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All dentists should pursue providing the best care available. Providing the best care available should involve the quest to provide evidence-based dentistry (EBD). If a question ever arises about the care that you are providing, having EBD to support your treatment is comforting, professionally and legally.

The American Dental Association (ADA) defines Evidence-Based Dentistry as “an approach to oral healthcare that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient’s oral and medical condition and history, with the dentist’s clinical expertise and the patient’s treatment needs and preferences.”

The statement that we dentists “practice” dentistry is very true. We are all doctors of dental surgery or medicine. We have been licensed to practice dentistry on the citizens of Tennessee. We are given the responsibility to take each patient’s unique clinical situation and make the best recommendations along with following all of the points of informed consent.1

Not all clinical care provided by dentists has EBD support. We must use the best evidence available to treat patients under sometimes unique circumstances. The randomized controlled trial (RCT) is the highest level of research. Glick stated in an editorial that, “RCTs are not the gold standard for answering all clinical questions. Recognizing that not all research or clinical experience is weighted equally, providers and patients should make informed and shared treatment decisions based on potential health benefits and potential harm. Applying that approach to individualized patient care is at the core of EBD.”2

Sackett, et al., stated that “Good doctors use both individual clinical expertise and the best available external evidence, and neither alone is enough. Without clinical expertise, practice risks become tyrannized by evidence, for even excellent external evidence may be inapplicable to or inappropriate for an individual patient. Without current best evidence, practice risks become rapidly out of date, to the detriment of patients.”3 Sackett’s most recent opinion of evidence-based medicine states that it is, “The integration of our best research evidence with our clinical expertise and patient’s unique values and circumstances.”4

We must always remember that the final decision on patient care comes from the patient, and they have the right to choose any care, or no care. This is clear from the tenets of informed consent.1

If an issue arises that you need EBD guidance, the National Library of Medicine web site is an excellent source. Go to your search engine on the desktop of your computer and type in “pubmed” and you will be taken to the home page of this very extensive compilation of medical-dental research maintained by the National Library of Medicine.

The American Dental Association Library and Archives is an access point for EBD. There are research librarians who are available to help ADA members with research. They can be reached at the ADA telephone number 800-621-8099 or ADA.org/library or https://www.ada.org/en/member-center/ada-library. The ADA has a library mailbox that is monitored constantly during working hours at library@ADA.org. The ADA Center for Evidence-Based Dentistry can be found at https://ebd.ada.org/en.

We all have a finite amount of time for continuing our quest for practicing with EBD. We should use evidence-based peer-reviewed journals. The Journal of the American Dental Association and the Journal of the Tennessee Dental Association have evidence-based peer-reviewed articles in each issue to assist in your life-long learning effort to provide the best care possible.

Glick made the following statement, “Health care providers must continually seek to improve the quality of patient care through sound professional judgment based on provider excellence, expertise and clinically relevant research.”2

If you have questions about EBD or need help with a research question and the above access points are not productive, please call the Tennessee Dental Association at 615-628-0208.

H. Clifton Simmons III, D.D.S.
Editor, Journal of the Tennessee Dental Association

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Dr. Rick Guthrie and wife, Cindy, at ADA meeting in Atlanta.

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Introduction

In the United States, one in 800 European-American and one in 2,000 African-American live births result in two of the most common congenital orofacial malformations, cleft lip and/or cleft palate.1,2 Lateral, oblique and median facial clefts are less common3 and while there are more common congenital defects, they are not compatible with term development or extra-uterine survival.

The polygenic occurrence of CP/CL has the highest population-specific frequency in Asian populations and populations of Asian descent, e.g., Native American, with one in 500 births.4 Most cleft palates, unilateral or bilateral, complete or incomplete, occur in combination with cleft lips5,6 and both clefting defects are more common in males than females with 80% presenting unilateral.3

An infant with a cleft requires a coordinated team of long-term providers for initial surgical correction and then to monitor and guide oral and maxillofacial growth and development. Dental, orthodontic, and otolaryngological care, speech therapy and later psychiatric care may be necessary. Given the severity of clefting, patients may require multiple major and/or minor corrective surgeries. The goal in surgically treating velopharyngeal insufficiency is restoration of a functional seal between the naso- and oropharynx to facilitate normal speech development without obstructing the upper airway.7,8 Pharyngeal flap surgery becomes a treatment option to restore velopharyngeal competence when unsuccessful soft palate cleft procedures result in scarring, loss of tissue, and/or foreshortening.9

In adults, the traditional goals in prosthodontic treatment of clefts include restoring the dentition, speech rehabilitation, and improved esthetics.10 Treatment options have broadened with the use of dental implants given our increased understanding of craniofacial growth and development. Today, improved surgical and orthodontic treatments allow cleft patients to receive more focused care in a more compressed timeframe to rehabilitation.11

Presentation (Case history)

A 69-year-old white female with a repaired unilateral cleft lip/palate including pharyngeal flap and residual cleft of the ventral hard palate was referred to the Department of General Dentistry from the Department of Oral

ABSTRACT

Clefting is a common congenital orofacial defect. Surgical primary palatoplasty is not always definitive for reconstruction of clefts secondary to foreshortened soft palates. Pharyngeal flap surgery can be used to facilitate a primary palatoplasty repair to restore veloalveolar competence and reduce hypernasality. Patent palatal clefting creates unique and challenging problems for prosthetic fabrication including risks of acute airway obstruction by extension of denture impression material through the palatal cleft. Preventive and retrieval measures must be adequately considered and available when emergency naso-oral airways are compromised in the office setting. This article presents the proper technique for impression making and the consequence of impression material lost within a cleft.

Keywords
cleft palate, velopharyngeal insufficiency, dental impressions
and Maxillofacial Surgery (OMFS) at the University of Tennessee Medical Center, Knoxville, Tennessee for fabrication of a complete maxillary denture (Figures 1 and 2).

She had previously consulted with OMS for surgical correction of her cleft but due to a history of diabetes with poor healing, hypertension, and central sleep apnea, it was determined that she was a poor candidate for surgical correction. Placing of dental implants was also relatively contraindicated due to poor bone quality and availability. The patient had had several surgical procedures to correct her labial and palatal clefting, including pharyngeal flap to reduce her velopharyngeal insufficiency and incompetency, which had contributed to her obstructive sleep apnea.

At her first appointment the patient presented with a chief complaint that, “My upper plate does not stay in.” She had a bone spur in her upper right maxillary arch. Examination revealed dentures constructed more than twenty years prior exhibited excessive wear with poor retention and discoloration. Also, a retained molar root tip in the right maxillary arch, an oral-nasal fistula, cleft lip and palate with surgical scaring, and a bifid uvula were noted. Alginate impressions were taken to fabricate custom impression trays and the previously mentioned root tip was removed.

During her second appointment, final impressions were taken with custom trays and PVS (polyvinyl siloxane). While the mandibular impression was taken without incident, during the maxillary impression procedure, a fragment of material extruded into her cleft during tray removal (Figure 3), separated and became lodged in her nasal cavity. While the plug of separated impression material was visible through the cleft it could not be visualized in the right nasal cavity due to a deviated septum (Figure 4). Eventually, the fragment migrated to her posterior oropharynx and was not visible since it moved superior to the pharyngeal flap. At this point, OMFS was consulted to attempt retrieval of the segment using topical anesthesia, a nasopharyngoscope, nasal speculum and forceps. While visible, the impression material was irretrievable due to the dorsal location above the pharyngeal flap coupled with patient discomfort and anxiety. At that time, she was admitted to the hospital and a CT scan (Figure 5) was obtained to definitively locate the foreign body prior to taking the patient to the operating room for retrieval.

Following oral intubation the impression material was visualized using a nasal speculum and nasopharyngoscope where it was discovered lodged in the dorso-superior aspect above the pharyngeal flap. The foreign body was retrieved and guided into the oropharynx and retrieved orally (Figure 6). Culture and sensitivity testing was performed and the patient was treated with antibiotics with no subsequent complications.

Wax Try-in and Delivery

Appointments were made for wax rim adjustments, a wax try-in of the denture teeth and final delivery of the prosthesis (Figures 7 and 8).

Cleft Impression Considerations

The severity, size, and location (hard or soft palate) of a cleft impacts the success and accuracy of impression technique and results. Procedures to prevent airway obstruction with impression materials should consider temporary obturation of the oral/nasal communication using gauze, cotton or even a pre-cut patch of rubber dam material. This is especially important when using an irreversible hydrocolloid (alginate) material as it can be forced into the opening. Material separated off the impression can be usually retrieved using cotton pliers. Beumer and coworkers, advise and illustrate defect blocking with petrolatum lubricated gauze to prevent “escape of impression material in to the paranasal sinuses” (p. 197). This technique assures incorporation of the gauze into the material removed with the impression. Sharma and coworkers, suggest fabrication of a custom tray with a “wash of light-body rubber base
impression material” (p. 337) as fractures rarely occur with rubber base material and withdraw completely from “small bony defects” (p. 337). Regardless of technique, most importantly the anticipation of potential problems to achieve successful impression records on any cleft palate patient are imperative.

References


Clint Brodal, D.D.S., Department of General Dentistry, University of Tennessee Medical Center, Knoxville, Tennessee
O. Lee Wilson, D.M.D., Department of General Dentistry, University of Tennessee Medical Center, Knoxville, Tennessee
J. W. Hudson, D.D.S., Department of Oral and Maxillofacial Surgery, University of Tennessee Medical Center, Knoxville, Tennessee
Murray K. Marks, Ph.D., University of Tennessee Medical Center, Knoxville, Tennessee. Contact Dr. Marks at 865-305-9191 or mmarks@utmck.edu
1. In the United States, one in how many European-American live births results in congenital orofacial malformations?
   a. 8
   b. 50
   c. 800
   d. 8000

2. The two most common congenital orofacial malformations are:
   a. cleft lip
   b. cleft palate
   c. oblique and median facial clefts
   d. answers a. and b.
   e. answers b. and c.

3. The polygenic occurrences of cleft lip and cleft palate has the highest population-specific frequency in:
   a. Hispanic
   b. Scandinavian
   c. Australian
   d. Asian populations and decent

4. The goal in surgically treating velopharyngeal insufficiency is:
   a. restoration of a functional seal
   b. entirely cosmetic
   c. facilitation of normal speech development
   d. answers a. and c.

5. In adults, the traditional goals in prosthodontic treatment include:
   a. restoring the dentition
   b. speech rehabilitation
   c. improved esthetics
   d. all of the above

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5.  a  b  c  d

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Temporomandibular Joint Disorder Education and Clinical Training in the Advanced Prosthodontics Program at the University of Tennessee Health Science Center, College of Dentistry


Introduction

Epidemiological studies report that temporomandibular disorders (TMD) affect 5-12% of the adult population.1-3 TMD is reported to be the second most common musculoskeletal condition resulting in pain and dysfunction.4 The cost of treating TMD excluding imaging has doubled recently to 4 billion in the last decade in the United States.5 A few studies have indicated that approximately 75% of the population have at least one sign of joint dysfunction (joint noise, deviation on opening, episodic locking) and approximately 22-40% suffer from one or more TMD symptoms, such as face or jaw pain.2,4,6 Societal barriers, limited knowledge, lack of support from insurance companies, and the self limiting nature of the disease prevent many patients from seeking therapy. The incidence of TMD varies with the age and sex of the individual. Many studies conclude that the prevalence of TMD is significantly more in young adults (20-40 years) and in females, compared with males for the same age group.7-11

Patient history, consideration of psychosocial factors, muscle and TMJ palpation, evaluation of range of mandibular movements, occlusal status, existence of parafunctional conditions, and data from imaging and other diagnostic tests have been utilized for diagnosis of TMD patients.12 Research diagnostic criteria have been developed, recently modified, and believed to provide a comprehensive assessment of the most common TMD conditions.13 In addition, many assessment tools are available which claim to aid in diagnosis of the TMD patient, such as surface electromyography (EMG) recordings, joint sound-vibration detection/amplification, and electronic jaw tracking instruments.11 These devices have received an approval from the ADA for aiding in the diagnosis of TMD.14

A wide variety of therapies have been used for management of TMD patients. They include both reversible and irreversible procedures. Reversible procedures for treating TMD include: supportive patient education, pharmacologic pain control, physical therapy and/or intraoral appliances.4,15 In addition, two philosophies exist regarding intraoral appliances, based on the treatment position of the mandible; they are known as stabilization appliances or anterior repositioning appliances.4,15 The irreversible procedures for treating TMD patients include: occlusal adjustment, crowns and bridges, orthodontics, and surgical intervention of the joint.4,15 Several long-term clinical studies have reported statistically and clinically significant symptom improvement in treated patients with no improvement in untreated patients.16-18 Also, studies conclude that signs and symptoms of TMD can be controlled in some patients using conservative/irreversible treatment procedures.19-22

The etiology of TMD is multifactorial. Trauma (micro trauma and macro trauma), stress,23 occlusal disharmony have been reported as three major etiological factors of TMD.24 Studies have also reported various perpetuating factors, initiating factors and predisposing factors may be purely coincidental, causal or increase the risk of TMD.25 The treatment of TMD is not limited to one specialty or even one field but has involved practitioners from a variety of disciplines and specialties.

Temporomandibular joint disorders (TMD) as defined by the glossary of prosthodontic terms refers to conditions producing abnormal, incomplete, or impaired function of the temporomandibular joint(s).25 TMD is not a single disorder but a term for describing a number of pathologic conditions of the masticatory system and are considered a subclass of musculo-skeletal disorders.26 Patients with TMD often exhibit one or more of the following signs and symptoms: headache, facial pain, neck and shoulder pain, dysphonia, otologic symptoms, teeth sensitivity, painful mastication, dysphonia, otorhinolaryngologic, neurologic, vascular, congenital, neoplastic, and/or inflammatory diseases in the orofacial

ABSTRACT

Temporomandibular disorders (TMD) affects 5-12% of the adult population and is reported to be the second most common musculo-skeletal condition, resulting in pain and dysfunction. It is imperative that dental schools take the initiative to educate the residents and also the dental students so they may appropriately diagnose and manage these patients. The study of TMD has been integrated in to the undergraduate and the postgraduate (Prosthodontic) curriculum at the University of Tennessee Health Science Center, College of Dentistry and a TMD clinic has been established in the Advanced Prosthodontic department since 2010.

Keywords

TMD, orofacial pain, splint
region. Pain or dysfunction associated with causes other than musculo-skeletal, may be considered as secondary TMD and usually requires multidisciplinary intervention.26 This article will focus on primary TMD which are associated with musculo-skeletal causes.

TMD education in dental schools of the United States and Canada has progressed but has not developed to current evidence-based knowledge.29 There is a lack of curriculum guidelines in some programs which has caused confusion in the minds of new graduates. However, it is critical to train dental students to accurately diagnose TMD since it is absolutely within the scope of dental school education and essential for dental practice.30 In addition, referring these patients to a prosthodontist, orthodontist or an oral surgeon may or may not solve the problem, depending on their exposure to these topics during their specialty training. Some dental schools offer post-graduate training programs in orofacial pain and TMD. These schools usually have organized curriculums and optimal facilities for training the pre-doctoral and post-doctoral students with evidence-based approaches.29

The American Dental Educators Association (ADEA) has published an official document defining the ADEA competencies for a new general dentist.31 As per the ADEA competency document, the new general dentist must be competent to “prevent, diagnose, and manage temporomandibular disorders.”30,35 The study of TMD has been integrated into the undergraduate curriculum at the University of Tennessee Health Science Center, College of Dentistry, beginning with the first-year dental students. In the third year, dental students are given live demonstrations to diagnose and treat TMD patients. Consistent with CODA standards, the College Of Dentistry has expanded the TMD course didactic curriculum of the Advanced Prosthodontic program, and established a TMD clinic in 2010. The TMD clinic provides the residents and dental students with an opportunity to learn to diagnose and treat TMD patients, under the supervision of experienced faculty members. Students periodically refer patients to the graduate clinic and follow them through the treatment, which provides them an opportunity to closely interact with a faculty member regarding their understanding of TMD and the conditions that mimic TMD. All residents and dental students are exposed to and experience treating TMD patients. The clinic has successfully diagnosed and managed TMD patients by providing affordable quality care.

Orthodontics23

Standard 4-3.4 A graduate of an advanced specialty education program in orthodontics must be competent to manage patients with functional occlusal and temporomandibular disorders;

Oral and Maxillofacial Surgery24

A graduate of an advanced specialty education program in Oral and Maxillofacial Surgery must be competent to:

Standard 4-13 Manage temporomandibular joint pathology and at least three other types of procedures.

Standard 4-15 Perform reconstructive surgery including, temporomandibular joint reconstruction.

It is imperative that dental schools take the initiative to educate residents and also dental students to appropriately diagnose, treat and manage TMD patients.30,35 The study of TMD has been integrated into the undergraduate curriculum at the University of Tennessee Health Science Center, College of Dentistry, beginning with the first-year dental students. In the third year, dental students are given live demonstrations to diagnose and treat TMD patients. Consistent with CODA standards, the College Of Dentistry has expanded the TMD course didactic curriculum of the Advanced Prosthodontic program, and established a TMD clinic in 2010. The TMD clinic provides the residents and dental students with an opportunity to learn to diagnose and treat TMD patients, under the supervision of experienced faculty members. Students periodically refer patients to the graduate clinic and follow them through the treatment, which provides them an opportunity to closely interact with a faculty member regarding their understanding of TMD and the conditions that mimic TMD. All residents and dental students are exposed to and experience treating TMD patients. The clinic has successfully diagnosed and managed TMD patients by providing affordable quality care.

Conclusion

In a dental school environment, the TMD clinic offers an educational tool for the students, residents and the faculty, and provides a conservative solution for the patient.35 Over the last 5 years, patients treated in the Advanced Prosthodontic TMD clinic at the University of Tennessee Health Science Center, School of dentistry have demonstrated a reduction in the intensity of signs and symptoms on follow-up appointments.

References

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William McHorris D.D.S., B.S. is an Associate Professor at the Department of Prosthodontics, University of Tennessee Health Science Center, College of Dentistry in Memphis, Tennessee.
1. According to this article, TMD affects what percentage of people?
   a. 5%-12%
   b. 33% of Australians
   c. 45% to 50% of Asians
   d. 75% of Africans

2. What is the second most common muscular skeletal condition resulting in pain and disability:
   a. Temporomandibular Joint Disorders
   b. Parkinson’s Disease
   c. Von Willebrand’s
   d. Alzheimer’s Disease

3. Instruments to ascertain diagnosis of TMD include:
   a. EMG recordings
   b. joint sound-vibration detection/amplification
   c. electronic jaw tracking instruments
   d. all the above

4. Reversible procedures for the treatment of TMD include:
   a. pharmacologic pain control
   b. intraoral appliances (removable)
   c. occlusal adjustment
   d. answers a. and b.

5. The majority of studies of TMD conclude that the signs and symptoms of TMD can be controlled in most patients by using conservative/reversible treatment procedures.
   a. true
   b. false

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Shade Matching in the Contemporary Dental Practice Using Visual Shade Guides


Introduction

The primary goals of the restorative dentist are to restore the function of damaged or missing tooth structures and to maintain stability in the dentition. However, in some cases, patients are unhappy with the esthetic appearance of their teeth. For many patients, pleasing dental esthetics are of the utmost importance, and they will ignore the value of function and emphasize the importance of appearance. For some, their overall feelings of well-being can be influenced by the appearance of their dentition. The blending of restorative materials with the teeth, producing a natural-looking appearance suitable to the patient in which the dental restoratives cannot be seen, should be a major goal of the restorative dentist. Selecting the shade of prosthetic teeth for complete dentures adds additional challenges in that patient expectations must be met while selecting the shade of prosthetic teeth that complements the patient’s complexion. The prosthetic teeth in removal partial dentures should also match the remaining natural teeth.

In the modern-day restorative dental practice, colorimetric instrumentation can be employed to choose a close color match. However, the most frequently used technique in the shade matching of teeth to restorative materials is done manually and visually with dental shade guides. This article discusses the contemporary techniques of clinically determining the color of teeth to restore dentate and edentulous patients using manual, visual shade guides. We included representative examples of shade guides that are currently used to match shades for direct operative dentistry restorations, indirect fixed prostheses, and removable prostheses. Issues related to communication of tooth shade between the dentist and the prosthetic lab are discussed. A brief review of pertinent color science principles is also presented.

ABSTRACT

This article is a review of the clinical shade matching techniques used in the contemporary dental practice. Shade guides used to match shades for direct operative dentistry restorations, indirect fixed prostheses, and removable prostheses were included in this review. Issues related to communication of tooth shade between the dentist and the prosthetic lab are discussed. A brief review of pertinent color science principles is also presented. The selection of tooth shade for dental restorative materials and prosthetic teeth is critical to achieve a close biomimetic result and acceptance by patients. Both visual and instrumental systems have greatly improved over the past twenty years. Manual-visual shade guide systems are cheaper to obtain, provide excellent results, and continue to be the most common means of shade selection in dentistry.

Keywords

Dental shade guides, visual shade guides, tooth shade matching, restorative dentistry, removable prosthodontics

Shade Matching Using Visual Shade Guides

Restorative dental materials and prostheses matched to patient tooth color using contemporary clinical techniques generally provide results acceptable for most patients. In the modern dental practice, visual shade guides and colorimetric instruments can be used to achieve a close color match. In spite of advances in the development of accurate clinical instruments such as colorimeters and spectrophotometers for the determination of tooth shade, the more economical visual shade guides with shade tabs are most commonly used for shade selection. However, the visual shade guide methods of determining shade are very subjective, and often these techniques depend on ambient factors and the color vision acuity of the clinician. When using a shade guide, the overall appearance is affected not only by the color of the teeth but also by existing tooth gloss, texture, translucency, and opalescence. Ambient dental operatory conditions such as wall color and illumination can also affect shade selection. The personal tastes and bias of the dentist and the patient can also influence color matching and shade choices.

The communication of color presents the first challenge to the clinician. The human perception of color depends on the physical parameters of light and a complex abstraction by brain neurons of the physical parameters of the reflectance of light from objects. The experience of color and the attributes of color given to objects is created by this abstraction. This is accomplished by discriminating between the wavelengths of light reflected from an object from those of light reflected from the environment.

The normal human eye is sensitive to wavelengths of light in the range of 400-700 nm. Throughout this range of visible light there is a gradual change in color from blue, through green, yellow, orange, to red. The eye is most sensitive to light in the green-yellow region. In 1802, an English physician, Thomas Young, proposed a three variable, or trichromatic theory of color vision. This theory is based upon the action of three differing receptors located in the retina. It was theorized that there is an overlapping of the absorption spectra...
from the three receptors, and excitation of each is transmitted independently to the brain. This theory subsequently received independent support in the mid-nineteenth century when it was demonstrated that all the colors perceived by humans can be matched by mixtures of three spectral lights. This theory was further promoted when the absorption spectra of pigments of single cones in the human eye were directly measured.1

Individuals with normal color vision do not perceive color exactly the same. However, the majority of them do observe color similarly.17 In fact, color perception changes with each individual. Covering one eye for approximately 90 seconds can change color perception.18 Personal emotions, medications, chronic illnesses, and aging can also change an individual’s color perception.17

Because of these variances in human observer color perception, various methods have been devised for quantifying color and expressing color numerically, thereby making it possible to communicate colors more accurately. A color space is a specific organization of colors. Since color space is a specific term, identifying a particular combination of color modeling and mapping function, it tends to be used informally to identify a color model.3 In 1905, Albert Munsell, developed a method of expressing colors and color space utilizing paper color chips classified according to their hue, lightness, and chroma.19 Hue is the attribute of color by which we distinguish red from green, blue, yellow, and so forth. Value indicates the lightness of the color, and the scale of value ranges from 0 for pure black to 10 for pure white. The whites, blacks, and grays are achromatic, having no hue. This lightness can be measured independently of hue. The degree of departure of a color from the neutral color of the same value is termed chroma. Colors of low chroma can be described as weak, while those of high chroma are strong or vivid. Chroma can be described as saturation levels of the hues.20

The selection of tooth shade begins with properly equipping the dental operatory with overhead and dental unit lighting that will produce the optimum shade selection. Two different scales are used to measure and communicate the color of light sources. Those are color temperature and color rendering index. Color temperature (CT), or temperature of a light source, is the temperature of an ideal blackbody radiator that radiates light of comparable hue to that of the light source. Blackbody radiation is the type of electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment, or emitted by a blackbody (an opaque and non-reflective body) held at a constant, uniform temperature. The radiation has a specific spectrum and intensity that depends only on the temperature of the body. Blackbodies only actually look black when they are cold. When heated, they glow like metals, first a dull red then progressively brighter and whiter like the filaments of incandescent light bulbs.3 Color temperature is conventionally expressed in temperature based on the Kelvin scale, using the symbol K. Color temperature can be thought of as a scale of redness (warmth) or blueness (coolness) of the light.21

Color Rendering Index (CRI) indicates how well a light source renders color as compared to a standard source (Northern Daylight). This is the most natural, completely balanced, and neutral light source. Color Rendering Index began to be important when fluorescent sources of various kinds became common.20 The fluorescent illuminants would often distort colors of objects, rendering them very different compared to other light sources such as daylight.3 Color Rendering Index is defined on a scale of 0-100. Sunlight has a CT of 5,500K and a CRI of 100. The most important factor in shade matching is the light source. Since natural light conditions vary, the recommended standard for dental shade matching is a CT of 5500K and a CRI greater than 93.22

As previously mentioned, the most frequently used technique in the shade matching of natural teeth to restorative materials and tooth shade selection for removable prosthodontic treatments are done manually and visually with dental shade guides.7 Using this method, shade matching is accomplished by visually comparing a tooth with multiple standards, usually represented as shade guide tabs (Figure 1). The shade selection done in this fashion is subjective and is influenced by the ability of the human observer to choose the best matching shade. Factors such as observer color perception, observer bias, ambient lighting, and the acceptance threshold of mismatch have effect on accurate shade matching. Also, not all commercial shade guides cover all the ranges of value, hue, and chroma present in human tooth structure.5 The aging of shade guides combined with possible darkening of the tabs due to cold sterilization can be a major problem. None of the currently available laboratory restorative material systems are available in more than two manufacturers of restorative materials shade systems with many available in only one. Quite often, cross-matching is required with the laboratory technologist to reformulate the material shades to match the particular dentition. This process is an extremely subjective and can lead to undesirable clinical mismatches.13

There are a variety of shade guides available to the practitioner. Examples are illustrated in Figure 2. Some are universal shade guides in that they could be used for matching ceramic materials and composite resin materials with teeth.
Many of the visual shade guides have similar design, so we will concentrate on one line of products to illustrate the manual, visual shade selection technique.

The VITA Vitapan Classical A1-D4® shade guide (Vita North America, Yorba Linda, California, USA) was introduced to dentistry in 1956 (Figure 3), and it is still one of the most popular shade guides used in dentistry. The VITA Classical A1-D4® is composed of sixteen tabs. The tabs are arranged into four groups (A-D) on hue with increasing chroma within the groups. In this arrangement, Group A is reddish-brown, Group B is reddish-yellow, Group C is gray, and Group D is reddish-gray.

As described by Paravina and Powers, the manufacturer also provides an arrangement of shade guide tabs by hue. Many dentists find that matching tooth shades is simplified by this arrangement of tabs, and this array of tabs by degree of brightness has been found to be easier and more reliable to use (Figure 4).23

In general, when using shade guides to select a shade, it is recommended that hue selection be made first, followed by chroma and value, in that order. The clinician should always do a final check and revise the shade selection. The following are recommendations for shade selection in the dental operatory:13

» Tooth shade matching should be done at the beginning of the appointment. Tooth dehydration can occur if the patient’s mouth is open for long periods during the procedure. Also, the dentist’s eyes can fatigue during the procedure.5

» Tooth shade should be determined in daylight or under standardized daylight lamps (CT of 5500K and CRI greater than 93).

» Dental operatory walls should be neutral in color.

» Teeth to be matched must be clean.

» Remove bright colors from the field of view and anything that would be distracting such as large jewelry, lipstick, eyeglasses, and facial makeup.

» View at the patient eye level.

» Evaluate shade under multiple light sources.

» Shade matching should be made quickly to avoid eye fatigue (5-7 seconds). The observer can look at a blue or gray card to rest eyes.

Shade selection for prosthetic teeth in a completely edentulous patient presents different challenges than shade selection for a dentate or partially dentate patient. When selecting a shade for a fully or partially dentate patient the shade that most closely matches the natural teeth is usually chosen. On the other hand, when selecting a shade for complete dentures the dentist and patient are not bound by this restriction and there exists a greater freedom of choice regarding shade selection. The selection of a shade can be difficult for some patients because it is a manual and subjective technique and not a mechanical procedure.23 With the wide selection of shades available, how might the practitioner narrow these down to the most optimal shade for the patient?

The first step in shade selection is listening to the patient’s desires.23 Very often the patient will prefer a shade that is lighter than their previous natural teeth. They may have a prior denture containing a shade they want to duplicate or change. In the case of an immediate denture the patient may want the same shade as their natural teeth or perhaps lighter. This information can be gathered during the initial patient interview.

It is important to allow the patient to participate in the decision-making process. Patient photographs of their natural dentition can be helpful in shade selection for an edentulous patient, and patients appreciate the use of these by the practitioner. It may also be helpful to obtain the input of a trusted family member or friend when it comes time for shade and tooth selection. This is psychologically effective and is another way to engage the patient in the shade selection process.24

There are several techniques that may aid the dentist in the selection process. The dentist may select a few shades that
blend well with the patient’s color, texture, and appearance of the skin. Those with a darker complexion may need a darker shade while fair skinned patients may require a lighter shade. Another technique is to place a selected shade tab next to the sclera (white region) of the eye. A value that is too high will be indicated by a tab that is brighter than the sclera. A third technique may be to choose the lightest and darkest shade tabs that the dentist thinks the patient may approve. Point out the difference in these two and ask the patient to select the tab that they most like or reject the tab they least like. Delete the rejected color and select another shade from the preferred half of the shade guide. Repeat this pair comparison and by the process of elimination you will arrive at a shade that is acceptable. The goal is to choose a shade in harmony with the patient’s skin, eyes, and hair color, but the most important factor is the desire of the patient.

Shade selection for prosthetic teeth is usually made with a shade guide consisting of several tooth-shaped tabs with varied amounts of hue, value, chroma, and sometimes characterization. The tabs represent the shades available for denture teeth. Shade conversion charts are available to cross-match shades from one manufacturer to another, but these are not always reliable because of the different filler chemistry, layering, and translucency of the many prosthetic teeth on the market today. It is important to use the shade guide specifically designed by the manufacturer of the teeth for the most predictable and consistent results.

Showing the patient the entire shade guide is not recommended. It is best to select a range of two or three shades that seem natural for the patient, and then allow the patient, and possibly significant other relation, to view these choices. If the clinician feels strongly about a particular shade the patient may be guided toward that selection, but it is important to allow patients to feel that the final decision was theirs.

Once a preliminary shade has been determined, the actual shade guide tooth should be observed in three locations: 1) outside the mouth next to the cheek, 2) under the upper lip with only the incisal edge exposed, and 3) under the upper lip with the mouth open and the majority of the tooth exposed. By viewing outside the mouth the dentist can compare the shade to skin, eye, and hair color. When viewing only the incisal edge, the often blue-gray tint in the incisal third of the tooth can be evaluated. Finally, in the last view you may see and evaluate the often yellow hue that can be seen in the middle and cervical thirds.

The selection of tooth shade for dental restorative materials and prosthetic teeth is critical to achieve a close biomimetic result and acceptance by patients. Both visual and instrumental systems have greatly improved over the past twenty years. As previously mentioned, the visual shade guide systems are cheaper to obtain, provide excellent results, and they continue to be the most common means of shade selection in dentistry.
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References


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| Shade Matching in the Contemporary Dental Practice Using Visual Shade Guides |

| Journal of the Tennessee Dental Association • 97-2 |
1. Color matching of the dentate patient is most often achieved by use of:
   a. a spectrophotometer
   b. a colorimeter
   c. a color wheel
   d. a visual shade guide

2. Factors that affect tooth shade are:
   a. tooth gloss
   b. texture
   c. translucency and opalescence
   d. all the above

3. Ambient factors that may affect tooth color are:
   a. wall color
   b. illumination
   c. a. and b.
   d. doctor’s eye pigment

4. Color Rendering Index (CRI) indicates how well a light source renders color as compared to what standard source?
   a. northern daylight
   b. an artist spotlight
   c. fluorescent light
   d. operatory light

5. The following can change color perception:
   a. personal emotions
   b. aging
   c. arcus senilis
   d. a. and b.

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Restorative Space Management of Misaligned and Malformed Teeth in the Esthetic Zone: A Case Report


Introduction

Restoring a patient’s smile utilizing the least invasive to the most complex procedures and techniques requires clinicians to understand their patients’ expectations. Many patients desire to return to their smiles of yesteryears. Providing therapeutic care using direct composite resin restorative material to restore a patient’s smile has become essential in this society’s image and perception of beauty. Patients will present with real or imagined wants and desires for dental therapeutic care, especially, the correction of crowded anterior dentition in the esthetic zone. Bernabe et al. defined this disharmony as “Crowding occurs when the space required for alignment of the permanent teeth exceeds the space available in the dental arch.” The crowded dentition can present in spatial misalignment (Figure 1). Brea et al., have identified several etiologies for crowded teeth, such as, “Drifting, aberrant eruption patterns, habits, tooth size discrepancies, space loss caused by early loss of deciduous teeth, and interproximal caries.” The concern for the dentist consisted of presenting a clinical treatment option(s) in consideration of the patient’s concern of the anticipated “esthetic zone” result. According to Shillingburg, the esthetic zone is defined as, “…the part of the mouth where high visibility requires a restoration or tooth replacement to simulate the appearance of a tooth.” This case report illustrates alternative treatment options of reducing misaligned and malformed teeth with a direct composite resin material. This has come to be known as Restorative Space Management (RSM).1,12,13

ABSTRACT

Patients have desires to return their existing, unacceptable esthetic zones to the fading remembrances of yesteryears’ excitingly youthful, gleamingly symmetrical dentition and smiles. This article presents the use of restorative space management (RSM), utilizing alternative therapeutic tooth reduction and treatment option, when orthodontic or fixed prosthetic or both dental therapeutic care has been declined for recapturing those remembrances. In treatment-planning of the case, direct application of non-adhesive resin may be used on diagnostic casts that are mounted on a semi-adjustable articulator. This mock-up presentation allows for visualization and subsequent discussion involving the potential treatment, along with the pros and cons. Restorative Space Management was accomplished using direct composite resin material and restorative armamentarium for the malformed and misaligned maxillary right lateral incisor leaving the palatal surface intact. The direct composite resin material was placed into a trimmed (cervical extension removed) anatomical cellulose acetate crown form (CACF) favoring the patient’s initial treatment outcome expectation. Restorative Space Management has the potential to return the dentition to a harmonious spatial alignment within the ordained space. This case report illustrates an alternative option for restorative space management using direct composite resin crowns to accomplish desired esthetics.

Keywords
restorative space management, esthetic zone, misaligned teeth, direct composite resin crown, celluloid acetate crown form

CASE REPORT

 Diagnosis

After the completion of periodontal therapeutic care, a middle-aged white female was referred to a restorative dentist. The referral related to the possible correction of malformed and misaligned maxillary lateral incisors teeth #7 and #10 by using direct composite resin material (Figure 1). This patient presented with unremarkable medical status. The clinical examination revealed missing teeth, porcelain-fused-to-metal crowns with supra-gingival metal exposure, and spatially misaligned teeth with clinical crown malformations. No caries were observed on the distal surface of tooth #8, clinically or radiographically. The periodontal status of the maxillary anterior teeth was stable as confirmed by the periodontal consultation. The patient was not concerned with the asymmetrical gingival architecture in the esthetic zone. An orthodontic consultation revealed that the maxillary anterior teeth’s bone level was not favorable for orthodontic care. The color of the dentition and porcelain ceramic crowns were not a concern for the patient. A misaligned and malformed tooth #7 exhibited moderate overlap onto the distal surface of tooth #8 with contralateral similarity to tooth #10 (Figure 1). The patient’s chief concern (“straightening the teeth”) met the “parameters guidelines for tooth preparation and modifications.” For the patient to understand the intended treatment option, prognostic procedures and techniques were performed, providing the patient with information.
to make an informed decision regarding therapeutic care of teeth #7 and #10.\textsuperscript{20,21}

**Prognostic Preparation and Treatment Planning**

To align anterior teeth in a harmonious relationship, the need to re-contour and re-position the labio-palatal and mesio-distal surfaces were necessary to establish a pleasing smile line (straight teeth) as requested by the patient. Reduction of the teeth was performed under the rubric of Restorative Space Management (RSM).\textsuperscript{11-13} Kim et al., defined RSM as "therapy that uses tooth preparation techniques and designs to accomplish the goals of orthodontic treatment."\textsuperscript{6,13} The goal consisted of re-contouring the teeth (e.g., morphologically and dimensionally) to a harmonious relationship within the allotted space. The recontouring of teeth #7 and #10 may result in obtaining appropriate form, function, comfort, and esthetics by using direct composite resin adhesive dentistry to meet the patient’s desired appearance outcome.\textsuperscript{1,3,6,7,22-26} Limitation(s), advantages, and disadvantages were considered when re-contouring the dentition to address the patient’s concern, straightening the teeth. The possible limitation of insufficient space to accommodate a harmoniously aligned tooth/teeth posed a challenge during the diagnostic wax-up and the impending possibility of selective endodontic treatment. The advantages of using direct composite resin material allowed: (1) control and creativity by the dentist at chairside to provide in full veneer coverage; (2) anatomical vertical and horizontal re-configuration of the teeth, and (3) proximal contact area correction.\textsuperscript{22} The disadvantages consisted of: (1) the reduction of the tooth surfaces for needed space for the full crown that may require elective endodontic care; (2) bonding to the cervical root surface; (3) the patient’s lack of return for reassessment and dental visits; (4) technique-sensitive adhesive procedure, and (5) continuously maintaining an isolated non-humid operating environment.\textsuperscript{22}

A microhybrid direct composite resin material with zirconia filler particles was the intended material for the RSM composite resin crown.\textsuperscript{24,26} This type of composite resin material is known for its excellent wear resistance; favorable prognosis for a chameleon result with patient’s dentition; and little or no chipping of the restoration.\textsuperscript{24,25} An A2 shade guide tab was selected during the steps of shade/color recognition and determination in the examination phase of shade matching.\textsuperscript{25,27} The teeth presented with the following characteristics: (1) a translucent layer of enamel over the entire facial surface; (2) horizontally and vertically smooth, convexed surface texture; (3) a mono-shade of A2 with a medium level of gloss, and (4) a dehydrated state with the appearance of white cloudy characteristic at the cervical third. A direct composite resin mock-up was performed on tooth #7 (Figure 2) to allow the patient to visualize the potential treatment outcome.\textsuperscript{16,17} The composite resin mock-up was done without the use of adhesive bonding agent which allowed: (1) the tooth to return to pre-existing status; (2) a visual and real-time prototype of the re-contoured tooth for form, function,
and esthetics; (3) an exhibition of the dentist's potential sculpting skill levels; and (4) patient's approval or non-approval of the possible treatment outcome.

As a result of tooth #7's misalignment, the cosmetic review was not sufficient to allow an adequate visualization of the forecasted potential repositioned tooth #7 within the space allocation; therefore, a diagnostic wax-up of teeth #7 and #10 was needed for the patient.16-19 The length and width measurements were obtained using a dental caliper with the following results: #8 (8.4mm width, 11.4mm length), and #10 (8.4mm length) to aid in the diagnostic wax-up. According to the Glossary of Prosthodontic Terms of 2005, diagnostic waxing was defined as, “waxing of intended restorative contours [of a tooth or teeth] on [the diagnostic] dental casts for the purpose of evaluation and planning restorations.” 28 Diagnostic waxing was appropriate to: (1) provide a preview of the potential treatment outcome for the patient and dentist; (2) satisfy the patient’s esthetic preference(s), and (3) accomplish the restorative principles of form, function, comfort, and esthetics.17

Maxillary and mandibular alginate impressions were made, and stone casts were fabricated for diagnostic mounting. Two sets of diagnostic casts were made for the maxillary arch and one for the mandibular arch. All casts were mounted on a semi-adjustable articulator with an incisal guide table. One maxillary cast was held for the archival pre-operative status of the patient’s dentition. The second cast (working cast) was used in the facial veneer reduction and diagnostic wax-up of teeth #7 and #10. The root canal and pulp chamber configuration were also radiographically reviewed for the possibility of elective endodontic therapy.20 The feasibility of elective endodontic treatment was later discussed with the patient. The stone teeth #7 and #10 were reduced using carbide (700L Friction Grip (FG) Flat End Fissure Carbide) and diamond (014 and 016 Friction Grip Diamond Medium coarse) burs. The reduction of the stone teeth before wax-up illustrated the potential clinical preparation design required for the harmonious re-alignment of the restored teeth. A full-contour diagnostic wax-up of teeth #7 and #10 (Figure 3) simulated a completed direct composite resin crown within the designated space for form, function, comfort, and esthetics. The patient was able to provide consent after the discussion of the limitations, advantages, and disadvantages. The patient approved the procedure beginning with tooth #7.21

Therapeutic Care: Restorative Space Management

The maxillary teeth were isolated with a rubber (now, termed dental) dam to lessen and prevent humidity, fluid contamination, and to shield soft tissue from trauma. The teeth received a prophylaxis using medium grit prophy paste (Blue Medium without Fluoride Prophy Paste) before performing the preparation design. The mesial overlapping portion of tooth #7 was removed with a carbide bur [(700L Friction Grip (FG) Flat End Fissure Carbide) Figure 4]. The distoproximal surfaces of tooth #8 revealed a class III carious lesion, which was not evident during clinical and radiographic examinations. A class III distal proximal preparation design was completed on tooth #8 using a carbide round bur (#2 Friction Grip (FG) Round Carbide). The carious class III defect was restored using total etch adhesive strategy, A2 composite resin material, and finishing and polishing armamentarium, as specified by the manufacturers’ guidelines. Following the class III restoration design completion, the facial veneer preparation design was completed as noted under the rubric of Cellulose Acetate Crown Form (CACF).

Cellulose Acetate Crown Form

The entire facial surface was reduced with medium grit diamond burs (014 and 016 Friction Grip Diamond Medium course) to allow appropriate length and harmony of the anticipated restored...
tooth #7 with the existing dentition. The palatal surface did not require reduction. The mesio- and distoproximal contact areas with tooth #7 were slightly opened using a diamond finishing strip (Interproximal Strip, Non-Perforated Diamond Strip Medium) to allow for CACF interproximal clearance. A slightly larger crown form with a thickness of 0.2 to 0.3mm was chosen to anticipate the composite resin shrinkage during photo-curing in order to prevent mesial and distal diastemas. The dental caliper was used to measure the mesio-distal width (6.65 mm) of tooth #7. A moderate size crown form (6.75 mm in width) was chosen to ensure: (1) complete coverage facial veneered of the prepared and non-prepared tooth for length, width, and depth; (2) appropriate mesial and distal proximal contact areas and embrasure formations, and (3) complete coverage of prepared tooth #7. The extended CACF material was removed with crown and bridge scissors to a minimum length of 8.7mm which resulted in the clinical illustration as presented in Figure 5. The CACF was evaluated for fit on the partially completed facial veneer (Figure 6). The completed facial veneer included the removal of the mesial and distal residual caries on the facial surface of tooth #7. The total etch adhesive strategy was followed according to the manufacturer’s guidelines. The re-contoured crown form was filled with A2 composite resin material leaving space in the middle portion to allow for the insertion of the prepared and non-prepared surfaces of tooth #7. To prevent voids at the mesio- and disto-faciopalatal point angles, an explorer was used to puncture an opening (escape vent) through the palatal surface at the mid-portion of the CACF (Figure 5). This escape vent allowed the extrusion of excess composite resin material. The extruded material was removed before photocuring to allow ease of retrieval of the CACF when this process had ended. Additionally, the excess composite resin material was removed from the cervical margin for which allowed for later ease of finishing the margins after polymerization. Finger pressure held the CACF in placed during the polymerization process to prevent the extrusive force generated by the direct composite resin material (Figure 7). If the finger pressure was not applied to the composite resin filled crown form, it would have been displaced resulting in an incorrect spatially aligned restoration with incongruent embrasures. The composite resin material within the CACF was cured for on all surfaces. After photo-curing, a small space between the CACF and composite resin material resulted due to polymerization shrinkage. The slightly larger CACF provided sufficient composite resin after polymerization shrinkage which created appropriate proximal contact areas and the prevention of diastemata. The residual extruded protuberance of composite resin material onto the palatal surface of tooth #7 was removed with a football shaped carbide finishing bur (OS1 12 fluted (7406) ET™) before removal of the CACF (Figure 8). An explorer was placed at the facio-cervical margin to cut the CACF for removal. As a result of the definitive mesial and distal proximal contact areas, the CACF was slightly difficult to remove. A hemostat was used to remove the remaining crown form. The dental dam was retracted with a composite resin instrument to protect the dental dam and soft tissue from damage during the circumferential cervical composite resin margins from finishing with an appropriate fluted finishing carbide bur. The retraction of the dental dam was continued during the sequential use of different grit size finishing disks.
followed by point and cups polishing instruments to obtain the surface topography to blend with the existing dentition.29 After the use of each finishing and polishing instruments, the debris was rinsed, and the tooth was dried for visual assessment of restoration for possible correction. The dental dam was removed, and the final contour was completed. The palatal surface was re-examined for occlusal contact functionality using articulating paper, appropriate size egg-shaped carbide finishing bur, and finishing and polishing points and cups. During the shade assessment phase, the finished composite crown was congruent with the examination phase (the initial appointment for shade selection).25,27 The occlusion was adjusted to function and was confirmed by the patient.

The patient was pleased with the treatment outcome using a direct composite resin crown which was within the budget and allowed to maintain a favorable oral hygiene regimen (Figure 9). The final esthetic treatment outcome met the patient’s initial expectation. The patient was advised concerning oral hygiene at-home maintenance, and subsequent routine dental visits.22

The patient returned for oral hygiene maintenance at 2½ months and exhibited favorable oral health and post-restorative results (Figure 10). Eight months later the patient received oral hygienic home maintenance instructions following oral hygiene prophylaxis care to assist her in compliance and adherence instructions. During this visit, the mesial and distal surfaces of tooth #7 papillae were noted to gain some volumetric improvement in the interdental embrasure spaces.14

**DISCUSSION**

Several authors have used the reduction of the teeth with either fixed prosthodontic care or composite resin material to reposition the tooth/teeth into the designated space for appropriate form, function, comfort, and esthetics. Gurel et al., and Brea review of RSM consisted of treating the dentition with fixed prosthodontic therapy.9,12 Croll, Marus et al., and Zorba used composite resin materials in the rehabilitative care of the dentition.4,6,7 When utilizing RSM technique with a direct composite resin material, the dentist must consider the amount of tooth reduction needed to allow repositioning the teeth. The treatment outcome can result in satisfaction of the patient’s initial expectations.

Alternatively, the restorative dentist may be confronted with the potentially unfavorable outcomes of (1) endodontic involvement due to the need for aggressive tooth reduction; (2) less than favorable gingival architecture and cervical embrasure configuration; (3) morphological and anatomical uncertainties that may lead to oral hygiene complications, and (4) occlusal scheme non-continuity. The most important concept was to plan the treatment strategy to include a direct composite resin prototype and diagnostic wax-up to determine the: (1) morphological and anatomical corrective needs and (2) limitations, advantages, and disadvantages that would allow the patient to make an informed decision regarding the treatment plan. The patient was pleased with the treatment outcome of using a direct composite resin crown within the designated desire and fiscal matter.

**CONCLUSION**

The clinician’s objectives in this case report was to provide patient-centered stomatognathic therapy based on the patient’s desires and clinical indications for care. The clinician was able to meet these objectives by accomplishing the following: (1) treatment within the
patient’s financial allocation; (2) minimal reduction to obtain a harmonious result with the existing dentition while honoring the patient’s perceived expectation; (3) provide a re-care appointment to help the patient maintain adherence and compliance instructions with at-home and in-office oral hygiene guidelines for favorable forecast toward the restoration’s longevity, and (4) avoiding elective endodontic therapy. Restorative space management, using direct composite resin material provided a viable treatment option which resulted in a harmonious spatial alignment and optical illusion of the corrected morphological and anatomical tooth form within the ordained space of the patient’s esthetic zone.

References

1. Crowding occurs when:
   a. vertical dimension has collapsed
   b. vertical dimension has increased too far open
   c. maxillary teeth are in by-pass occlusion with the mandibular teeth
   d. the space required for the alignment of teeth exceeds the available arch space

2. Several etiologies resulting in crowding include:
   a. drifting
   b. tooth-size discrepancies
   c. early loss of deciduous teeth
   d. all the above

3. The esthetic zone is defined as the area where high-visibility requires restorative procedures to effect a harmonious smile.
   a. true
   b. false

4. Prognostic procedures and techniques were performed in this case to:
   a. provide the patient with information so they make an informed consent
   b. impress the other doctors assisting with the case
   c. pass the Esthetic Dentistry Board for specialization
   d. none of the above

5. In this case, recontouring of teeth #7 and #10, using direct composite resin may result in:
   a. appropriate form
   b. appropriate function
   c. comfort
   d. appropriate esthetics
   e. all the above

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Restorative Space Management of Misaligned and Malformed Teeth in the Esthetic Zone: A Case Report

Circle the correct letter answer for each CE Exam question:

1. a b c d
2. a b c d
3. a b
4. a b c d
5. a b c d e

Date exam taken: _____________________

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☐ Full ☐ Partial ☐ No

Your comprehension of material

☐ Excellent ☐ Fair ☐ Poor

Appropriateness of the material

☐ Excellent ☐ Fair ☐ Poor

Was the material adequately in-depth?

☐ Yes ☐ No

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Displacement of Anterior Flabby Ridge Tissue During Impression Making of an Edentulous Maxillary Arch: A Quantitative Comparison of Three Impression Materials

John R. Antonelli, DDS, MS; Mauricio Guerrero, DDS; Timothy L. Hottel, DDS, MS, MBA; Mark Scarbecz, PhD; Vu H. Tran; Stefan A. Hottel

Introduction

The stability and retention of complete dentures depends on the support provided by the residual ridges and the palate. A study of edentulous subjects, covering 25 years of complete denture wearing showed continued reduction of the residual ridges during this period, and the pattern and magnitude of alveolar bone loss exhibited great individual variation.\(^1\) The mean rate of reduction of the maxillary alveolar ridge was reported to be most rapid (0.73 mm/yr) during the first year after extraction of teeth and insertion of the denture.\(^2\)

Reduction of residual ridges is chronic, progressive, and irreversible. Massive resorption of alveolar bone in the maxillary and mandibular arches could result in displaceable, or flabby ridges, which often results in symptoms of pain and unretentive dentures. Flabby ridges in the edentulous maxilla have been reported to be almost five times more prevalent than in the mandible (24% vs. 5%, respectively).\(^1\) Flabby ridges could occur following tooth extractions; wearing ill-fitting dentures; and by compressive and rotational forces generated by natural mandibular anterior teeth that are transmitted to the maxillary denture, causing resorption of alveolar bone (combination syndrome).\(^3,4\)

When flabby maxillary anterior tissue is compressed during conventional impression making, tissue is captured in a deformed state. A denture constructed on the master cast would cause displacement of tissue under masticatory loading. When unloaded, the tissue would regain its rest position, possibly resulting in a loss of peripheral seal and dislodgement of the denture.\(^5,6\) Loose and ill-fitting dentures could cause significant discomfort and psychological problems; therefore, it is recommended to avoid compressing flabby anterior tissue during impression making.\(^7,8\)

ABSTRACT

Edentulous patients with combination syndrome display gross resorption of bone in the anterior maxillary ridge and the replacement of bone by mobile (flabby), fibrous tissue. Mobile tissues compromise the stability of complete dentures, which are often poor in both function and appearance. It is advised to make impressions of flabby ridges by employing a two-stage technique that uses low viscosity impression materials to capture flabby tissues in a manner that is minimally displacive. By capturing tissues in their resting position, the denture should maintain its contact with the tissues when the teeth are out of occlusion, and retention should be optimal for patients. There is little information in the literature to guide dentists in the use of materials for making final impressions of edentulous arches, especially where tissues are rated as high mobility, high displacement, and very difficult to treat. This study attempts to quantify the displacement of such maxillary anterior tissues when three popular impression materials—polysulfide, zinc oxide eugenol paste and tissue conditioner—are used to make final impressions. CAD/CAM technology was used to scan a patient’s edentulous maxilla in its relaxed state, and an acrylic cast was milled that served as the control relaxed tissue cast. The same technology was used to scan each final impression, and acrylic casts were milled from the scans. Six identical points (three on the hard palate and three on moveable anterior tissue) were chosen and the distance between points was measured to determine the degree of tissue displacement caused by each impression material. Polysulfide caused the greatest displacement of tissue; zinc oxide paste caused the least displacement along two of the three reference points. This information should help practitioners to make evidence-based decisions when selecting impression materials for patients with flabby ridges.

Keywords

Flabby ridge, combination syndrome, final impression, polysulfide, zinc oxide eugenol paste, tissue conditioner

Various impression techniques have been used to obtain support of flabby anterior ridges while reducing their capacity for movement during function. Watson\(^9\) employed a two-stage technique in which a window over the flabby tissue was created in a rigid custom impression tray. The technique makes it possible to capture a composite mucocompressive impression of rigid (normal) denture bearing tissue in the arch and a mucostatic impression of flabby anterior tissue. In reality, capturing anterior flabby tissue in this manner is minimally displaced rather than mucostatic because the denture-bearing tissue is compressed to various degrees during impression making, regardless of the material used.\(^10\) This two-stage impression technique employs the basic principles of complete denture construction, and uses materials that are familiar to the general dentist. For example, in one two-stage impression technique, after the rigid custom tray was border molded with green stick compound, polysulfide impression material was used to record rigid tissue, and ultra-low viscosity vinyl polysiloxane impression material was syringed into the tray window over displaceable anterior ridge tissue to produce a composite (i.e., minimally...
Discussed mucocclusive) final maxillary impression. Others advocate using low viscosity impression materials such as irreversible hydrocolloid, zinc oxide eugenol paste, and plaster to minimize flabby tissue displacement.

Discussion

In a 2005 survey, 945 U.S. prosthodontists and 42 dental schools responded to questions about materials and methods used for making final impressions for complete dentures. The most popular materials used by prosthodontists for making impressions of edentulous arches were polyvinylsiloxane (36%); polysulfide (34%); and polyether (16%). Only 10% of prosthodontists used zinc oxide eugenol paste. Irreversible hydrocolloid, tissue conditioner, functional waxes, and impression plaster were each used by 1% of the prosthodontists. Prosthodontists who completed their training more recently (<10 years) favored polyvinylsiloxane and polyether. Sixty-four percent of U.S. dental schools reported using polysulfide impression material, followed by 26% for polyvinylsiloxane, and 5% for polyether. A 1999 survey of general dentists in the U.K. revealed that when multiple responses were accepted about which impression materials they used for making final impressions for complete dentures, a high percentage (93%) reported using irreversible hydrocolloid; approximately 33% used zinc oxide eugenol paste, and 14% used polyvinylsiloxane.

This study attempts to quantify displacement of flabby maxillary anterior tissue when polysulfide (Regular Permlastic™, Kerr Corp., Orange, CA 92867), zinc oxide eugenol paste (COE-FLO™, GC America Inc., Alsip, IL 60803), and tissue conditioner (Tissue Conditioner™, Henry Schein Inc., Melville, NY 11747) are used for making final impressions for complete dentures. Each material has been used successfully for this purpose. An edentulous, 56-year-old male patient experienced ongoing lack of retention and stability of his complete maxillary denture. Consequently, both function and appearance of the prosthesis were compromised. An examination of the residual ridges as low displacement; average, clinically acceptable displacement; or high mobility, high displacement. Intraoral examination revealed that the anterior residual ridge (canine-to-canine area) moved more than 2 mm; therefore, it was rated as high mobility, high displacement, and very difficult to treat.

When the patient refused to discontinue wearing the ill-fitting maxillary denture prior to making impressions, including final impressions for replacement dentures, it was decided to reline the ill-fitting denture with tissue conditioner, which was changed every other week to minimize tissue displacement and inflammation, and increase retention and comfort. A radiographs revealed severe maxillary anterior alveolar ridge resorption. It was discovered that masticatory forces displaced mobile anterior hypertrophic (and flabby) denture-bearing tissue in the maxilla, which contributed to loss of peripheral seal and instability of the denture. The dental history revealed that the mandibular anterior teeth were extracted approximately 2 years ago. Flabby anterior tissue in this case is likely to be the result of combination syndrome. MacEntee15 stated that concerns about support for the denture should be noted if the residual ridge moves more than 2 mm under light pressure, or if there is less than 1 mm of mucosa attached firmly to the underlying periosteum. Massad et al.16 graded the displacement of tissue overlying the

**Table 1**

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyvinylsiloxane</td>
<td>36%</td>
<td>Low displacement</td>
</tr>
<tr>
<td>Polysulfide</td>
<td>34%</td>
<td>High displacement</td>
</tr>
<tr>
<td>Polyether</td>
<td>16%</td>
<td>Very difficult to treat</td>
</tr>
</tbody>
</table>

**Figure 1:** CAD/CAM Scan of the Edentulous Maxillary Arch. The area of displaceable tissue is outlined (dotted line).
paste, and 13 times greater displacement than tissue conditioner. Along points C-D, use of polysulfide caused tissue to displace 0.90mm—7.5 times greater displacement than zinc oxide eugenol paste, and 3.6 times greater displacement than tissue conditioner. The differences in tissue displacement between the three impression materials were not as great along points A-B, although the use of polysulfide impression material once again caused the greatest displacement. However, it is recommended that any benefit in terms of improved health outcomes must be both clinically and statistically significant.17 Clinical and statistical significance are important for interpreting clinical research results; they should be complimentary. To be clinically significant, (1) a change in an outcome must be of interest to someone—clinicians or patients—so that the effect of one treatment compared to another makes a difference; (2) the difference between groups must produce an important outcome (e.g., reduction in symptoms, improvement in quality of life); and (3) the differences must be statistically significant.17 While the differences in tissue displacement produced by each of the materials tested cannot be evaluated statistically, lack of long-term patient follow-up makes it impossible to claim that they meet the first criterion for clinical significance (e.g., an impact on tissue inflammation; denture retention; comfort; or alveolar resorption rate). Also, the replacement dentures fabricated from polysulfide impressions proved to be stable and retentive, and required only two post-insertion adjustments.

<table>
<thead>
<tr>
<th>Distance Between Reference Points on Casts (mm)</th>
<th>Tissue Displacement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A—B</td>
<td>C—D</td>
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<tr>
<td><strong>Control Cast</strong></td>
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</tr>
<tr>
<td>12.30</td>
<td>9.17</td>
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<tr>
<td><strong>Polysulfide Cast</strong></td>
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<td>12.67</td>
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<td><strong>ZOE Paste Cast</strong></td>
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<td>12.04</td>
<td>9.29</td>
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<tr>
<td><strong>Tissue Conditioner Cast</strong></td>
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<td>12.59</td>
<td>9.42</td>
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**Summary**

Dental colleges today are compelled to teach techniques and procedures that are evidence-based. The Commission on Dental Accreditation, our specialized accrediting agency, states that competencies for dental students must reflect an evidence-based definition of general dentistry.18 If all faculty members would role model this philosophy so that it could become rooted in the mindset of our students, then it should follow that there would be a close connection between what students learn in dental school and how they perform in private practice. Owen,17 recommends that if we consider the emerging and profound impact that an evidence-based approach has on clinical practice, then we should base treatment on uncontroversial, evidence-based—rather than essentially anecdotal—criteria. While we must seek information from high-quality research to help establish evidence-based procedures for complete denture impressions, the paucity of such research prompts us to recommend that practitioners should continue to rely on information from experienced clinicians and use techniques that produce good results.

Standard mucocompressive impression techniques could result in unretentive and unstable dentures because prostheses would be fabricated on casts of flabby tissues captured in distorted states. To date, studies about the superiority of any impression materials has depended on personal preference, based on analysis of theoretical principles.19 Petrie et al.13 concluded that years of experience had a statistically significant effect on the materials prosthetists chose for border molding procedures, but not for the materials used for making final impressions of edentulous arches. When there are no rigorous laboratory or clinical tests to support our contentions about the superiority of any impression material(s) to use for complete denture impressions in different clinical situations, then we must call upon the judgment of experienced clinicians because this in our hierarchy of evidence is perfectly appropriate.20

Diagnosing the tissue condition should be a determining factor when selecting an impression technique and final impression material(s) for a specific patient.12 By quantifying the degree of tissue displacement caused by three popular impression materials, this investigation attempts to help practitioners make evidence-based decisions about the choice of final impression materials to use for impressing displaceable tissue.

**References**


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Vu H. Tran is a D4 Dental Student at Nova Southeastern University College of Dental Medicine in Fort Lauderdale, Florida.

Stefan A. Hotell is a D3 Dental Student at the University of Tennessee Health Science Center College of Dentistry in Memphis, Tennessee.
1. The mean rate of reduction in alveolar residual ridges:
   a. chronic
   b. progressive
   c. irreversible
   d. all of the above

2. Flabby ridges:
   a. are five times more prevalent in the maxilla
   b. result in ill-fitting dentures
   c. occur primarily in the mandibular arch
   d. answers a. and b.

3. Dr. Watson employed a two-stage impression technique, which made it possible to capture:
   a. a composite mucocompressive impression
   b. a mucostatic impression of flabby tissue
   c. answers a. and b.

4. In a 2005 survey, 945 prosthodontists responded that they preferred to use which impression material for the final denture impression?
   a. polyvinylsiloxane
   b. polysulfide
   c. polyether
   d. zinc oxide/eugenol
   e. all the above

5. MacEntie, stated that if the residual ridges move more than 2 mm under light pressure it should cause the dentist concern for denture fit.
   a. true
   b. false

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*Displacement of Anterior Flabby Ridge Tissue During Impression Making of an Edentulous Maxillary Arch: A Quantitative Comparison of Three Impression Materials*


Circle the correct letter answer for each CE Exam question:

1. a b c d
2. a b c d
3. a b c
4. a b c d e
5. a b

| Date exam taken: ________________________________ |

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<table>
<thead>
<tr>
<th>Assess your mastery of the material</th>
<th>Full</th>
<th>Partial</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your comprehension of material</td>
<td>Excellent</td>
<td>Fair</td>
<td>Poor</td>
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<tr>
<td>Appropriateness of the material</td>
<td>Excellent</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>Was the material adequately in-depth?</td>
<td>Yes</td>
<td>No</td>
<td></td>
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</tbody>
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Departmental History, Expansion and Industry Contributions

After graduating from the University of Tennessee Health Science Center (UTHSC) College of Dentistry in 1916, and serving in the U.S. Army during World War I, John Jones Ogden, DDS, returned to Tennessee desiring to do something different. He would become the first dentist in the state to limit his practice to oral surgery. Dr. Ogden was a fellow of the American Society of Oral Surgeons, vice president of the American Dental Association, and served as president of the Tennessee State Dental Association in 1932. He is credited as the designer of the parallel forceps used universally in anterior maxillary tooth extraction. Dr. Ogden founded the Department of Oral and Maxillofacial Surgery (OMS) in the UTHSC College of Dentistry in the 1940s and served as chair until 1948.

Julius Roy Bourgoyne, DDS, served as OMS chair from 1948-1959. Dr. Bourgoyne received his DDS degree from Loyola University and completed his oral surgery residency at Charity Hospital in New Orleans, Louisiana. He is credited with developing the surgery program into a hospital-based residency. The program then went on to receive operating room privileges first at John Gaston Hospital (Figure 4), now Regional One Health, and followed with Baptist Memorial and Methodist Le Bonheur Healthcare Hospitals. During his time as chair, the Oral Surgery training program was lengthened from two to three years and the curriculum was expanded to include anesthesia, exodontia, pathology, trauma, medicine and general surgery.

In 1961, Lloyd C. Templeton, DDS, became the chairman and residency director of OMS. During his tenure, the residency program increased to two residents per year. He was the program director until 1965 and chair until 1966.

In 1965, Dr. Joe Hall Morris became the program director and then chairman of the department in 1966. Dr. Morris graduated from the UTHSC College of Dentistry in
1945 and completed his oral surgery residency there as well. After residency, Dr. Morris served as an oral surgeon in the U.S. Army at Fort Benning, Georgia. Dr. Morris has greatly contributed to the field of oral and maxillofacial surgery and is best known for his development of the Bi-Phase External Fixation Splint (Figure 5) and the Orthognathic Surgery Simulating Instrument (OSSI) (Figure 6). In 1983, the residency program expanded its hospital coverage to include the Regional Medical Center at the Elvis Presley Trauma Center. Today this facility is known as Regional One Health and it serves as the main teaching hospital for the OMS residency.

In 1988, Jimmy Albright, DDS, became the OMS chair. Dr. Albright completed his dental training at UTHSC in 1963. He then went on to become a dental officer in the U.S. Navy and completed his oral and maxillofacial surgery training at Bethesda Naval Hospital in 1973. Dr. Albright was on active duty until 1974, and then served as a reserve officer until 1990. Dr. Albright served as residency director from 1978 to 1988. During this time the residency program was extended to four years, bringing the current number of residency positions to eight. Dr. Albright stepped down as chair in 1997. He still works part time with the residency program and provides the program with many orthognathic cases each year.

Ben R. Hipp, DDS, became the departmental chair in 1997 and served until his retirement in 2001. Dr. Hipp received his dental degree from the College of Dentistry at University of Missouri-Kansas City. He graduated from the United States Army Command and General Staff College and completed his oral and maxillofacial training at Walter Reed Army Hospital in Washington, D.C. and Tripler Army Medical Center in Hawaii. Retiring from active duty as a colonel in the United States Army Dental Corps in 1985, he became a professor at the UTHSC College of Dentistry.

Today, the program continues to thrive under the leadership of Dr. Larry Weeda, who received his dental degree from the College of Dentistry at the University of Missouri-Kansas City in 1974. After graduation, Dr. Weeda went on to accept a commission in the U.S. Navy and completed his OMS training in 1984 at Portsmouth Naval Hospital. Dr. Weeda served as a surgeon in the Navy until he retired at the rank of Captain in 1998. During his time as chair, Dr. Weeda has continued to improve training and education for both the dental students and the OMS residents. In 2003, an optional MD degree training track was approved for those graduating surgery residents who are interested in the extra medical education.

James Christian, DDS, is the current
OMS residency director. He received his dental degree at Temple University and completed his oral and maxillofacial surgery training at the University of Connecticut. Dr. Christian brings a wealth of knowledge and experience in the field of TMJ pathology and reconstruction to the residency program.

Jeffery Brooks, DDS, is the current director of 3D imaging and surgical implantology at the University of Tennessee Health Science Center College of Dentistry, where he is also a full-time faculty member. Dr. Brooks specializes in 3D imaging for virtual planning of surgical cases and helps in planning implant placement. His most recent accomplishment is obtaining a 3D printer for the oral surgery residency to assist in surgical guided implant placement. He received his dental training at the University of Mississippi and completed his oral and maxillofacial surgery training at the University of Tennessee Health Science Center.

James W. Pledger, DDS, is the newest OMS faculty member, joining the faculty in July 2017. He graduated from the University of Tennessee College of Dentistry in 2001, and completed his oral and maxillofacial surgery residency at the College in 2005. Dr. Pledger served in the United States Air Force as a staff oral and maxillofacial surgeon instructing both AEGD-2 and oral surgery residents prior to stepping into private practice. After seven years of private practice, he has decided to pursue a full-time career in academia. He brings a wealth of knowledge about implants and the latest trends in oral maxillofacial surgery including the use of L-PRF.

About the Program

The University of Tennessee Health Science Center Oral and Maxillofacial surgery program is a four-year certificate program with an optional six-year program leading to an MD degree. The Oral Surgery clinic is affiliated with the University of Tennessee Health Science Center College of Dentistry and is located in the Dunn Dental building on Union Avenue. Hospitals affiliated with the program include Regional One Health (Figure 7), the Memphis Veterans Affairs Medical Center, Le Bonheur Children’s Hospital, Methodist University Hospital, Methodist South, and Baptist Memorial Hospital. Regional One Health and Le Bonheur Children’s Hospital are level one trauma centers while Methodist University Hospital is a level two trauma center. The program utilizes the National Resident Match Program to accept two categorical residents per year. The oral surgery training program covers advanced dentoalveolar surgery, impaction surgery, complicated trauma, orthognathic surgery, and more.

Figure 5: Bi-phase external fixation splint developed by Dr. Joe Hall Morris.
Courtesy of the Department of Oral and Maxillofacial Surgery, College of Dentistry, University of Tennessee Health Science Center, Memphis

Figure 6: The Orthodontic Surgical Simulating Instrument developed by Dr. Joe Hall Morris.
Courtesy of the Department of Oral and Maxillofacial Surgery, College of Dentistry, University of Tennessee Health Science Center, Memphis

Figure 7: Regional One Health which serves as the primary operating hospital for the OMS residency.
Courtesy of Regional One Health Office of Communications, taken by Dr. John Swearingen, Memphis
surgery, implantology, facial cosmetic surgery, TMJ therapy, and benign pathology resection with reconstruction.

**Curriculum**

The University of Tennessee Health Science Center Oral and Maxillofacial Surgery residency program employs different types of curricula to ensure the resident receives a high level postgraduate education. This includes many lectures from grand rounds, pathology conferences, orthognathic surgery conferences, review of trauma cases, guest lectures, and faculty lectures. Each resident also completes a surgical anatomy course focusing on the head and neck during the intern year. During the duration of the residency, each resident will participate in off-service rotations including internal medicine, anesthesia, general surgery, ear nose and throat, plastic surgery, oculoplastics and surgical oncology. Each resident becomes certified in Pediatric Advanced Life Support, Advanced Cardiac Life Support, and Advanced Trauma Life Support.

A PGY-1 resident completes seven months of OMS, three months of anesthesia, and two months of internal medicine. A PGY-2 resident will complete six months of OMS, two months of anesthesia, three months of general surgery and one month of research. A PGY-3 resident completes seven months of OMS, and one month of each: ear, nose, and throat; plastic surgery; oculoplastics; surgical oncology and research. The Chief PGY-4 resident completes 12 months of OMS service. After completion, the resident will receive a certificate of completion and will be eligible to complete the certification process for the American Board of Oral and Maxillofacial Surgery (ABOMS).

**About The UTHSC College of Dentistry**

The UTHSC College of Dentistry was founded in 1878 in Nashville, Tennessee at the Nashville Medical College. UTHSC adopted the Nashville Medical College in 1879. In 1911, the UTHSC Colleges of Medicine and Dentistry moved to Memphis, Tennessee. The original College of Dentistry was located in Rogers Hall on Monroe (Figure 1) from 1911–1949. In 1949, the college was moved to its second location on Union Avenue where it resided until 1978 (Figure 2). In 1978 the College of Dentistry moved to its current location in the Dunn Building (Figure 3) off Union Ave. The Dunn Building is named after former Governor Winfield C. Dunn, who graduated from the UTHSC College of Dentistry in 1955. The dental clinic was recently renovated with state-of-the-art equipment and the Department of OMS is currently being renovated. The UTHSC College of Dentistry is the oldest dental school in the South and the third oldest public dental school in the United States.

*Note: This article is for information purposes only. NO Continuing Education will be credited for this article.

**Disclosure:** The authors did not report any disclosures.

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Dr. Larry Weeda, Jr., Professor and Chairman, Department of Oral and Maxillofacial Surgery, University of Tennessee College of Dentistry, Memphis, Tennessee.

Dr. John C. Swearingen, Chief Resident, Department of Oral and Maxillofacial Surgery, University of Tennessee College of Dentistry, Memphis, Tennessee. Contact Dr. Swearingen at 901-482-1897 or jcswrngn@gmail.com.

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**Current Residents at the University of Tennessee OMS training program**

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Dental School</th>
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