,25}

The following case describes the guided surgical placement of two implants, one of which required a simultaneous indirect sinus elevation. The CAD/CAM implant surgical guide was modified to include a channel to direct the local anesthesia needle for administration of maxillary nerve block via the GPC.

CASE REPORT AND TECHNIQUE

Case presentation

A female patient aged 67 years with a noncontributory medical history presented to Harvard School of Dental Medicine. The patient was partially edentulous in both the maxillary and mandibular arches and was interested in implant rehabilitation. Apart from the third molars, the patient was missing her maxillary right second premolar, right first and second molars, left first and second premolars, left first molar, mandibular right second premolar, and right first and second molars (Fig 1). The patient was planned for implant-supported restorations for the replacement of the maxillary right second premolar and first molar, maxillary left first premolar and first molar



Fig 1 (a) Occlusal view of the maxillary arch on presentation. (b) Left side view of the patient's dentition on presentation. (c) Pretreatment panoramic radiograph.

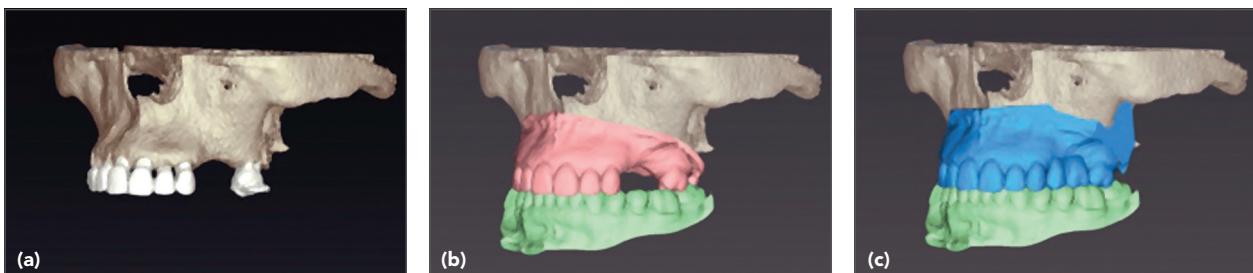


Fig 2 (a) Postsegmentation 3D rendering of maxillary complete-arch CBCT scan. (b) Digital diagnostic scans registered onto CBCT scan. (c) Digital wax-up registered onto CBCT scan.

(second premolar was omitted due to space restrictions), and mandibular right second premolar and first molar. Of these planned implants, the maxillary right first molar and left second premolar implants were planned for a simultaneous indirect sinus elevation. The mandibular right second premolar and first molar were planned with a simultaneous guided bone regeneration (GBR) procedure. The patient opted to have the procedures done by quadrant beginning with the maxillary left quadrant. Therefore, the remainder of this case report will focus on the treatment provided to that quadrant only.

Implant planning and surgical guide fabrication

A maxillary complete-arch cone beam computed tomography (CBCT) scan was exposed at 120 kV, 5 mA with a voxel size of 0.3 mm (I-CAT, Imaging Sciences International). The CBCT Digital Imaging in Medicine (DICOM) files were imported into the implant planning software, CodiagnostiX (Dental Wings). Using the segmentation function of the planning software, the bones and teeth were isolated, and scatter was removed from the 3D images (Fig 2a).

Digital diagnostic scans of both the maxillary and mandibular arches were made and articulated directly using an intraoral scanner (iTero Element 2, Align Technology), then exported as Standard Tessellation Language (STL) files. The STL files were imported into the planning software and registered onto the CBCT scan using the maxillary dentition as a reference (Fig 2b). Copies of the STL files were imported into 3D sculpting based computer-aided design (CAD) software (Meshmixer, Autodesk), on which a diagnostic wax-up was done. The diagnostic wax-up was then registered onto the CBCT

Key Point

The following case describes the guided surgical placement of two implants, one of which required a simultaneous indirect sinus elevation

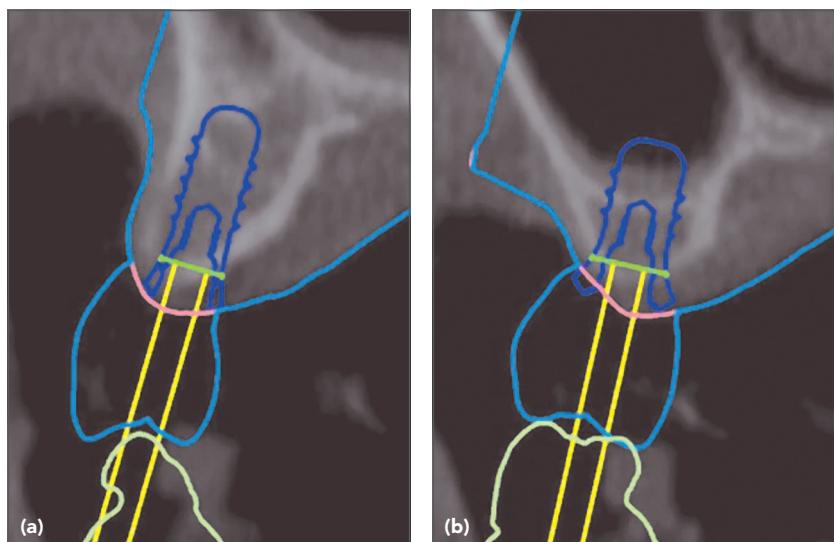


Fig 3 (a) First premolar virtual implant planning. (b) First molar virtual implant planning.



Fig 4 (a) Left GPF (circled) identified on the axial view of the CBCT. (b) Left GPF (arrow) identified on the coronal view of the CBCT. (c) Dashed line outlining the GPC on the sagittal view of the CBCT.

Key Point

Based on the prosthetic requirements provided by the diagnostic wax-up, implants were planned for the first premolar and the first molar

scan as previously described (Fig 2c). Based on the prosthetic requirements provided by the diagnostic wax-up, implants were planned for the first premolar (Standard Plus RN 4.1 × 10 mm, Institut Straumann) and the first molar (Standard Plus WN 4.8 × 8 mm, Institut Straumann) (Fig 3).

The left GPF and GPC were identified on the axial, coronal, and sagittal views of the CBCT (Fig 4). A 28-mm virtual marker (Template Fixation Pin, Institut Straumann) was planned to enter from the GPF to the pterygopalatine fossa, traversing the GPC (Fig 5). A customized guide sleeve was designed for this marker to have a length of 2 mm and an outer diameter of 2.5 mm. The marker was then moved along its axis until the guide sleeve rested above the palatal mucosa (Fig 6).

After finalization of the position of the implants and the fixation pin, a surgical guide was designed in the planning software. The customized guide sleeve presented a channel directed toward the GPF through which the needle can be inserted for maxillary nerve block anesthesia (Fig 7a). The guide was then exported as an STL file, which was sent to a commercial dental laboratory for fabrication by means of 3D printing (Fig 7b).

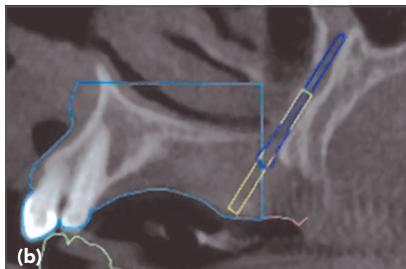
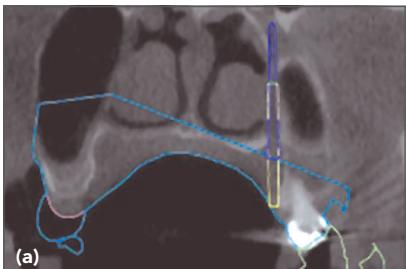


Fig 5 (a) Initial positioning of the fixation pin on the coronal view, as planned to enter from the GPF, traversing the GPC, and extending to the pterygopalatine fossa. (b) Initial positioning of the fixation pin on the sagittal view.

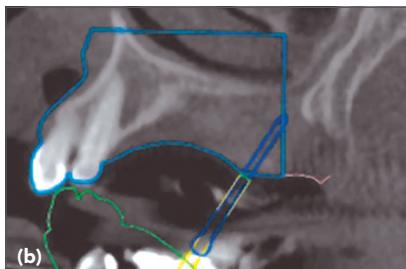
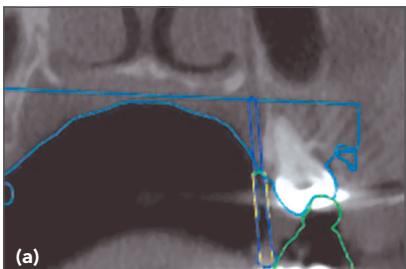


Fig 6 (a) Final position of the fixation pin on the coronal view, with the guide sleeve resting above the palatal mucosa. (b) Final position of the fixation pin on the sagittal view.



Fig 7 (a) Surgical guide as designed on the planning software. (b) 3D printed surgical guide.



Fig 8 (Left) Administration of local anesthesia through the specified channel designed in the surgical guide.

Fig 9 (Right) Implants placed.

Surgical procedure

The surgical guide was seated in the patient's mouth. Seating was confirmed through the designed inspection windows. A long 27-gauge needle (Monoject, Covidien) bent to 30 degrees from the hub was introduced into the channel penetrating the palatal mucosa, inserted through GPF, and negotiated along the GPC. To avoid injection into a vessel, aspiration was performed several times during the insertion until the hub was 2 to 3 mm away from the guide (Fig 8). 1.8 mL of 2% lidocaine HCL with epinephrine 1:50,000 was administered after negative aspiration, and the surgical guide was removed. Shortly thereafter, the patient reported numbness across the left side of the maxillary arch, midface, upper lip, and nose. Blanching of the palatal mucosa was noted as well.

Key Point

The surgical guide was seated in the patient's mouth and seating was confirmed through the designed inspection windows

After confirming adequate anesthesia, a full thickness mucoperiosteal flap was reflected. The surgical guide was resected; the osteotomy for each implant was prepared according to the planning and the guided surgery protocol. The indirect sinus elevation was performed using osteotomes and grafted using xenograft bone substitute (Bio-Oss, Geistlich). Both implants were placed, primary stability was achieved, and the implants were covered with healing abutments (Fig 9).

The mucoperiosteal flap was reapproximated passively and sutured in place for primary closure. Postoperative and hygiene instructions were given, and medication prescribed. The patient was seen for follow-up after 10 days; the patient did not report any significant issues or complaints. Clinical examination revealed normal healing with no signs of infection.

DISCUSSION

Key Point

Due to the invasiveness and complexity of the procedures performed, which included the elevation of a full-thickness mucoperiosteal flap, sinus floor elevation, and the placement of two implants, a maxillary nerve block was deemed the most suitable local anesthesia approach

Due to the invasiveness and complexity of the procedures performed, which included the elevation of a full-thickness mucoperiosteal flap, sinus floor elevation, and the placement of two implants, a maxillary nerve block was deemed the most suitable local anesthesia approach. A single 1.8-mL carpule provided profound anesthesia lasting for the entire duration of the procedure. The modification made to the CAD/CAM implant surgical guide allowed for a more controlled needle insertion and navigation, reducing the risk of anesthesia failure and associated risks.

According to Mercuri, failure to obtain anesthesia is a common problem faced with the GPC technique for maxillary nerve block, particularly for novice clinicians.⁵ The inability to locate the GPF altogether is a frequent cause of anesthesia failure.⁵ The GPF is commonly located in the posterior part of the hard palate 3 to 4 mm anterior to the posterior border of the hard palate, at the junction of the vertical alveolar bone and the horizontal palate.^{2,5,8} This often corresponds to the area on the palatal mucosa distal to the maxillary second molar.^{5,8} However, the GPF could be located further distally and more closely related to the third molar when present rather than the second molar.^{8,9} As for the GPC, studies have demonstrated variability in its length, shape, and direction in the sagittal plane.^{7,9} The length of the canal ranges from 15 to 44 mm with a mean of 31.1 mm according to Tomaszewska et al.⁹ Intracanal bony exostoses, tortuous canals, and age related canal obliteration could impede the passage of the needle through the canal and prevent proper administration of local anesthetics.^{5,7} CBCT analysis and a working knowledge of the anatomical landmarks and potential variations in this region are necessary, as the inability to locate the GPF and negotiate the GPC is a contraindication for this anesthetic technique.^{5,6,9}

Sved et al studied the complications associated with maxillary nerve block anesthesia and reported diplopia of the ipsilateral eye as the most common complication associated with this anesthesia approach, with a possible occurrence rate of 35.6%.¹⁷ The patient should be reassured and informed that the diplopia is transient and is also a good indicator of profound anesthesia.¹⁷ Neural trauma can occur; however, the occurrence rate is less than 1%.¹⁷ This can be the case when patients complain of "electric shock" during needle insertion.¹⁷ If this occurs, the needle should not be inserted farther, and alternative anesthesia procedures should be used, as this approach may not produce profound anesthesia at this point.¹⁷ Anesthetizing the orbital nerve, although rare, can occur if the needle is too

long or advanced too far along the GPC.⁵ Anesthetizing the orbital nerve leads to transient blindness of the ipsilateral eye; however, a consultation with the ophthalmologist is advised.⁵ Despite these potential complications, maxillary nerve block is considered a safe and efficient way to control pain.^{5,17}

Image guidance methods have been used with nerve blocks to increase accuracy when landmarks are difficult to identify.^{11,12,19} In pain medicine, x-ray fluoroscopy is the most common form of image guidance; however, it only displays bones, which makes it suitable only for nerve blocks that depend on bony landmarks.¹¹ Furthermore, targets such as the pterygopalatine fossa and foramen ovale may not be adequately visualized on radiographs.^{11,12} CT guidance is another approach used in the maxillofacial region, particularly for extraoral routes.^{12,19} X-ray guidance methods tend to prolong the procedure and expose patients to excessive radiation.¹¹

Three-dimensional imaging and CAD/CAM technologies allow clinicians to align multiple data sets in order to perform a comprehensive diagnostic evaluation and implant planning.²¹ This makes guided implant placement surgery more efficient and accurate.^{22–24} To make further use of the diagnostic data available, clinicians have modified surgical implant guides to include features that aid in execution of other adjunctive procedures.^{20,25} Similar to this reported case, Dahiya et al have designed a modified implant surgical guide with additional guide sleeves that allow accurate administration of local anesthetics for nasopalatine and greater palatine nerve blocks.²⁰ Although the principle behind designing the local anesthetics administration channels was the same as the one used in this case report, Dahiya et al only targeted the GPF with the virtual marker for greater palatine nerve block rather than align it with the entire length of GPC.²⁰ Therefore, without consideration of both the location and angulation of GPC, it may not be possible to administer a maxillary nerve block anesthesia. Another example of modified implant surgical guides is described by Goodacre et al.²⁵ In their report, they modified the guide to outline the sinus wall access for a lateral approach sinus augmentation with simultaneous implant placement.²⁵

The local anesthetics used in this report contained a vasoconstrictor, epinephrine at a concentration of 1:50,000 as recommended by Aravena Torres et al.¹³ The vasoconstrictor lowers the rate of absorption and prolongs the anesthetic action, potentially reducing the need for reinjection.¹ The vasoconstrictor can reduce bleeding in the surgical field and can reduce submucosal bleeding in the highly vascular area of needle entry.^{1,10} Furthermore, the vasoconstrictor may reduce the dissemination of the solution into adjacent structures, potentially reducing complications such as diplopia and headaches.^{10,13} Lower concentrations of vasoconstrictor including the use of plain local anesthetic solution have also been recommended, particularly in patients with cardiovascular problems.^{1,2,4,10} However, lower concentrations of vasoconstrictor reduce the duration of action of the local anesthetics, which should be taken into account.^{1,4,10}

The incorporation of a channel in the surgical guide for block anesthesia delivery is a promising approach that can potentially increase the efficacy and safety of local anesthetics administration; nevertheless, it does present with some limitations. The time necessary to plan such a modification to the surgical guide is increased, although it is not done chairside and indeed has the potential to shorten the surgical procedure. In patients with limited mouth opening, it may be difficult to introduce the needle into the GPF. A 30-degree bend of the needle at the hub may facilitate the entry of the

Key Point

Three-dimensional imaging and CAD/CAM technologies allow clinicians to align multiple data sets in order to perform a comprehensive diagnostic evaluation and implant planning which makes guided implant placement surgery more efficient and accurate

Key Point

This case demonstrates the utility of digital and CAD/CAM technology to modify a surgical guide to aid in administering a block to the maxillary branch of the trigeminal nerve

needle into the foramen.⁵ However, with the guide seated, it may be more difficult to maneuver the needle into the channel in such patients. Although non-negotiable canals present a contraindication for maxillary nerve block via the GPF, occasionally, if resistance is met during needle insertion due to bony exostoses or a tortuous canal, redirecting the needle tip may alleviate this issue.⁵ Despite designing the channel to be 2.5 mm in diameter to allow for some degree of repositioning if necessary, the presence of the guide can limit any further redirection and prevent the needle from reaching the required depth to produce the desired anesthetic effect.

This case demonstrates the utility of digital and CAD/CAM technology to modify a surgical guide to aid in administering a block to the maxillary branch of the trigeminal nerve. Further research and clinical trials are warranted to confirm the accuracy of local anesthetics administration and to assess whether it reduces morbidity.

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REFERENCES

1. Boyce RA, Kirpalani T, Mohan N. Updates of topical and local anesthesia agents. *Dent Clin North Am* 2016;60:445–471.
2. Reed KL, Malamed SF, Fonner AM. Local anesthesia part 2: Technical considerations. *Anesth Prog* 2012;59:127–136; quiz 137.
3. Hawkins JM, Moore PA. Local anesthesia: Advances in agents and techniques. *Den Clin North Am* 2002;46:719–732, ix.
4. Levine AI, DeMaria S. Regional anesthesia. In: Taub PJ, Patel PK, Buchman SR, Cohen MN (eds). *Ferraro's Fundamentals of Maxillofacial Surgery*. New York: Springer New York, 2015:77–90.
5. Mercuri LG. Intraoral second division nerve block. *Oral Surg Oral Med Oral Pathol* 1979;47:109–113.
6. Aoun G, Zaarour I, Sokhn S, Nassee I. Maxillary nerve block via the greater palatine canal: An old technique revisited. *J Int Soc Prev Community Dent* 2015;5:359–364.
7. Rapado-González O, Suárez-Quintanilla JA, Suárez-Cunqueiro MM. Anatomical variations of the greater palatine canal in cone-beam computed tomography. *Surg Radiol Anat* 2017;39:717–723.
8. Ikuta CR, Cardoso CL, Ferreira-Júnior O, Lauris JR, Souza PH, Rubira-Bullen IR. Position of the greater palatine foramen: An anatomical study through cone beam computed tomography images. *Surg Radiol Anat* 2013;35:837–842.
9. Tomaszewska IM, Kniotek EK, Pena IZ, et al. Computed tomography morphometric analysis of the greater palatine canal: A study of 1,500 head CT scans and a systematic review of literature. *Anat Sci Int* 2015;90:287–297.
10. Hawkins JM, Isen D. Maxillary nerve block: The pterygopalatine canal approach. *J Calif Dent Assoc* 1998;26:658–664.
11. Koizuka S, Nakajima K, Mieda R. CT-guided nerve block: A review of the features of CT fluoroscopic guidance for nerve blocks. *J Anesth* 2014;28:94–101.
12. Okuda Y, Okuda K, Shinohara M, Kitajima T. Use of computed tomography for maxillary nerve block in the treatment of trigeminal neuralgia. *Reg Anesth Pain Med* 2000;25:417–419.
13. Aravena Torres P, Cresp Sinning N, Büchner Sagredo K, Muñoz Rocha C, Cartes-Velásquez R. Relationship between volume of pterygopalatine fossa and block anesthesia of maxillary nerve: A pilot study. *Int J Morphol* 2011;29:857–861.
14. Nevin M, Puterbaugh PG. Conduction, Infiltration and General Anesthesia in Dentistry. 4th ed. New York: Dent Items Interest Publishing co.; 1938:140.
15. Silverman SL. A new and more accurate technique for injecting the superior maxillary division. *J Am Med Assoc* 1923;81:112.
16. Wong JD, Sved AM. Maxillary nerve block anaesthesia via the greater palatine canal: A modified technique and case reports. *Aus Dent J* 1991;36:15–21.
17. Sved AM, Wong JD, Donkor P, et al. Complications associated with maxillary nerve block anaesthesia via the greater palatine canal. *Aus Dent J* 1992;37:340–345.
18. Iwanaga J, Voin V, Nassee AA, et al. New supplemental landmark for the greater palatine foramen as found deep to soft tissue: Application for the greater palatine nerve block. *Surg Radiol Anat* 2017;39:981–984.
19. Kodama Y, Seo K, Tanaka R, Arashiyama T, Ajima H, Takagi R. Placement of mandibular nerve block using computed tomography to locate the foramen ovale in a patient with severe dislocation after segmental mandibulectomy. *Br J Oral Maxillofac Surg* 2009;47:407–408.
20. Dahiya A, Garbacea A, Kattadiyil MT, AlHelal A. Digital technology for performing a nasopalatine and greater palatine nerve block with a modified implant surgical guide: A technique article. *J Prosthet Dent* 2018;120:338–342.
21. Jamjoom FZ, Kim DG, McGlumphy EA, Lee DJ, Yilmaz B. Positional accuracy of a prosthetic treatment plan incorporated into a cone beam computed tomography scan using surface scan registration. *J Prosthet Dent* 2018;120:367–374.
22. Tahmaseb A, Wu V, Wismeijer D, Coucke W, Evans C. The accuracy of static computer-aided implant surgery: A systematic review and meta-analysis. *Clin Oral Implants Res* 2018;29(suppl 16):416–435.
23. Tahmaseb A, Wismeijer D, Coucke W, Derkens W. Computer technology applications in surgical implant dentistry: A systematic review. *Int J Oral Maxillofac Implants* 2014;29(suppl):25–42.
24. El Kholy K, Janner SFM, Schimmel M, Buser D. The influence of guided sleeve height, drilling distance, and drilling key length on the accuracy of static computer-assisted implant surgery. *Clin Implant Dent Relat Res* 2019;21:101–107.
25. Goodacre BJ, Swamidass RS, Lozada J, Al-Ardah A, Sahl E. A 3D-printed guide for lateral approach sinus grafting: A dental technique. *J Prosthet Dent* 2018;119:897–901.

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Clinical guidelines for vital pulp therapy

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Vital pulp therapy is a minimally invasive procedure designed to preserve the dental pulp when it is affected by dental caries, trauma, restorative procedures or dental anomalies.¹⁻⁴ The treatment can be completed in both asymptomatic and symptomatic teeth, including those diagnosed with reversible or irreversible pulpitis.⁴⁻⁸ Teeth with necrotic pulps should be treated by root canal treatment, otherwise they may have to be extracted. The type of intervention to be used can vary from a direct pulp cap to a pulpotomy depending on the extent of affected tissue and level of inflammatory response; thus, depending on the amount of pulp tissue to be preserved.⁹⁻¹¹ Mineral trioxide aggregate (MTA) is recommended for use as a pulp capping or pulpotomy agent or alternatively, another pure calcium silicate cement (CSC) may be used, not combined with any resin or resin-modified material.¹²⁻¹⁵

Key words: calcium silicate cement (CSC), clinical guidelines, mineral trioxide aggregate (MTA), pulp capping, pulpotomy, vital pulp therapy

INTRODUCTION

Key principles

The protocol suggested here can be flexible, allowing treatments to be adjusted, as long as the following principles are considered:

1. The use of a dental operating microscope (DOM) increases visibility, enhances the accuracy of caries detection and removal, pulp tissue identification and the placement of pulp capping material or agent, and improves the quality of the final restoration.¹⁶
2. The necrotic pulp tissue must be removed without exception.
3. The non-haemorrhaging pulp tissue should be considered necrotic and removed until healthy, bleeding tissue (inflamed or noninflamed), deemed saveable, is uncovered; magnification increases the ability to identify non-vital tissue.
4. Haemostasis, achieved by using various concentrations of sodium hypochlorite (NaOCl) is recommended; the higher the concentration, the more effective the haemostasis.¹⁷⁻¹⁹
5. In the case of direct pulp capping or partial pulpotomy, a tissue that continues to bleed after 10 minutes of NaOCl exposure should be considered irreversibly inflamed, and a complete pulpotomy is the better recourse.
6. The treatment applied should not be limited by the amount of pulp affected, tooth type and location, or the age of the patient.¹⁸

TREATMENT RECOMMENDATIONS

Pulp capping and pulpotomy

1. The assessment of pulpal health should be based on a differential diagnosis that includes the patient's reported symptoms, sensibility

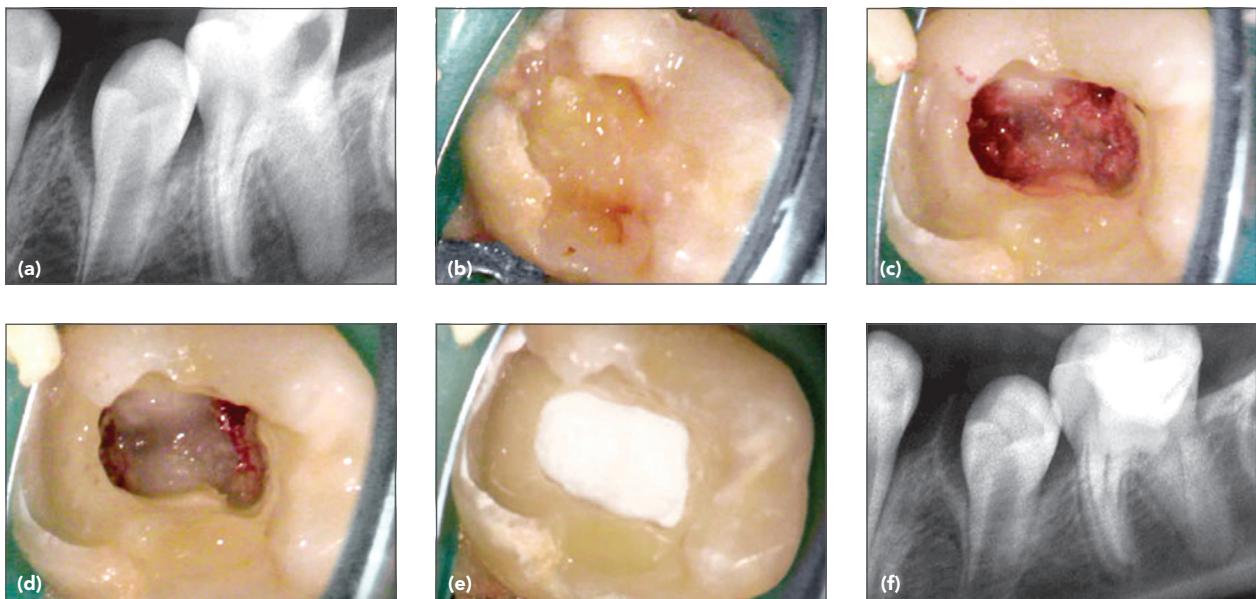


Fig 1(a) to (f) (a) Periapical radiograph of a 10-year-old female patient presenting with a symptomatic deep caries lesion situated distally on the mandibular left first molar (b) Carious dentine visible after initial cavity design completed with a highspeed diamond bur and water coolant (c) Occlusal view of the pulp chamber following removal of inflamed and necrotic coronal pulp tissue using a high speed long-shank round diamond bur (d) Radicular pulp in orifices after complete pulpotomy; 8.25% NaOCl was used to achieve haemostasis (e) Access opening view after placing 4 mm thickness white mineral trioxide aggregate (MTA) (ProRoot MTA, Dentsply, Tulsa, OK, USA) on the radicular pulp tissue and pulpal floor; a light cured flowable composite resin was placed directly over the MTA before the final restoration placement (f) Postoperative radiograph showing final, bonded restoration and completed MTA pulpotomy; the patient was symptom-free the following day.

Key Point

Vital pulp therapy is a minimally invasive procedure designed to preserve the dental pulp when it is affected by dental caries, trauma, restorative procedures or dental anomalies

testing, percussion testing, tooth mobility evaluation and radiographic imaging.

2. After achieving profound local anaesthesia and placing a dental dam, the clinical crown should be disinfected with NaOCl or chlorhexidine; optical magnification and enhanced illumination (ideally using a DOM) are highly recommended. The cavity design outline should be completed using high speed burs under constant water cooling.
3. The caries excavation may be completed using long shank No. 2 to 6 round burs in a slow speed handpiece augmented by hand instruments; a caries-detector dye may be used in conjunction with a DOM to remove caries.²⁰
4. The cavity and exposure site(s) should be washed with 1.5% to 8.25% NaOCl; heavy bleeding may be controlled with a cotton pellet, moistened with NaOCl and by applying a moderate pressure for 5 minutes. If there is no bleeding after the pulp is exposed, the area must be examined for necrotic tissue, which should be removed with a high-speed round diamond bur under water coolant until the bleeding tissue is exposed. Uncontrolled haemorrhaging (bleeding over 10 minutes) can be managed with a full pulpotomy or pulpectomy after assessing the condition of the radicular tissue (Fig 1). It is critical that all necrotic tissue is removed.
5. Prepare the mineral trioxide aggregate (MTA) and calcium silicate cement (CSC) according to the manufacturer's instructions.

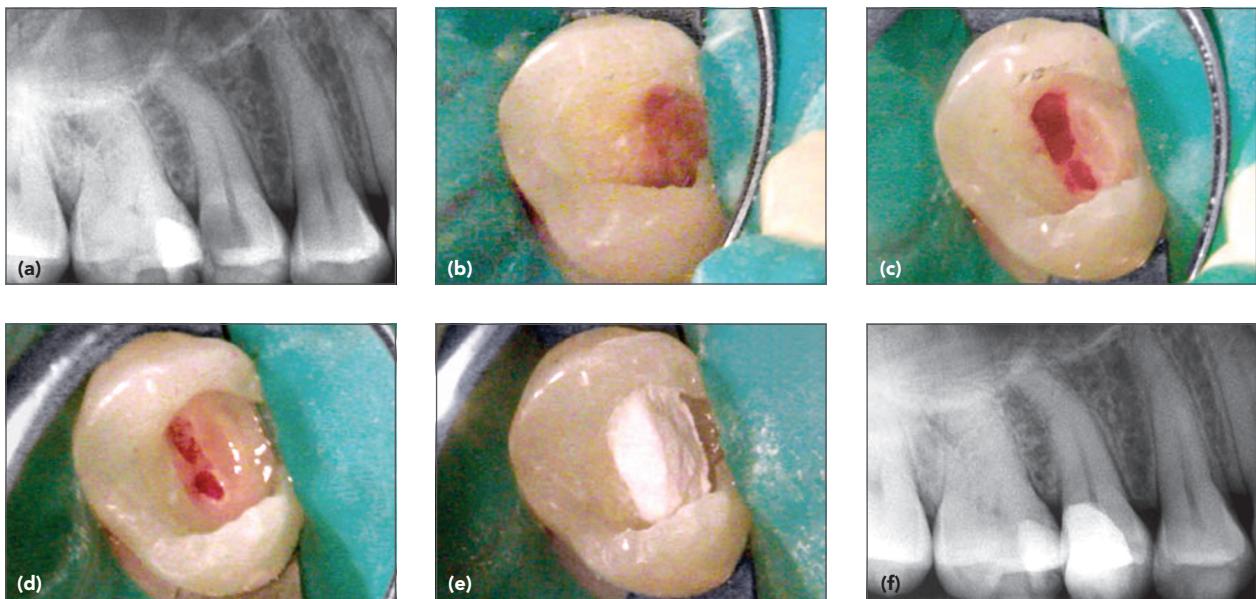


Fig 2(a) to (f) (a) Periapical radiograph of a deep caries lesion in a partially symptomatic maxillary right second premolar in a 21-year-old female patient (b) View after initial cavity design preparation and application of a caries-detector dye (c) Occlusal view of two large pulp horns just after exposure, showing a normal bleeding pattern (d) Pulp exposure after 8.25% NaOCl application and haemostasis (e) View under a dental operating microscope (DOM) after pulp exposure and axial wall placement of a RetroMTA (BioMTA, Seoul, Korea); the calcium silicate cement (CSC) was subsequently covered with a flowable composite and restored with a bonded two-surface composite (f) Radiographic review at 1 year postoperatively showing normal periapical appearance. The premolar responded positive to cold testing and demonstrated no abnormal mobility, or periodontal probing depths.

6. Using a suitable instrument (composite instrument, Glick No. 1 endodontic instrument or MTA carrier gun), apply a large bulk of the pulp capping material over the exposure site, including most of the surrounding dentine, at a thickness ≥ 1.5 to 3 mm.
7. Remove excess moisture at the site with a dry cotton pellet and leave a clear periphery of dentine for the adhesive bonding (Fig 2). NOTE: Using an etch-and-rinse technique with a phosphoric acid gel is not possible at this stage because the MTA or CSC can be easily washed away. For protection, either the MTA or CSC must show a firm set, or a flowable composite and/or resin modified glass ionomer (RMGI) material must have been accurately placed, and should have completely covered the pulp capping material.
8. Apply a small amount of a light curing flowable compomer, a RMGI (or an equivalent light-cured resin glass ionomer liner) or a flowable composite resin, to cover the pulp capping material and light cure to set according to the manufacturer's instructions. NOTE: the placement of flowable resins can be more challenging in cases of direct pulp capping than in indirect pulp capping and pulpotomy procedures.
9. Etch the enamel and remaining cavity walls with 34% to 37% phosphoric acid gel or liquid for 15 to 30 seconds, rinse thoroughly and apply a dentine adhesive, for example, fourth generation, two-bottle systems (primer and bond or a dual curing dentine/enamel bond) are highly recommended. Avoid using single bottle self-etching dentine

Key Point

The placement of flowable resins can be more challenging in cases of direct pulp capping than in indirect pulp capping and pulpotomy procedures

Key Point

Treatment outcomes are dependent on multiple factors that may positively or negatively affect the long-term success of vital pulp therapy

adhesives.²¹ Cure the dentine adhesive according to the manufacturer's instructions.

10. A composite resin material should be incrementally placed as a permanent, final restoration; light cure the composite resin according to the manufacturer's instructions.
11. The pulp vitality should be assessed at the next appointment, preferably at 7 to 10 days using a cold test. A radiographic assessment is only needed in case of a negative result in the sensibility testing, or onset of pain symptoms during the first year. Assessments can be made yearly, or every two years if indicated. It is important to note that some patients may experience discomfort during the first 24 hours directly following treatment but this should resolve expeditiously; however, if symptomatology continues, a more aggressive treatment may be indicated.

NOTE: These recommendations can only be used as guidelines for optimal care and management of exposed dental pulps. Treatment outcomes are dependent on multiple factors that may positively or negatively affect the long-term success of vital pulp therapy. The clinician is ultimately responsible for assessing the indications and treatment requirements on a case-by-case basis, to provide the ideal management for each patient.

REFERENCES

1. Bogen G, Chandler NP. Vital pulp therapy. In: Rotstein I, Ingle JI (eds). *Ingle's Endodontics*, ed 7. Raleigh: PMPH, 2019.
2. Bogen G, Kuttler S, Chandler N. Vital pulp therapy. In: Hargreaves K, Berman LH (eds). *Cohen's Pathways of the Pulp*, ed 11. St Louis: Elsevier, 2016:849–876.
3. Ricucci D, Siqueira JF Jr. Vital pulp therapy. In: Ricucci D, Siqueira JF Jr, (eds): *Endo-dontology: An Integrated Biological and Clinical View*. London: Quintessence, 2013.
4. Dammaschke T, Camp JH, Bogen G. MTA in vital pulp therapy. In: Torabinejad M (ed). *Mineral Trioxide Aggregate – properties and clinical applications*. Ames: Wiley Black-well, 2004.
5. Asgary S, Hassanzadeh R, Torabzadeh H, Eghbal MJ. Treatment outcomes of 4 vital pulp therapies in mature molars. *J Endod* 2018;44:529–535.
6. Cao Y, Bogen G, Lim J, Shon WJ, Kang MK. Bioceramic materials and the changing concepts in vital pulp therapy. *J Calif Dent Assoc* 2016;44:278–290.
7. Linsuwanont P, Wimonsuthikul K, Pothimoke U, Santiwong B. Treatment outcomes of mineral trioxide aggregate pulpotomy in vital permanent teeth with carious pulp exposure: the retrospective study. *J Endod* 2017;43:225–230.
8. Marques MS, Wesselink PR, Shemesh H. Outcome of direct pulp capping with mineral trioxide aggregate: a prospective study. *J Endod* 2015;41:1026–1031.
9. Asgary S, Eghbal MJ, Bagheban AA. Long-term outcomes of pulpotomy in permanent teeth with irreversible pulpitis: a multicenter randomized controlled trial. *Am J Dent* 2017;30:151–155.
10. Kundzina R, Stangvaltaite, Eriksen HM, Kerosuo E. Capping carious exposures in adults: a randomized controlled trial investigating mineral trioxide aggregate versus calcium hydroxide. *Int Endod J* 2017;50:924–932.
11. Linu S, Lekshmi MS, Varunkumar VS, Sam Joseph VG. Treatment outcome following direct pulp capping using bioceramic materials in mature permanent teeth with carious exposure: a pilot retrospective study. *J Endod* 2017; 43:1635–1639.
12. Camilleri J, Laurent P, About I. Hydration of Biodentine, Theracal LC, and a prototype tricalcium silicate-based dentin replacement material after pulp capping in entire tooth cultures. *J Endod* 2014;40:1846–1854.
13. Parirokh M, Torabinejad M, Dummer PMH. Mineral trioxide aggregate and other bioactive endodontic cements: an updated overview – part I: vital pulp therapy. *Int Endod J* 2018;51:177–205.
14. Poggio C, Arciola CR, Beltrami R, et al. Cytocompatibility and antibacterial properties of capping materials. *Scientific World Journal* 2014;2014:181945.
15. Sarkar NK, Caicedo R, Ritwik P, Moiseyeva R, Kawashima I. Physicochemical basis of the biologic properties of mineral trioxide aggregate. *J Endod* 2005;31:97–100.
16. Low JF, Mohd Dom TN, Baharin SA. Magnification in endodontics: A review of its application and acceptance among dental practitioners. *Eur J Dent* 2018;12:610–616.
17. Demir T, Cehreli ZC. Clinical and radiographic evaluation of adhesive pulp capping in primary molars following hemostasis with 1.25% sodium hypochlorite: 2-year results. *Am J Dent* 2007;20:182–188.
18. Matsuo T, Nakanishi T, Shimizu H, Ebisu S. A clinical study of direct pulp capping applied to carious-exposed pulps. *J Endod* 1996;22:551–556.
19. Taha NA, Khazali MA. Partial pulpotomy in mature permanent teeth with clinical signs indicative of irreversible pulpitis: a randomized clinical trial. *J Endod* 2017;43:1417–1421.
20. Fusayama T. A simple pain-free adhesive restorative system by minimal reduction and total etching. St. Louis: Ishiyaku Euroamerica, 1993.
21. Nikaido T, Nurrohman H, Takagaki T, Sadr A, Ichinose S, Tagami J. Nanoleakage in hybrid layer and acid-base resistant zone at the adhesive/dentin interface. *Microsc Microanal* 2015;21:1271–1277.

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Modified tunnel double papilla procedure for root coverage in the anterior mandible

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Free connective tissue grafts, barrier membranes, pedicle flaps, soft tissue allografts, and xenografts have been described for root coverage and augmenting the zone of attached gingiva. The present report evaluated a modified tunnel surgical procedure for root coverage of mandibular anterior teeth where a connective tissue graft was combined with a tunnel and double papilla flap. Fourteen patients with 18 consecutive Miller Class I or II gingival recession defects in the anterior mandible were treated with a connective tissue graft combined with a tunnel and double papilla flap procedure. The following parameters were recorded at baseline and every 6 months postsurgery for up to 19 months: probing depth (PD), vertical recession dimension (RD), keratinized tissue width (KT), and recession width (RW). Statistical analysis consisted of descriptive statistics, analysis of variance with repeated measures, and t test. Statistical analysis proved significant differences between pre- and postoperative values. Mean percentage of root coverage was 83.28% (standard deviation: 22.897), while complete root coverage was obtained in 55% of sites. Baseline values differed between Class I and II recession defects. Clinical attachment level gain, KT gain, and amount of root coverage were statistically significantly larger in Class II defects, while the degree of residual recession and percentage of root coverage were similar in both recession classes. A statistically significant interaction between recession class, independent variable, and pre- and postoperative vertical recession defects (dependent variables) was recorded ($P = .004$). Within the limitations of the sample size, the reported procedure showed predictable root coverage with color match combined with an increased zone of keratinized tissue.

The goal of treatment for localized gingival recessions is to achieve a maximum degree of root coverage together with optimal soft tissue esthetics¹; however, complete root coverage (CRC) may not be the most important treatment outcome, especially in nonesthetic areas such as the anterior mandible, where presence of an adequate zone of attached gingiva to prevent muscle and frenum pull may be more important than CRC. Free connective tissue and epithelialized grafts, barrier membranes, and pedicle flaps have been suggested for gingival recession treatment.²⁻⁶ Root coverage techniques that include coronal flap repositioning together with connective tissue grafts (CTGs) appear to be the gold standard,³⁻⁶ showing high degrees of root coverage ranging between 80%^{7,8} and 98.4%⁹ with excellent esthetic results¹⁰ both in short- and long-term follow-ups.^{3,10-12} The double papillae pedicle graft was first described by Cohen and Ross¹³ to treat localized mucogingival defects. When combined with CTGs,¹⁴⁻¹⁶ excellent results for gingival augmentation and root coverage have been reported, including a mean coverage of 97.4% to 97.7%, with CRC in over 80% of cases.^{15,16}

*These authors contributed equally to this work.

The purpose of the present study was to evaluate a surgical procedure combining CTG with a tunnel and double papilla flap for root coverage of mandibular anterior teeth.

MATERIALS AND METHODS

Patients and experimental teeth

The present report includes 18 consecutive sites presenting Miller Class I or II gingival recession defects that were treated in 14 systemically healthy nonsmoking patients (4 males and 10 females, aged 16 to 57 years) by the same periodontist (A.S.) with the same procedure. All patients signed an informed consent concerning the planned treatment and received detailed information about alternative methods. The Tel Aviv University ethics committee approved this retrospective study's protocol.

The inclusion criteria were well maintained periodontal patients with: no active periodontal disease; a low full-mouth plaque score; probing depth no greater than 3 mm on the facial aspect of the tooth to be treated; at least one buccal Miller Class I or II recession defect¹⁷ on the mandibular anterior; exposed root surface devoid of restorative margins or caries; and normal tooth mobility.

Eighteen consecutive root coverage procedures were performed: 7 on Class I and 11 on Class II defects (14 incisors and 4 canines). Two cases of adjacent recessions were treated (three adjacent recessions in one patient and two in another), but only the recession with the largest defect was taken into consideration for the analysis. In 4 patients, two separate procedures were performed to treat nonadjacent teeth. The same operator (A.S.) performed all surgical procedures and clinical recordings.

Treatment procedures

Oral hygiene instructions included atraumatic toothbrushing.

Measurements were performed with a North Carolina periodontal probe (Hu-Friedy) and rounded to the nearest millimeter mark according to operator's estimation. The following parameters were recorded at baseline, at 6 months postsurgery, and at every recall visit:

Probing depth (PD): measured from the most apical aspect of the gingival margin to the bottom of the pocket

Vertical recession dimension (RD): measured at the midfacial aspect of the tooth from the cementoenamel junction (CEJ) to the gingival margin

Keratinized tissue width (KT): measured at the midfacial aspect of the tooth from the gingival margin to the mucogingival line

Recession width (RW): measured only at baseline, at the most coronal level of the recession

The location of the mucogingival junction pre- and postsurgery was determined with a periodontal probe placed horizontally in the alveolar mucosa; by coronally pushing the movable alveolar mucosa, the mucogingival junction became evident. This simple procedure allowed precise identification of the mucogingival junction. This clinically identified mucogingival junction was used for performing KT measurements.

Key Point

The purpose of the present study was to evaluate a surgical procedure combining connective tissue graft with a tunnel and double papilla flap for root coverage of mandibular anterior teeth

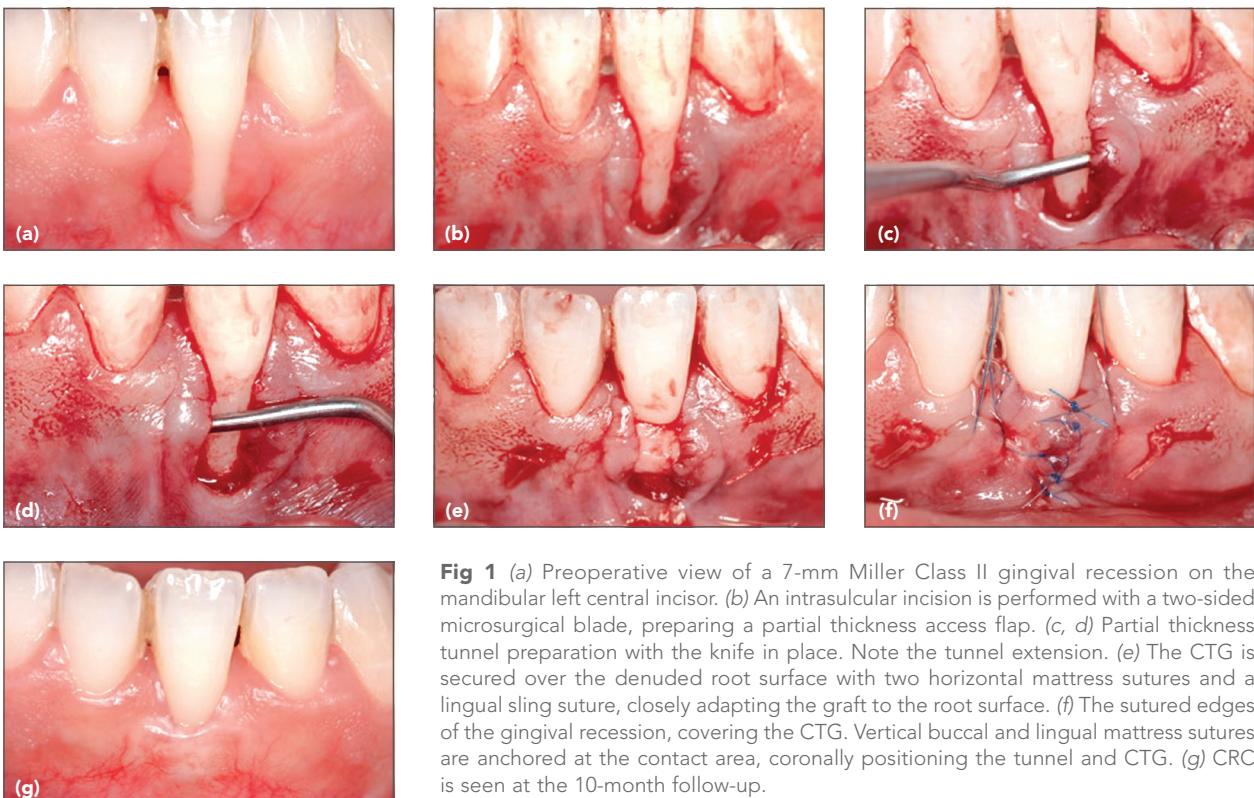


Fig 1 (a) Preoperative view of a 7-mm Miller Class II gingival recession on the mandibular left central incisor. (b) An intrasulcular incision is performed with a two-sided microsurgical blade, preparing a partial thickness access flap. (c, d) Partial thickness tunnel preparation with the knife in place. Note the tunnel extension. (e) The CTG is secured over the denuded root surface with two horizontal mattress sutures and a lingual sling suture, closely adapting the graft to the root surface. (f) The sutured edges of the gingival recession, covering the CTG. Vertical buccal and lingual mattress sutures are anchored at the contact area, coronally positioning the tunnel and CTG. (g) CRC is seen at the 10-month follow-up.

Surgical procedure

Before the procedure, for future suture anchoring, high-flow composite was applied on the buccal side and proximal contact points of teeth scheduled for treatment. This was not performed where a postorthodontic splint was present.

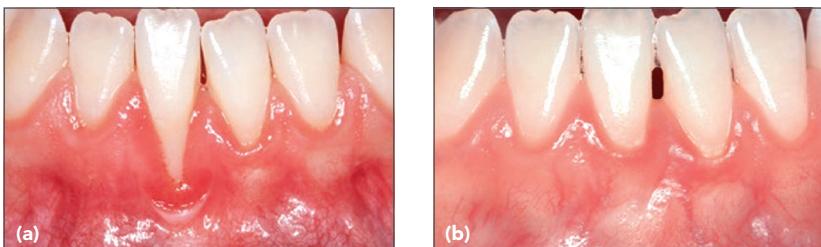
Patients were instructed to rinse with 10 mL of 0.2% chlorhexidine digluconate (CHX) solution for 1 minute, and local anesthesia with 2% articaine+adrenaline (Ubestisin, 3M ESPE) was applied to the surgical site. The exposed root surfaces were planed with Gracey curettes (SAS1-2 or SMS1-2, Hu-Friedy) and thoroughly scrubbed and rinsed with saline.

Partial thickness access was gained through an intrasulcular incision performed with a microsurgical blade with cutting edges on both sides and on the tip of the blade (Figs 1a and 1b). A partial thickness tunnel was prepared with tunneling knives (1 and 2, Braun, Aesculap) and a microsurgical blade (Braun, Aesculap) with a single cutting edge. The tunnel was extended 3 to 4 mm apically beyond the mucogingival junction and distally/mesially beyond the distal/mesial aspect of the adjacent tooth or teeth while undermining the facial aspect of the interdental papilla. Tissue undermining allowed for tension-free coronal displacement and close approximation of the proximal gingival borders of the recession (Figs 1c and 1d). A CTG was harvested as described by Hürzeler and Weng.¹⁸ After trimming, the CTG was placed on the denuded root surface, covering the midfacial aspect of the adjacent teeth. The apicocoronal CTG height was about 5 to 6 mm. The graft was

Key Point

Patients were instructed to rinse with 10 mL of 0.2% chlorhexidine digluconate solution for 1 minute, and local anesthesia with 2% articaine + adrenaline was applied to the surgical site

Fig 2 (a) Preoperative aspect of a Miller Class II case. (b) Posttreatment follow-up at 18 months. Note the degree of root coverage and quality of attached gingiva.



Key Point

Periodontal dressing was applied only on the lingual aspect to avoid contact of the tongue with the sutures during the first postoperative days

then gently placed in the tunnel with two horizontal mattress sutures (vicryl rapide 4/0 or 5/0, Ethicon), one mesially and the other distally.¹⁹ Another sling suture (5/0 vicryl rapide, Ethicon), starting from the lingual side, secured the graft to the tooth (Fig 1e). The two edges of the gingival recession were then approximated tension free, with simple interrupted sutures starting from the apical part of the recession, using a nonresorbable 6/0 suture material (Polypropylene, Hu-Friedy). These sutures allowed primary soft tissue closure over the CTG. Finally, two vertical buccal and lingual mattress sutures (5/0 vicryl or 6/0 polypropylene, Ethicon) were anchored at the contact area, coronally positioning the tunnel together with the graft²⁰ (Fig 1f).

Periodontal dressing (Coe-Pak, GC America) was applied only on the lingual aspect to avoid contact of the tongue with the sutures during the first postoperative days. The same type of dressing was applied to cover the donor site in the palate. No dressing was applied on the vestibular aspect.

Postoperative instructions included analgesia, if needed, and rinsing twice a day with 0.2% CHX solution for 4 weeks. Toothbrushing in the surgical area was discontinued during the first postoperative month. Sutures were removed after 10 to 12 days, at which time gentle professional cleaning with a rubber cup and pumice was performed. Patients were instructed to carefully clean the buccal aspect of the treated teeth with cotton sticks soaked in 0.2% CHX solution while avoiding any contact with the gingival margin. One month after surgery, toothbrushing was recommenced with an ultra-soft toothbrush. Follow-up was once a week during the first 2 months, at which time professional cleaning was also performed.

Statistical analyses

The sample was statistically analyzed both as a single group and as two groups, to compare outcome of Class I and Class II recession defects. Descriptive statistics, analysis of variance (ANOVA) with repeated measures, and t test were performed.

RESULTS

Postoperative healing was uneventful. No differences in any of the parameters were registered in any of the patients after 6 months of follow-up. Differences between pre- and postoperative values of all parameters were statistically significant in all recession defect types (Figs 1g, 2a, and 2b).

TABLE 1 Results for each parameter for class I recession defects

Parameter	N	Mean	SD	Range
Follow-up (mo)	7	7.71	2.928	6–12
KT (mm)	7	1.71	0.488	1–2
RW (mm)	7	2.57	0.535	2–3
RD (mm)	7	3.00	1.000	2–5
Att. Loss (mm)	7	3.71	1.254	2–6
CAL gain (mm)	7	2.86	0.690	2–4
KTG (mm)	7	1.71	0.756	1–3
PRD (mm)	7	0.57	1.134	0–3
ΔRD (mm)	7	2.4286	0.53452	2–3
Root coverage (%)	7	86.6667	24.03701	40–100

KT, RW, RD, and Att. Loss values refer to the baseline situation, while CAL gain, KTG, RRD, ΔRD, and percentage of root coverage values refer to the follow-up situation. SD = standard deviation; KT = keratinized tissue width; RW = recession width; RD = vertical recession dimension; Att. Loss = attachment loss; CAL = clinical attachment level; KTG = keratinized tissue gain; RRD = residual recession defect; ΔRD = root coverage measured along the long root axis.

TABLE 2 Results for each parameter for class II recession defects

Parameter	N	Mean	SD	Range
Follow-up (mo)	11	9.09	4.182	6–19
KT (mm)	11	0.82	0.405	0–1
RW (mm)	11	3.36	0.674	3–5
RD (mm)	11	5.64	1.362	3–7
Att. Loss (mm)	11	6.45	1.508	4–8
CAL gain (mm)	11	4.55	1.508	3–7
KTG (mm)	11	2.91	1.221	1–5
PRD (mm)	11	1.18	1.537	0–5
ΔRD (mm)	11	4.4545	1.50756	2–7
Root coverage (%)	11	81.1255	23.05399	28.57–100

KT, RW, RD, and Att. Loss values refer to the baseline situation, while CAL gain, KTG, RRD, ΔRD, and percentage of root coverage values refer to the follow-up situation. SD = standard deviation; KT = keratinized tissue width; RW = recession width; RD = vertical recession dimension; Att. Loss = attachment loss; CAL = clinical attachment level; KTG = keratinized tissue gain; RRD = residual recession defect; ΔRD = root coverage measured along the long root axis.

Key Point

Mean root coverage was 86.67% in Class I defects, 81.13% in Class II defects, and 83.28% for the whole sample

Mean root coverage was 86.67% (standard deviation [SD]: 24.04%) in Class I defects (Table 1), 81.13% (SD: 23.05%) in Class II defects (Table 2), and 83.28% (SD: 22.897%) for the whole sample (Table 3). CRC was achieved in 10 out of the 18 sites (55%). In one Class II site (Table 2), a residual recession defect of 5 mm (preoperative depth: 7 mm) was recorded. Aside from this patient, in whom the anchoring sutures were very loose, the periodontal dressing was still in place at the suture removal appointment in all patients.

Follow-up times were similar in Class I and II recession defects (Tables 1 and 2). However, other baseline parameters (KT, attachment loss, RD, and RW) were statistically significantly different (Tables 1 and 2). At the final evaluation, clinical attachment level gain, KT gain, and amount of root coverage were statistically significantly larger in Class II recession defects (Tables 1 to 3); residual recession and percentage of root coverage were similar in both groups (Tables 1 to 3). ANOVA with repeated measures

TABLE 3 Results for each parameter for the entire sample combined into a single group

Parameter	N	Mean	SD	Range	P (Class I vs Class II)
Follow-up (mo)	18	8.56	3.714	6–19	.460
KT (mm)	18	1.17	0.405	0–2	.001
RW (mm)	18	3.06	0.725	2–5	.019
RD (mm)	18	4.61	1.787	2–7	.000
Att. Loss (mm)	18	5.39	1.944	2–8	.001
CAL gain (mm)	18	3.89	1.491	2–7	.014
KTG (mm)	18	2.44	1.199	1–5	.035
PRD (mm)	18	0.94	1.392	0–5	.380
ΔRD (mm)	18	3.6667	1.57181	2–7	.004
Root coverage (%)	18	83.2804	22.89731	28.57–100	.631

P value refers to statistical differences between Miller Class I and Class II recession defects.

KT, RW, RD, and Att. Loss values refer to the baseline situation, while CAL gain, KTG, RRD, ΔRD, and percentage of root coverage values refer to the follow-up situation. SD = standard deviation; KT = keratinized tissue width; RW = recession width; RD = vertical recession dimension; Att. Loss = attachment loss; CAL = clinical attachment level; KTG = keratinized tissue gain; RRD = residual recession defect; ΔRD = root coverage measured along the long root axis.

Key Point

Although numerous surgical approaches for root coverage have been reported, coronally advanced flap together with connective tissue graft is still considered the gold standard

showed a statistically significant interaction ($P = .004$) between Miller Classes (I or II; independent variable) and pre and postoperative vertical recession defects (dependent variables).

DISCUSSION

Although numerous surgical approaches for root coverage have been reported, coronally advanced flap together with CTG is still considered the gold standard.^{3–6} The present surgical procedure positively responds to the accepted criteria for success in terms of root coverage, color matching,^{1,2} and attached KT. The presented modified tunnel double papilla procedure eliminates the need for vertical releasing incisions, while combining the advantages of previously reported techniques.^{15,20,21} Large variations have been reported regarding the extent of root coverage and the percentage of cases with CRC: One study reported root coverage ranging between 63% to 86%;²² another achieved CRC in approximately 50% of defects;²³ and in a systematic review, 80.9% of root coverage (range: 50% to 97.3%) was reported, with 46.6% (range: 7.7% to 91.6%) of cases achieving complete defect coverage for Miller Class I and II cases.²⁴ In agreement with a recent systematic review,²⁴ in the present evaluation, mean root coverage was 83.28%, while CRC was recorded in 55% of the sites. When reviewing these results, it must be taken into consideration that all recession defects presented a thin periodontal biotype and were located in the anterior mandible, an area known to have worse results than other regions in the oral cavity,^{16,25} especially in Class II defects where no keratinized tissue is available apical to the recession defect.²⁶ Furthermore, the main treatment goal, especially in Class II recession defects in the mandibular anterior area, is to provide a maintainable situation by creating a band of attached keratinizing tissue, preventing frenum and muscle pull. CRC is not particularly the treatment goal. Although baseline parameters were generally different, the presented

procedure was able to achieve a similar outcome in both Class I and Class II recession defects.

Better mean root coverage and percentage of cases with CRC in the anterior mandible^{25,26} with CTG procedures have been previously reported, but it should be taken in consideration that the baseline average recession defect was larger in the present evaluation than in those studies. The present report was limited to the anterior mandible; treatment results of recession defects including other areas have reported better results.^{15,16}

The mean KT gain in this study was 2.4 mm, similar to previous reports using CTG combined with a double pedicle papilla flap (2.9 mm)²⁷ and using CTG with a coronally advanced flap (2.5 mm).²⁶ However, the present KT gain was higher than the reported gain (1.22 mm) from the modified tunnel technique with a CTG.²⁶

The microsurgical approach for the tunnel preparation and the suggested suturing technique may have enhanced the blood supply, especially during early healing.^{21,28} Though no surgical dressing was applied in all previously reported evaluations applying both tunnel and modified tunnel techniques,^{20,21,26,29,30} it was applied in the present report. In the one case where only limited root coverage was obtained, there was no dressing at the suture removal appointment and the anchoring sutures were very loose, though this is not conclusive.

CONCLUSIONS

In spite of the limited sample, shortterm follow-up, and lack of blinded examination, it may be concluded that the present technique is valuable for obtaining root coverage with good esthetic results and creating or enlarging the amount of attached keratinized tissue in the anterior mandible, even in deep recessions. However, a larger sample with long-term follow-ups is necessary to confirm its predictability.

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REFERENCES

- Miller PD Jr. Root coverage grafting for regeneration and aesthetics. *Periodontol* 2000 1993;1:118–127.
- Wennström JL. Mucogingival therapy. *Ann Periodontol* 1996;1:671–701.
- Langer B, Langer L. Subepithelial connective tissue graft for root coverage. *J Periodontol* 1985;56:715–720.
- Roccuzzo M, Bunino M, Needleman I, Sanz M. Periodontal plastic surgery for treatment of localized gingival recessions: A systematic review. *J Clin Periodontol* 2002;29(suppl 3):s178–s194.
- Chambrone L, Chambrone D, Pustiglioni FE, CHambrone LA, Lima LA. Can subepithelial connective tissue grafts be considered the gold standard procedure in the treatment of Miller Class I and II recession-type defects? *J Dent* 2008;36:659–671.
- Jahnke PV, Sandifer JB, Gher ME, Gray JL, Richardson AC. Thick free gingival and connective tissue autografts for root coverage. *J Periodontol* 1993;64:315–322.
- Paolantonio M, di Murro C, Cattabriga A, Cattabriga M. Subpedicle connective tissue graft versus free gingival graft in the coverage of exposed root surfaces. A 5-year clinical study. *J Clin Periodontol* 1997;24:51–56.
- Harris RJ. Root coverage with connective tissue grafts: An evaluation of short- and long-term results. *J Periodontol* 2002;73:1054–1059.
- Nemcovsky CE, Artzi Z, Tal H, Kozlovsky A, Moses O. A multicenter comparative study of two root coverage procedures: Coronally advanced flap with addition of enamel matrix proteins and subpedicle connective tissue graft. *J Periodontol* 2004;75:600–607.
- Greenwell H, Bissada NF, Henderson RD, Dodge JR. The deceptive nature of root coverage results. *J Periodontol* 2000; 71:1327–1337.

Key Point

Microsurgical approach for the tunnel preparation and the suggested suturing technique may have enhanced the blood supply, especially during early healing

12. Moses O, Artzi Z, Sculean A, et al. Comparative study of two root coverage procedures: A 24-month follow-up multicenter study. *J Periodontol* 2006; 77:195–202.
13. Cohen DW, Ross SE. The double papillae repositioned flap in periodontal therapy. *J Periodontol* 1968;39:65–70.
14. Nelson SW. The subpedicle connective tissue graft. A bilaminar reconstructive procedure for the root coverage of denuded root surfaces. *J Periodontol* 1987;58:95–102.
15. Harris RJ. The connective tissue and partial thickness double pedicle graft: A predictable method of obtaining root coverage. *J Periodontol* 1992;63:477–486.
16. Harris RJ. The connective tissue with partial thickness double pedicle graft: The results of 100 consecutively treated defects. *J Periodontol* 1994;65:448–461.
17. Miller PD Jr. A classification of marginal tissue recession. *Int J Periodontics Restorative Dent* 1985;5:8–13.
18. Hürzeler M, Weng D. A single incision technique to harvest subepithelial connective tissue grafts from the palate. *Int J Periodontics Restorative Dent* 1999;19:279–287.
19. Zabalegui I, Sicilia A, Cambra J, Gil J, Sanz M. Treatment of multiple adjacent gingival recessions with the tunnel subepithelial connective tissue graft: A clinical report. *Int J Periodontics Restorative Dent* 1999;19:199–206.
20. Azzi R, Etienne D. Recouvrement radiculaire et reconstruction papillaire par greffon conjonctif enfoui sous un lambeau vestibulaire tunnelisé et tracé coronairement. *J Parodontol et Implantol Oral* 1998;17:71–77.
21. Zuh O, Fickl S, Wachtel H, Bolz W, Hürzeler M. Covering of gingival recessions with a modified microsurgical tunnel technique: Case report. *Int J Periodontics Restorative Dent* 2007;27:457–463.
22. Wennstrom JL, Zucchelli G, Pini Prato GP. Mucogingival therapy—Periodontal plastic surgery. In: Lang NP, Lindhe J, Karring T (eds). *Clinical Periodontology and Implant Dentistry*, ed 5. Oxford: Blackwell Munksgaard, 2008:955–1028.
23. Bouchard P, Malet J, Borghetti A. Decision-making in aesthetics: Root coverage revisited. *Periodontol* 2000 2001;27:97–120.
24. Chambrone L, Tatakis DN. Periodontal soft tissue root coverage procedures: A systematic review from the AAP Regeneration Workshop. *J Periodontol* 2015;86(suppl 2):s8–s51.
25. Nart J, Valles C, Mareque S, Santos A, Sanz-Moliner J, Pascual A. Subepithelial connective tissue graft in combination with a coronally advanced flap for the treatment of Miller Class II and III gingival recessions in mandibular incisors: A case series. *Int J Periodontics Restorative Dent* 2012;32:647–654.
26. Thalmair T, Fickl S, Wachtel H. Coverage of multiple mandibular gingival recessions using tunnel technique with connective tissue graft: A prospective case series. *Int J Periodontics and Restorative Dent* 2016;36:859–867.
27. Harris RJ, Miller LH, Harris CR, Miller RJ. A comparison of three techniques to obtain root coverage on mandibular incisors. *J Periodontol* 2005;76:1758–1767.
28. Burkhardt R, Lang NP. Coverage of localized gingival recessions: Comparison of micro- and macrosurgical techniques. *J Clin Periodontol* 2005;32:287–293.
29. Aroca S, Keglevich T, Nikolidakis D, et al. Treatment of class III multiple gingival recessions: A randomized clinical trial. *J Clin Periodontol* 2010;37:88–97.
30. Yaman D, Demirel K, Asku S, Basegmez C. Treatment of multiple adjacent Miller Class III gingival recessions with a modified tunnel technique: A case series. *Int J Periodontics Restorative Dent* 2015;35:489–497.

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Effect of molar preparation axial height on retention of adhesively-luted CAD-CAM ceramic crowns

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Purpose: To evaluate the effect of axial wall height (AWH) on failure resistance of CAD-CAM adhesively-bonded, all ceramic crowns on molar preparations with a conservative total occlusal convergence (TOC).

Materials and Methods: 60 newly extracted maxillary third molars were divided into 5 groups ($n = 12$) and prepared for all-ceramic crowns with occlusal cervical AWH of 0, 1, 2, 3, and 4 mm, all containing a conservative 10-degree TOC. Scanned preparations were fitted with lithium-disilicate glass-ceramic crowns using a self-adhesive resin-composite luting agent after intaglio surface preparation with hydrofluoric acid and silane. Specimens were stored at 37°C/98% humidity for 24 h and tested to failure at a 45-degree angle applied to the palatal cusp on a universal testing machine. Mean results were analyzed using ANOVA and Tukey's test ($p = 0.05$). **Results:** Preparations containing 2, 3, and 4 mm AWH demonstrated similar and higher failure resistance than the 0- and 1-mm axial wall height groups. **Conclusions:** Under the conditions of this study, evidence is presented that under certain conditions CAD-CAM adhesive technology may compensate for less than optimal AWH. Based on both failure load results and failure mode analysis, adhesively-luted maxillary molar CAD-CAM crowns based on a preparation containing 10-degree TOC require at least 2 mm AWH for adequate resistance and retention. However, adoption of these findings is cautioned until both fatigue analysis and appropriate clinical evidence has been provided.

Key words: CAD-CAM, adhesion, lithium disilicate, failure load, axial wall height, total occlusal convergence.

Recommendations relating molar preparation parameters of total occlusal convergence (TOC) and axial wall height (AWH) have been traditionally established for full-coverage preparations. To wit, traditional molar preparation recommendations have 4 mm AWH with a TOC ranging between 2 and 12 degrees for optimal resistance and retention form.⁸ Some authors previously advocated that the ideal preparation TOC should be between 2 and 6 degrees.⁸ However, studies report that practitioners routinely could not achieve this earlier recommendation, upon which an acceptable TOC between 10 and 20 degrees has been suggested.^{9,10} Furthermore, an occlusal-cervical (OC) height:facial-lingual (FL) width ratio of 0.4 is recommended to prevent crown tipping movement,^{9,10} which is usually met by the previously mentioned 4 mm AWH. Adherence to these suggestions may not be routinely accepted or understood,¹¹ and single-unit preparations submitted to commercial laboratories report that approximately 50% exhibited a 0.4 OC height:FL width ratio,¹⁸ with other studies reporting TOC values between 23 and 78 degrees.¹⁶ Realistically,

clinical achievement of any of these recommendations is dependent on remaining tooth structure, and crown lengthening procedures may not be a financial, esthetic, or functional option.

However, with the advent of all-ceramic restorations, adhesive composite cements are claimed to not only offer some micromechanical retention but also an additional advantage by providing chemical adhesion between the restoration and tooth surface.¹⁵ The advantages of adhesive resin technology have previously been described with earlier all-ceramic and metal-ceramic materials.^{2,6,12,17} Moreover, some CAD-CAM proponents purport that adhesive resin bonding techniques allow treatment options that would traditionally require elective endodontic treatment and/or periodontal surgical procedures.^{3,4} The aim of this study was to evaluate whether CAD-CAM adhesive technology could compensate for reduced molar AWH on all-ceramic preparations based on a conservative 10-degree TOC. The null hypothesis was that there would be no difference in failure resistance between full-coverage, all-ceramic, CAD-CAM molars based on preparations with 1, 2, 3, and 4 mm of AWH as well as a flat-surfaced preparation containing no AWH (referred to hereafter as the 0 AWH group).

Key Point

With the advent of all-ceramic restorations, adhesive composite cements are claimed to not only offer some micromechanical retention but also an additional advantage by providing chemical adhesion between the restoration and tooth surface

MATERIALS AND METHODS

Sixty freshly-extracted human maxillary molars were collected from local oral and maxillofacial surgery clinics; the teeth had been extracted as per routine clinical indications under local Institutional Review Board (IRB) protocol approval. The teeth were randomly assigned to 5 groups ($n = 12$) and the occlusal surfaces removed to 1 mm below the marginal ridge with a slow-speed, water-cooled diamond saw (Buehler, Lake Bluff; IL, USA). The sectioned teeth were then mounted in autopolymerizing denture base methacrylate resin (Diamond D, Keystone Industries; Cherry Hill, NJ, USA). All-ceramic crown preparations were performed by one operator following recommended guidelines for CAD-CAM restorations (Cerec 3D Preparation Guidelines, Dentsply Sirona; Bensheim, Germany), using a high-speed electric dental handpiece (EA-51LT, Adec; Newburg, OR, USA) with a diamond bur (8845KR.31.025, Brassler USA; Savannah, GA, USA) under continuous water coolant spray. To standardize OC finish-line placement, specimens were first prepared containing a 4-mm AWH (Fig 1) which was then reduced to form the respective AWH groups (Figs 2 to 4).

Preparation TOC (10 degrees) was standardized with the handpiece placed in a fixed lathe arrangement. To facilitate correct restoration placement, the 0-OC AWH specimens (Fig 5) were additionally prepared with a facial-lingual groove the approximate width and half the depth of a #8 round bur.

This feature was placed in the same approximate vector of the planned loading force to serve as a negligible impediment to dislodging forces. All final preparations were refined by a board-certified prosthodontist. Preparation parameters (exposed dentin area, OC-AWH, TOC, and OC-AWH:buccal-lingual width [BLW] ratio) were determined with a digital measuring microscope (KH-7700, Hirox USA; Hackensack, NJ, USA).

The prepared tooth specimens were restored by a single operator using a CAD-CAM acquisition device (Cerec AC/ Cerec MC XL, Dentsply Sirona, Software version 4.2.4.72301) according to manufacturer's recommendations.

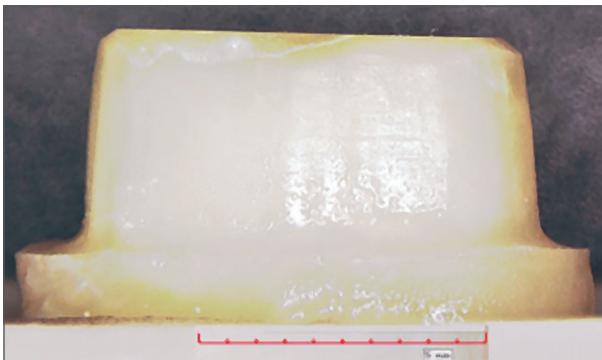


Fig 1 Specimen with 4-mm AWH.

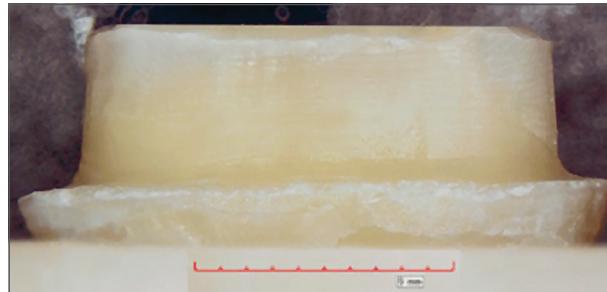


Fig 2 Specimen with 3-mm AWH.

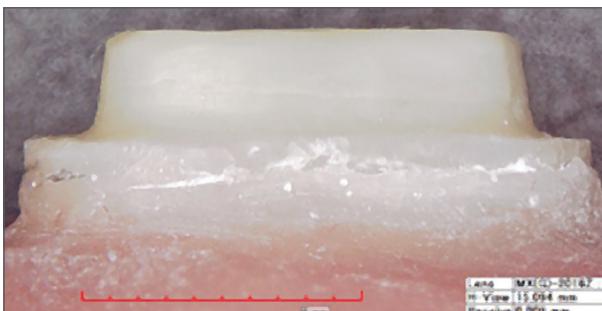


Fig 3 Specimen with 2-mm AWH.



Fig 4 Specimen with 1-mm AWH.

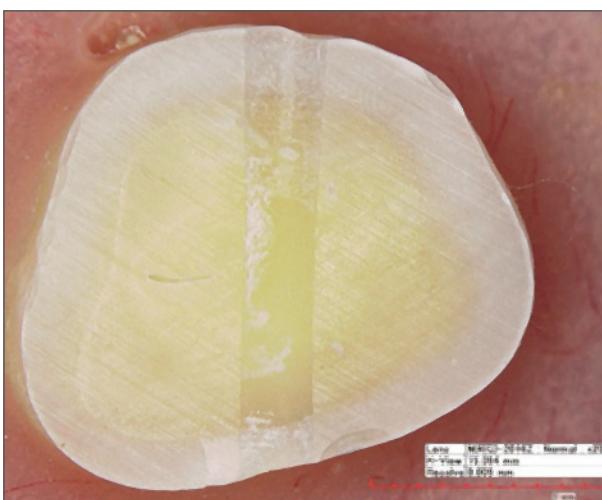


Fig 5 Specimen with 0-mm AWH with orientation groove.

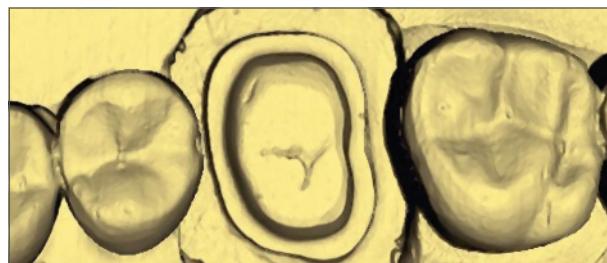


Fig 6 Digital scan results of preparation inserted in quadrant template.

Prior to scanning, specimens were placed into a standardized template (Fig 6) to simulate clinical conditions. Restoration design featured a standardized occlusal anatomy and occlusal table height which detailed a minimum occlusal thickness anatomy of 2 mm. The design of each restoration was then completed to ensure proper contours following manufacturer's and/or material recommendations and were milled from a lithium-disilicate

Key Point

A full-coverage, indirect restoration's retention and resistance form is determined by a combination of preparation total occlusal convergence, surface area, and axial wall height

glass-ceramic restorative material (e.max CAD, Ivoclar Vivadent; Schaan, Liechtenstein). After milling, two coats of glaze (IPS e.max CAD Crystall/Glaze spray, Ivoclar Vivadent) were applied to the restorations and then crystallized following the manufacturer's protocol in a dental laboratory ceramic furnace (Programat P700, Ivoclar Vivadent).

The milled restorations were seated on each respective preparation using a disclosing agent (Oclude, Pascal International; Bellevue, WA, USA), after which the restoration was steam cleaned and dried. Intaglio surfaces were then prepared by etching with 5% hydrofluoric acid (IPS Ceramic Etching Gel, Ivoclar Vivadent) for 20 s, rinsed with water spray, and dried with oil-free compressed air. Silane agent (Monobond Plus, Ivoclar Vivadent) was applied to the etched ceramic surface using a microbrush following manufacturer's instructions, with the silane agent air dried after a 60-s reaction time using oil-free compressed air. Prepared tooth surfaces were prepared for cementation by cleaning with a pumice and water slurry, rinsed, and dried using oil-free compressed air. A self-adhesive composite cement (Rely-X Unicem, 3M Oral Care; St Paul, MN, USA) was applied on the restoration's intaglio surface and seated with digital finger pressure. Excess marginal cement was then removed with a rubber-tipped gingival stimulator (GUM latex-free stimulator, Sunstar Americas; Schaumburg, IL, USA) with the restoration exposed to a light-emitting diode (LED) visible-light-curing unit (VLC) for 20 s on all surfaces (Bluephase G2, Ivoclar Vivadent). The completed specimens were stored under dark conditions at $37^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and $98\% \pm 1\%$ humidity. Twenty-four hours after cementation, each specimen was placed into a vise fixture mounted on a universal testing machine (RT-5, MTS; Eden Prairie, MN, USA) with the long axis of the tooth at a 45-degree angle to the testing fixture. The palatal cusp was loaded with a 3-mm diameter, hardened stainless-steel piston with a 0.5-m radius of curvature,¹⁴ and were loaded at a rate of 0.5 mm/min until failure, with the failure load recorded in Newtons. The failure mode for each specimen was determined by visual examination under 20X magnification (KH-7700, Hirox USA) to determine if the failure was cohesive in the lithium-disilicate glass-ceramic, adhesive between the ceramic and the tooth structure, catastrophic failure of the tooth/restoration complex, or cohesive fracture of the tooth material apical to the preparation.

The Shapiro-Wilk Test and Bartlett's test first ascertained the normal distribution and homogeneity of variance of the mean data, with analysis performed using ANOVA with Tukey's post-hoc test. Statistical analysis was performed with a computer-based program (SPSS 20, IBM SPSS; Chicago, IL, USA) with a 95% level of confidence ($p = 0.05$).

RESULTS

The tooth preparation parameters are presented in Table 1.

Preparation parameter standardization was reasonably successful. Within each group, the coefficient of variation ranges for preparation AWH were 2% to 6%, TOC 7% to 16%, and preparation surface area 8% to 14%.

Failure load results are listed in Table 2. The 2-, 3-, and 4-mm AWH groups demonstrated greater failure load resistance as compared to the 0- and 1-mm groups.

Failure mode analysis results are presented in Table 3. All 0-mm and half of the 1-mm AWH preparations failed adhesively. Interestingly, the

TABLE 1 Mean preparation parameters

AWH group	AWH (mm)	TOC (degrees)	Surface area (mm ²)	AWH:BLW ratio
0 mm	*	*	85.1 (6.9)	*
1 mm	7	1.71	0.488	1–2
2 mm	7	2.57	0.535	2–3
3 mm	7	3.00	1.000	2–5
4 mm	7	3.71	1.254	2–6

n = 12; AWH = axial wall height; TOC = total occluso-gingival convergence; BLW = buccal-lingual width; *not applicable.

TABLE 2 Mean failure load (N)

Preparation AWH (mm)	Failure load (N)
0	291.1 (124.0) ^A
1	735.1 (310.9) ^B
2	1170.0 (297.6) ^C
3	1253.4 (210.0) ^C
4	996.2 (424.1) ^{BC}

n = 12; groups identified with same superscript capital letter are statistically similar within the column (Tukey's test, p = 0.05).

TABLE 3 Failure mode analysis

OC AWH group	Adhesive	Failure mode		
		Crown/tooth complex	Cohesive root fracture	Cohesive ceramic fracture
0	12	0	0	0
1	6	1	0	5
2	5	4	0	3
3	0	4	6	1
4	0	3	7	2

n = 12; OC = occluso-cervical; AWH = axial wall height.

remainder of the 1-mm group predominantly failed with cohesive ceramic fractures. The 2-mm AWH group also exhibited approximately 50% adhesive failures, but the majority of the failures were either cohesive root or ceramic fractures. The 3- and 4-mm AWH groups failed mainly by cohesive root fracture, followed by fracture of the tooth-restoration complex and a small number of cohesive ceramic failures.

DISCUSSION

A full-coverage, indirect restoration's retention and resistance form is determined by a combination of preparation TOC, surface area, and AWH.^{9,10} Specifically, molar preparations are recommended to contain a minimum of 4-mm AWH within a TOC taper ranging from 10 to 20 degrees.^{9,10} Furthermore, when ideal parameters cannot be achieved, clinicians may augment preparation retention and resistance form with the addition of secondary features such as boxes and grooves.^{8,10} However, secondary features with CAD-CAM preparations are more constrained by limitations imposed by the milling bur dimensions. Nevertheless, some CAD-CAM technology proponents suggest that adhesive technology can counterbalance traditional preparation features that were required for aqueous-based cements.^{3,4} Accordingly, this study examined whether CAD-CAM adhesive technology could compensate for less than optimal preparation axial wall height at a standardized conservative 10-degree TOC.

Key Point

This study examined whether CAD-CAM adhesive technology could compensate for less than optimal preparation axial wall height at a standardized conservative 10-degree total occlusal convergence

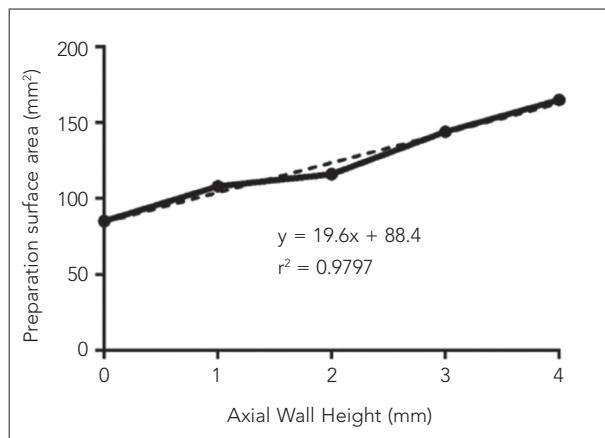


Fig 7 Correlation of preparation axial wall height and preparation surface area.

Key Point

Based on this study's failure load results and failure mode findings, it may be reasonable to suggest that for CAD-CAM adhesive molar preparations with 10-degree total occlusal convergence, 2 mm of axial wall height might be sufficient for adequate retention and resistance features

The authors feel that the preparation standardization goal met with reasonable success, as the covariance ranged less than 6% for preparation AWH, 16% for TOC, and preparation surface area within each group was less than 15%. Additionally, surface area increase as a function of OC axial wall height was found to follow a linear function, as presented in Fig 7.

In addition, specimens were restored with identical occlusal anatomy, form, contours, and occlusal table height using a standard biogeneric copy. Under the conditions of this study, the 10-degree TOC was chosen because it represented the most conservative aspect of the 10- to 20-degree range recommended by Goodacre et al.^{9,10} Further studies involving this protocol with more advanced TOC are currently in progress.

Under the conditions of this study, the null hypothesis was rejected. Preparations containing the 0- and 1-mm AWH failed at significantly less force than the preparations containing 2-, 3-, and 4-mm AWH. The entire 0-mm AWH group failed adhesively, and half of the 1-mm AWH specimens demonstrated adhesive failures, while the remainder displayed cohesive ceramic and tooth-restoration complex failure. The 2-mm AWH group demonstrated more tooth restoration complex failures instead of cohesive ceramic fracture. The 3- and 4-mm AWH groups demonstrated no adhesive failures and increasing cohesive root fractures. This study was designed with a stable occlusal table height, which understandably necessitated different ceramic occlusal thicknesses with each AWH group. It may be reasonable to expect that the thinner occlusal thickness required by the greater AWH groups would experience more cohesive ceramic failures. Nevertheless, this was not observed in the present study, with the groups possessing thicker occlusal aspects experiencing more cohesive ceramic failures. While the definitive etiology of this finding remains elusive, it is conjectured that it may be due to early undetectable adhesive failure that results in the wedging of the crown restoration into the preparation and generating force vectors that would be more favorable for ceramic cohesive failure. Based on this study's failure load results and failure mode findings, it may be reasonable to suggest that for CAD-CAM adhesive molar preparations with 10-degree TOC, 2 mm

of AWH might be sufficient for adequate retention and resistance features. Accordingly, these findings also suggest that an optimal AWH:BLW ratio may require additional consideration. However, utmost caution is advised in definitively, clinically adopting these initial in vitro findings until further evidence is available, especially from planned fatigue studies.

To the author's knowledge, this study is somewhat unusual, in that it evaluates the molar preparation AWH effect at a fixed TOC using CAD-CAM adhesive technology on actual tooth substrate. Although the surface area of the preparations was measured, this study did not investigate failure stress. Calculated adhesive molar stress values can be affected by many factors to include aberrant stress distribution patterns due to specimen malalignment on the testing fixture,¹² not to mention uneven internal load forces between the restoration and the tooth preparation surface. Moreover, static testing creates a different stress state than that observed with clinical failures,¹⁴ while some evidence has been reported that little relationship exists between the failure stresses and the recorded failure load.¹²

The authors recognize this study's limitations. Only one self-adhesive luting agent was used, and it cannot be assumed that other self-adhesive resin-composite luting agents would provide similar results. Also, the groups contained different occlusal table thicknesses, and resulting diverse force vectors could have influenced the results. Although different occlusal table differences were necessitated by this study's conditions, it was hoped that the same OC finish line location on each specimen might mitigate potential lever arm force differences. As mentioned earlier, this study used only static load to failure; although fatigue testing may have more clinical relevance,¹ it was beyond the scope of this evaluation, as was specimen thermocycling. Thermocycling is suggested to introduce stresses between bonded interfaces⁷ that would have potentially altered the results of this study.

CONCLUSIONS

Under certain conditions, CAD-CAM adhesive technology may compensate for less than optimal axial wall height. Based on both failure load results and failure mode analysis, adhesively-luted maxillary molar CAD-CAM crowns based on a preparation containing 10-degree TOC require at least 2 mm AWH for adequate resistance and retention. However, clinical adoption of these findings is cautioned until both fatigue analysis and appropriate clinical evidence has been provided.

Acknowledgments

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Key Point

Under certain conditions, CAD-CAM adhesive technology may compensate for less than optimal axial wall height

REFERENCES

1. Arola D. Fatigue testing of biomaterials and their interfaces. *Dent Mater* 2017;33:367–381.
2. Bernal G, Jones RM, Brown DT, Munoz CA, Goodacre CJ. The effect of finish line form and luting agent on the breaking strength of Dicor crowns. *Int J Prosthodont* 1993;6:286–290.
3. Bindl A, Richter B, Mörmann WH. Survival of ceramic computer-aided design/manufacturing crowns bonded to preparations with reduced macrotension geometry. *Int J Prosthodont* 2005;18:219–224.
4. Chen C, Trindade FZ, de Jager N, Kleverlaan C, Feilzer AJ. The fracture resistance of a CAD/CAM Resin Nano Ceramic (RNC) and a CAD ceramic at different thicknesses. *Dent Mater* 2014;30:954–962.
5. El-Mowafy OM, Fenton AH, Forrester N, Milenovic M. Retention of metal ceramic crowns cemented with resin cements: effects of preparation taper and height. *J Prosthet Dent* 1996;76:524–529.
6. Friedlander LD, Munoz CA, Goodacre CJ, Doyle MG, Moore BK. The effect of tooth preparation design on the breaking strength of Dicor crowns: Part 1. *Int J Prosthodont* 1990;3:159–168.
7. Gale MS, Darvell BW. Thermal cycling procedures for laboratory testing of dental restorations. *J Dent* 1999;27:89–99.
8. Gilboe DB, Teteruck WR. Fundamentals of extracoronal tooth preparation. Part I. Retention and resistance form. *J Prosthet Dent* 1974;32:651–656.
9. Goodacre C, Campagni W, Auilino S. Tooth preparations for complete crowns: An art form based on scientific principles. *J Prosthet Dent* 2001;85:363–376.
10. Goodacre CJ. Designing tooth preparations for optimal success. *Dent Clin N Am* 2004;48:359–385.
11. Guth JF, Wallbach J, Stimmelmayr M, Gernet W, Beuer F, Edelhoff D. Computer-aided evaluation of preparations for CAD/CAM-fabricated all ceramic crowns. *Clin Oral Investig* 2013;17:1389–1395.
12. Kelly JR. Perspectives on strength. *Dent Mater* 1995;11:103–110.
13. Kelly JR, Benetti P, Runguanganunt P, Della Bona A. The slippery slope—Critical perspectives on in vitro research methodologies. *Dent Mater* 2012;28:41–51.
14. Kelly RJ, Runguanganunt P, Hunter B, Vailati F. Development of a clinically validated bulk failure test for ceramic crowns. *J Prosthet Dent* 2010;104:228–238.
15. Krämer N, Lohbauer U, Frankenberger R. Adhesive luting of indirect restorations. *Am J Dent* 2000;13(Spec No.):60D–76D.
16. Patel PB, Wildgoose DG, Winstanley RB. Comparison of convergence angles achieved in posterior teeth prepared for full veneer crowns. *Eur J Prosthodont Restor Dent* 2005;13:100–104.
17. Sjögren G, Bergman M. Relationship between compressive strength and cervical shaping of the all-ceramic Cerestore crown. *Swed Dent J* 1987;11:147–152.
18. Tiu J, Al-Amleh B, Waddell JM, Duncan WJ. Reporting numeric values of complete crowns. Part 1: Clinical preparation parameters. *J Prosthet Dent* 2015;114:67–74.

Clinical relevance: Under certain situations, CAD/CAM adhesive technology may compensate for less than optimal axial wall height.

Original Article from: *J Adhes Dent* 2019;21(6):545–550.



Q2 WIZARD

- 1. Which of the following conditions have the features of perioral melanin pigmentation and intestinal polyps?**
 - a. Addison disease
 - b. Gorlin Coltz Syndrome
 - c. Neurofibromatosis
 - d. Peutz Jegher's syndrome

- 2. Which one of the following statements regarding cluster headaches is least likely to be true?**
 - a. Pain usually lasts for 15-30 minutes
 - b. Causes nasal stuffiness & facial flushing
 - c. May mimic tooth ache or pain due to sinuses
 - d. Mostly affects elderly females

- 3. A 48-year-old female presents with a 6 month history of recurrent mealtime swelling and pain in her right submandibular region. Clinical examination does not reveal any dental abnormality. What is the most likely cause of her symptoms?**
 - a. Lymphadenitis
 - b. Sialolithiasis
 - c. Sialometaplasia
 - d. Sialorrhea

- 4. Which one of the following terms is most appropriate to describe pain occurring at the site of nerve injury?**
 - a. Analgesia
 - b. Anesthesia
 - c. Causalgia
 - d. Hypesthesia

- 5. Which of the following conditions is most likely to have referred pain?**
 - a. Irreversible pulpitis
 - b. Reversible pulpitis
 - c. Acute apical periodontitis
 - d. Phoenix abscess

- 6. Which of the following statements regarding trigeminal neuralgia is not true?**
 - a. Vascular compression of the trigeminal ganglion is one of the causes
 - b. The pain involves all three divisions of the trigeminal nerve equally
 - c. There is an electrical quality of the pain
 - d. The pain is severe, often shooting into the bone and teeth

- 7. Radiographic contrast can be directly affected by altering which of the following?**
 - a. Milliamperage
 - b. Exposure time
 - c. Kilovoltage
 - d. Angulation

- 8. Gutta-percha is best sterilized by which of the following methods?**
 - a. Immersion in full-strength sodium hypochlorite
 - b. Immersion in rubbing alcohol
 - c. Dry heat
 - d. Bead sterilizer

- 9. Which of the following tooth is most likely to exhibit a C-shaped root canal configuration?**
 - a. Mandibular second molar
 - b. Maxillary first premolar
 - c. Maxillary second premolar
 - d. Mandibular first molar

- 10. What are von-Korff fibers?**
 - a. The first-formed collagen fibers formed between preodontoblasts
 - b. Unmyelinated sensory fibers in the cell-free zone of Weil
 - c. Odontoblastic processes interposed between ameloblasts
 - d. Silver-stained ground substance located between odontoblasts

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ANSWERS OF Q2 WIZARD - VOLUME 3 NUMBER 6

- | | | | | | | | | | |
|------|------|------|------|------|------|------|------|------|-------|
| 1. c | 2. d | 3. b | 4. a | 5. c | 6. a | 7. b | 8. b | 9. b | 10. d |
|------|------|------|------|------|------|------|------|------|-------|

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MEETINGS

- April 1–4, 2020
AAE Annual Meeting
Nashville, Tennessee
<https://www.aae.org/specialty/education-events/aae-annual-meeting/>
- April 2–4, 2020
ALD 2020: Dentistry's Laser Meeting
San Diego, CA
<https://www.laserdentistry.org/index.cfm/conference>
- April 11–12, 2020
International Dental Lab Expo & Conference
New Delhi, India
<https://www.dentallabexpo.com/>
- April 22–25, 2020
AACD 2020
Orlando, United States
<https://www.aacdconference.com/>
- April 23–24, 2020
3rd World Congress on Dental & Oral Health
Barcelona, Spain
<https://www.worlddentalconference.org/>
- May 7–10, 2020
American Academy of Orofacial Pain 44th Scientific Meeting 2020
United States
https://aaop.clubexpress.com/content.aspx?page_id=4002&club_id=508439&item_id=868417
- May 7–9, 2020
New Orleans Dental Conference & LDA Annual Session
New Orleans
<http://www.nodc.org/>
- May 14–16, 2020
Expodental Meeting
Rimini, Italy
<https://expodental.it/it>
- May 28–30, 2020
Pacific Northwest Dental Conference
Seattle, US
<https://wsda.org/pndcseattle>
- June 18–19, 2020
European Forum on Dentistry and Dental Materials
Rome, Italy
<https://www.longdom.com/dentalmaterials>
- June 24–26, 2020
BAOMS Annual Scientific Meeting
London
https://www.baoms.org.uk/professionals/events_and_courses/488/baoms_annual_scientific_meeting_facing_the_future
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1. Grossman E, et al (1986) J Perio Res; Supplement: 33-43.
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