Canadian Journal of Restorative Dentistry & Prosthodontics
The official publication of the Canadian Academy of Restorative Dentistry and Prosthodontics

Journal canadien de dentisterie restauratrice et de prosthodontie
Publication officielle de l'Académie canadienne de dentisterie restauratrice et de prosthodontie

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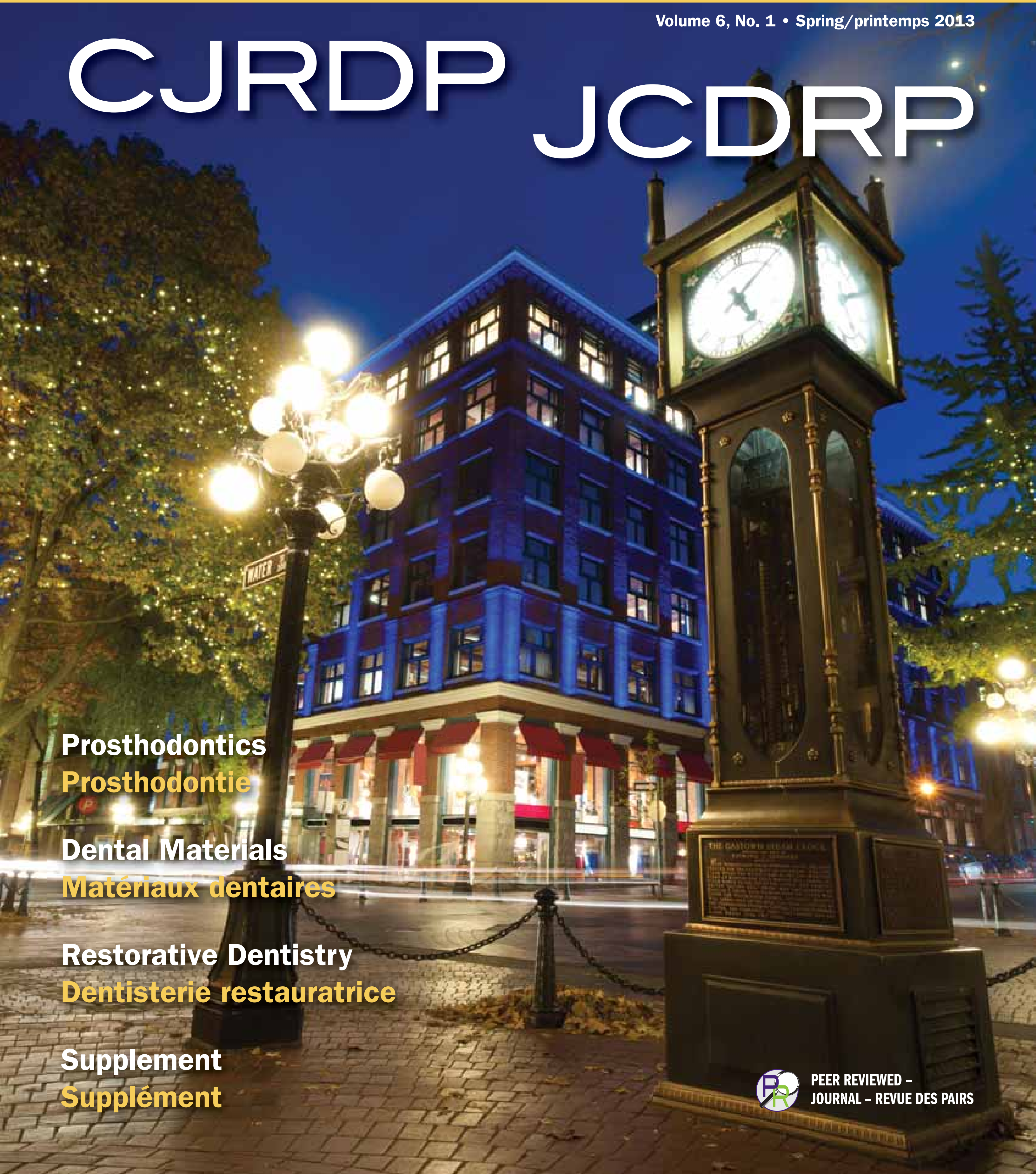
Volume 6, No. 1 • Spring/printemps 2013

CJRDP JCDRP



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CJRDP Editorial Board/Le comité de rédaction JCDRP

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Website: www.palmeripublishing.com

PPI Palmeri Publishing Inc.

Articles published express the viewpoints of the author(s) and do not necessarily reflect the views and opinions of the Editorial Board.

Printed in Canada
Canadian Publications Mail Product Sale Agreement 40020046

CJRDP JCDRP

www.cardp.ca

Volume 6, No. 1
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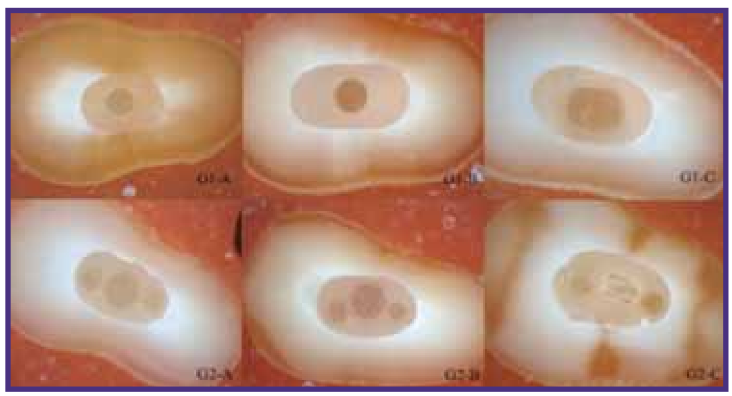
In this issue / Dans cette édition

FEATURES/ARTICLES



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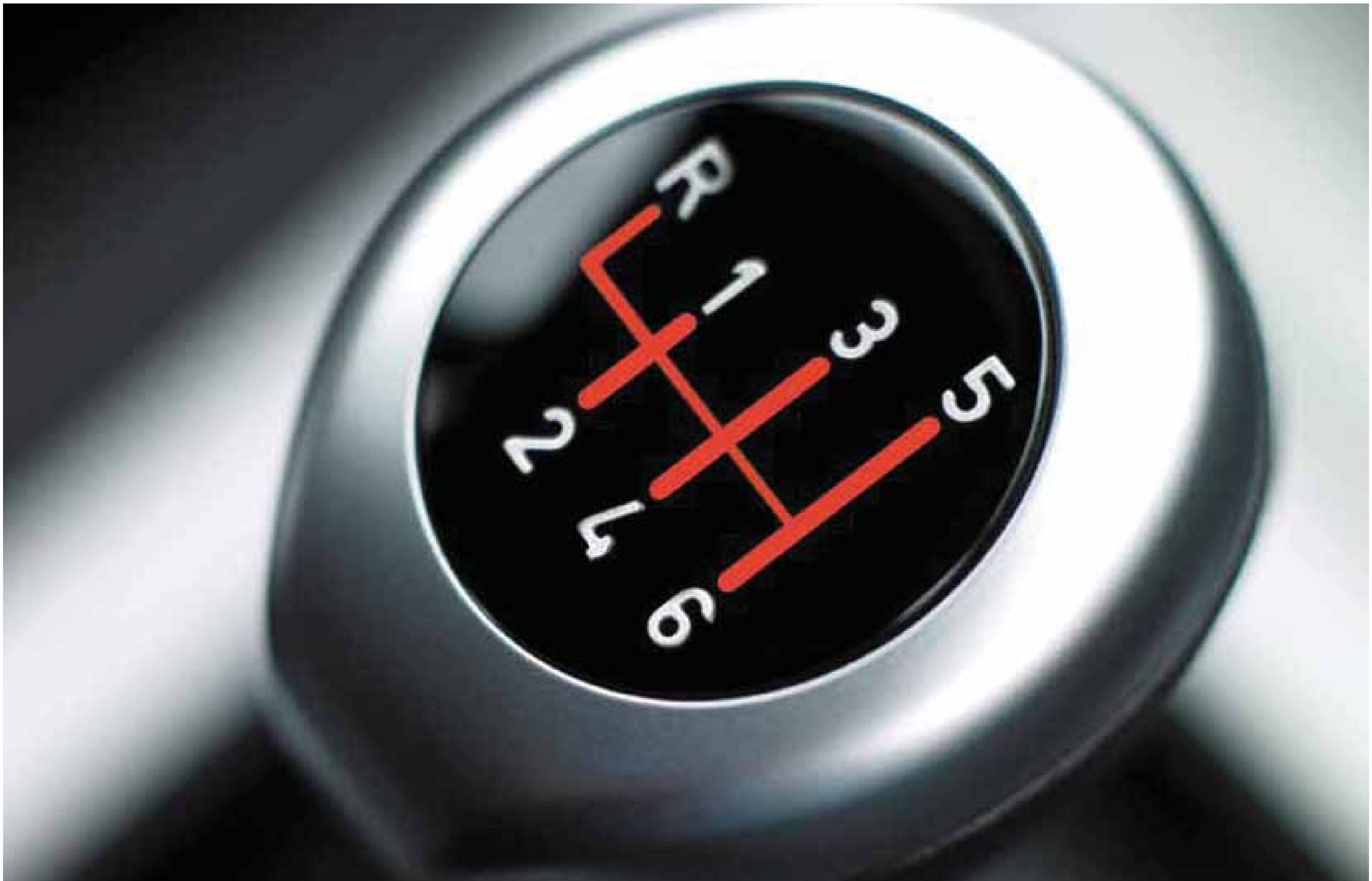
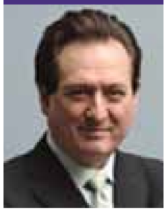
Cover image / Photo couverture:
The Gastown steam clock, Vancouver, BC





Dr. Dennis Nimchuk
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The History of CARDP and… The Vancouver, 2013 – Annual Scientific Meeting – The Art of What we Know

The Canadian Academy of Restorative Dentistry and Prosthodontics (CARDP) has a legacy going back to 1962 of conducting an Annual Scientific Meeting. In fact the holding of the *Annual Scientific Meeting* is the entrusted "raison d'être" of the Academy, whose primary purpose is to disseminate important clinical and research based dental knowledge to its members. The members of the Academy benefit greatly from this exercise, as does the public that they serve.

The present is a world away from 1962. In 1962 there existed sparse access to quality continuing education. If any single practitioner wanted to advance in the Art and Science of Dentistry, it was quite difficult, requiring considerable travel effort and expense in a search for personalized mentoring. A solution to the limitation of obtaining advanced dental education came from the vision of a group of motivated and dedicated Dentists who would come to form a collaboration that would provide the resources required to bring continuing education to a geographically accessible focal point. It was this way that The Canadian Academy of Prosthodontics was born and then followed a number of years later by The Canadian Academy of Restorative Dentistry. In 1992 these two paralleling Academies merged to become what is now known as The Canadian Academy of Restorative Dentistry and Prosthodontics.

Besides the primary objective of disseminating knowledge to the members, a secondary benefit of holding a collective Annual Scientific Program quickly became apparent. The realization set in that a unique development of support and collegiality occurred among this collective group of like-minded Dentists who would gather from cities and provinces across the country. The interaction became almost as important as the Scientific Meeting itself. Year by year as the knowledge base grew, so did the fraternization of its members. CARDP today is much more than a roster of attendees, it is an organization firstly for learning but also for friendship and for the support of colleagues.

Things have radically changed from the 1960's in the way that knowledge is disseminated. Technologically today it is possible to obtain continuing education electronically though the world-wide-web without even leaving home or by ordering DVD's online or by downloading short-burst, concentrated video instruction. As well, in the lecture auditorium, the technology of computer-driven digital presentations can produce stunning, interactive performance-based experiences that can captivate and mesmerize an audience. Today we have choices for learning; from a myriad of convenient internet-based learning methods, or the time-tested melting pot where people gather together to learn, to become stimulated and to engage in conversation and agreement or to examine disagreement. Both choices are valid but it is the meeting place that is still the format that is most favored; people gathering together, to learn together and to interact together for the benefit of each and all. This is the basis of *The Annual Scientific Meeting*.

It has been 7 years since the CARDP Meeting has been held in Vancouver and anticipation has been building as to the Program and who will be showcased and what will be presented. It is the role of the Scientific Program Chair and the Program Committee to put forward a program that will inspire and motivate and teach and even to entertain.

This time right now is when the three greatest developments in the last half century of clinical dentistry have stabilized and matured; firstly, the ability to bond composite resin to enamel, to dentine and to other substrates; secondly, the ability to replace teeth with titanium root form implants and thirdly, the ability to marry the technicians art of creating natural looking ceramic restorations with the dependability of industrial production. Aside from these three developments there have been no transformative clinical therapies or technologies that have come onto the dental marketplace. This present is a time when consolidation of technologies and of finessing what has been developed is evolving. This is the basis of our program in 2013… *"The Art of What We Know"*. Six speakers on Friday and eight on Saturday morning plus sixteen Table Clinic presentations in the afternoon is the format style.

For composite-based technology, Dr. David Clark, from Tacoma, Washington, one of the foremost innovators in the art of applied clinical composite technology will showcase on how to utilize composite bonding to make resin based restorations better, quicker, more esthetic and more enduring. If you feel competent at composite restorations, Dr. Clark will endeavor to show you how raise the bar.

For implant-based technology, we are planning to showcase three experts who will present how dental implants can be delivered in a better way, less invasively, more naturally and more enduring. Dr. Harold Baumgarten from Philadelphia will teach us how to achieve the best of outcomes in dental implants. Dr. Leslie David from Toronto, will bring to us her formidable skill sets of Oral and Maxillofacial surgery where implant placement is not so straight forward.

For ceramic-based technology, Dr. Christian Coachman, renowned, from Rio de Janeiro, one of the foremost dental technicians in the world, will showcase how contemporary ceramics can be made for installation in the mouth and defy detection. Dr. Coachman will stimulate us with the opportunities and possibilities of creating the most intricate and super-natural porcelain designs. Dr Chris Wyatt and Dr. Roxanna Saldarriaga will show how the technology and the clinical art blend.

These are our Friday highlights. Saturday we will present 18 minute rapid fire presentations and then in the afternoon Table Clinics. We are excited to showcase in Vancouver our outstanding roster of great presenters who will speak and present not just about what is known and developed but how to clinically divine and create the best of the "Art of What we Know".

But this is not all. Like all recent CARDP Scientific Meetings, this meeting will start off with pre-meeting, intra-meeting and post-meeting events that follow our perpetual CARDP theme of "Work, Play, Learn". It is the function of the Scientific Program and the Arrangements Committees to structure this program and this year's program we believe will be outstanding.

On Wednesday, a limited attendance, hands-on, full day course is offered with Dr. David Clark. This course is a **must attend** for every restorative Dentist. He will personally reveal all of the tips and tricks that he has developed over two decades of innovation. You cannot help but be clinically improved after this intensive day.

The next day, Thursday, is full of limited attendance choices: guided sturgeon and salmon fishing in one of the magnificent rivers of the Pacific Northwest; golfing at one of Vancouver's elite courses; personalized airplane tours of the city of Vancouver and it's venue of mountains and sea; and if you have a craving for the culinary arts you can take a hands-on cooking instruction based on the cuisine of the Pacific Northwest. Thursday evening is "Meet and Greet". Join our Corporate Sponsors and old friends and make new ones at this relaxed hosted evening of camaraderie and good food.

On Friday, when the main Scientific Program begins, spouses and partners can go on a tour of the renowned and eye-popping Museum of Anthropology which houses one of the most significant collections of indigenous native art anywhere. You will be able to browse in the Museum Store before heading off to luncheon with the cityscape of Vancouver in the backdrop at "Seasons in the Park" restaurant. This, followed by dessert and a garden tour at the Nimchuk Residence.

Friday night is Harbour tour, on the water. A casually elegant evening of food, music and balmy evening salt air in a party atmosphere with the twinkling city lights of Vancouver as a backdrop.

After the Saturday scientific program, in the evening, join in for a hosted Champagne Reception preceding the Black Tie Optional, President's Ball; terrific food, great venue, great upbeat music and dancing. The Presidents Ball is a wonderful way to close out the meeting and say goodbye to friends and to Vancouver.

Dr. Dennis Nimchuk, Program Essay Chair
Dr. Ron Zokol, Program Clinic Chair
Dr. Myrna Pearce, Convention Chair
Dr. Ashok Varma, President and Conference Director

Histoire de l'ACDRP et… Vancouver 2013 – Rendez-vous Annuel Scientifique – L'Art de ce que nous savons!

L'académie canadienne de dentisterie restauratrice et de prosthodontie (ACDRP) remonte à 1962 pour son *Congrès Annuel Scientifique*. En fait la tenue du Congrès Annuel Scientifique est « la raison d'être » de l'Académie, dont l'objectif principal est de divulguer d'importantes recherches cliniques sur des connaissances dentaires à ses membres. Les membres de l'Académie bénéficient grandement de ces exercices, tout comme le publique qu'ils servent.

Le présent est bien loin du monde de 1962! En 1962 il y avait peu d'accès à une excellente formation continue. Si un praticien voulait s'avancer dans l'Art et la Science de la Dentisterie, c'était difficile, et demandait des efforts considérables, de voyage ainsi que des dépenses dans la recherche pour un accompagnement personnalisé. Une solution, pour la restriction à obtenir une éducation dentaire avancée, est arrivée de la vision d'un groupe de dentistes motivés et dévoués, qui en sont venus à collaborer, afin d'apporter les ressources nécessaires pour amener la formation continue à un point géographique d'accès facile. C'est ainsi que l'Académie Canadienne Prosthodontique a vu le jour, suivit quelques années plus tard par l'Académie Canadienne de Dentisterie Restauratrice. En 1992 ces deux Académies parallèles, fusionnèrent pour devenir ce qui est maintenant connu sous le nom L'Académie canadienne de dentisterie restauratrice et de prosthodontie.

En plus de l'objectif principal qui est de divulguer des connaissances à tous ses membres, un avantage second pour la tenue d'un Programme Annuel Scientifique collectif, est devenu rapidement apparent. La réalisation s'est définie par un développement unique de soutien et de collégialité, produite au sein de ce groupe collectif de Dentistes aux vues similaires, qui se réunissaient, venant des villes et provinces de tout le pays. L'interaction se trouva aussi importante que la Rencontre Scientifique elle-même. D'année en année, alors que la fondation des connaissances augmentait, de même la fraternisation entre les membres. ACDRP de nos jours est bien plus que juste une liste de participants ; c'est une organisation premièrement pour apprendre, mais aussi de camaraderie et de support entre ses membres.

Les choses ont radicalement changées depuis les années 60, en ce sens que la connaissance s'est disséminée. Technologiquement aujourd'hui, il est possible d'obtenir une éducation avancée électroniquement grâce à une toile mondiale, sans sortir de chez soi, ou en commandant un DVD en ligne, ou en téléchargeant de rapides et courtes instructions par vidéo. De même, dans un auditorium de lecture, la technologie de présentations digitales sur ordinateur, peut produire de superbes et interactives expériences, basées sur la performance, pouvant captiver et hypnotiser toute une assistance. Aujourd'hui nous avons plusieurs choix pour apprendre : une myriade de méthodes pratiques d'apprentissage, basée sur l'Internet, ou le melting-pot éprouvé par le temps, dans lequel les gens se rassemblent, pour se stimuler et pour prendre part à des conversations et compromis, ou pour examiner des divergences de vues. Les deux choix sont valables, mais c'est encore l'endroit de rencontre qui est la formule la plus populaire ; les gens se rencontrent, apprennent ensemble, communiquent entre eux pour le bien de chacun et de tous. Ceci est l'idée de la *Rencontre Scientifique Annuelle*.

Cela fait maintenant 7 ans que la Rencontre de l'ACDRP a eu lieu à Vancouver et l'expectation est grande pour ce Programme, pour qui sera présenté et qu'est-ce qui sera présenté. C'est le rôle du Président du Programme Scientifique et du Comité de Programme, d'apporter une formule qui inspirera, motivera et enseignera, et d'un certain point distraira !

Actuellement, c'est le temps où les trois plus grandes évolutions en dentisterie clinique des cinquante dernières années, se sont stabilisées et ont mûri ; d'abord, la possibilité d'ajouter du composite sur la porcelaine, sur la dentine et aussi sur certains autres composants. Deuxièmement, la possibilité de remplacer des dents dans leur forme de racine, par des implants en titanium, et troisièmement, la possibilité de combiner le côté artistique des techniciens, pour créer des restaurations, les plus naturelles possible, en céramique, avec la fiabilité de la production industrielle. En dehors de ces trois évolutions, il n'y a pas eu de transformation de traitements cliniques ou de technologies qui soient arrivées sur le marché dentaire. Ce temps est un temps d'évolution pour le renforcement des technologies et le peaufinage de ce qui a été développé. C'est la base de notre programme en 2013.... *« L'Art de ce que nous savons »*. Six conférenciers le vendredi et huit le samedi matin, plus seize entretiens cliniques en après-midi, seront notre format type.

Pour la technologie de base des composites, le Dr. David Clark, de Tacoma état de Washington, l'un des inventeurs les plus connus dans l'art de la technologie clinique appliquée des composites, mettra en vedette, comment utiliser l'application du composite pour faire de meilleures restaurations à base de résine, plus rapidement, plus esthétiques, et plus durables. Si vous vous sentez compétent dans la restauration des composites, le Dr. Clark s'efforcera de vous montrer comment vous surpasser.

Pour la technologie de base des implants, nous avons prévu de mettre en avant trois experts qui démontreront comment les implants dentaires peuvent être transmis d'une meilleure façon, moins invasive, plus naturelle et plus durable. Le Dr. Harold Baumgarten de Philadelphie vous expliquera comment obtenir les meilleurs résultats pour les implants dentaires. Dr. Leslie David de Toronto, nous apportera ses formidables compétences en Chirurgie buccale et maxillo-faciale, lorsque le placement d'implant n'est pas toujours une affaire toute simple!

Pour la technologie de base en céramique, le renommé Dr. Christian Coachman, de Rio de Janeiro, l'un des principaux techniciens dentaires dans le monde, mettra en valeur comment les céramiques actuelles peuvent être faites pour une mise en bouche sans aucune détection. Le Dr. Coachman nous intéressera avec les opportunités et les possibilités de création de conceptions, les plus complexes et super-naturelles en porcelaine. Dr. Chris Wyatt et Dr. Roxanne Saldarriaga nous montreront comment la technologie et l'art clinique s'interchangent.

Ceci, sont les faits saillants de notre vendredi. Le samedi nous aurons le matin, de rapides présentations de 18 minutes, et en après-midi les Entretiens Cliniques. Nous sommes excités à l'idée de mettre en vedette, à Vancouver, notre liste imposante d'excellents conférenciers qui parleront et présenteront, non seulement tout ce qui est connu et développé, mais aussi comment prédire et créer ce qu'il y a de mieux pour « L'Art de ce que nous savons ».

Et ce n'est pas tout ! Comme toutes les récentes Conférences Scientifiques de l'ACDRP, cette conférence commencera avec des évènements, avant la réunion, pendant et après la réunion, sur le thème perpétuel de l'ACDRP : « Travail, Distraction, Instruction ». C'est la fonction du Programme Scientifique et des Comités d'Organisation de structurer ce programme, et le programme de cette année, nous le pensons, sera exceptionnel.

Mercredi, pour un groupe limité, des travaux pratiques d'une journée seulement, seront offert par le Dr. David Clark. Cette classe est **obligatoire** pour tout dentiste. Il offrira personnellement tous les tuyaux et ruses qu'il a développé pendant deux décades d'innovation. Vous ne pourrez pas vous empêcher d'être cliniquement amélioré après cette journée intense.

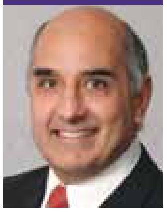
Le jour suivant, le jeudi, est rempli de choix, à participation limitée : tour guidé pour la pêche au saumon et à l'esturgeon dans une des magnifiques rivières du Pacifique Nord-Ouest ; golf sur un des terrains les plus selects de Vancouver ; tours d'avion personnel sur la ville de Vancouver, ses collines et sa mer ; et si vous êtes un adepte de la cuisine, vous pourrez suivre un cours pratique sur la cuisine du Nord-Ouest Pacifique. Jeudi soir sera le « Saluer et Rencontrer » ! Rejoignez nos Commanditaires Corporatifs et vos connaissances, et faites-vous de nouveaux amis durant cette soirée détendue et animée, de camaraderie et de bonne nourriture.

Vendredi, lorsque le Programme Scientifique principal commence, les épouses et compagnons peuvent aller faire un tour au renommé et fabuleux Musée d'Anthropologie qui contient une des plus importantes collections d'Art indigène autochtone au monde. Vous aurez l'occasion de flâner dans la boutique du Musée avant d'aller prendre le lunch avec le paysage de Vancouver en fond de toile, au restaurant « Saisons dans le Parc ». Cela, suivit par le dessert et une visite du jardin de la Résidence des Nimchuk.

Vendredi soir, un tour du Port, sur l'eau. Une soirée élégante et désinvolte de nourriture, musique, embaumée d'air salin, dans une ambiance festive avec le scintillement des lumières de Vancouver dans le fond.

Suivant le Programme Scientifique du samedi, pour la soirée, retrouvez-nous pour une Soirée animée au champagne avant le bal de Gala du Président ; splendide nourriture, endroit idéal, excellente musique et danse. Le Gala du Président est une façon agréable de terminer la rencontre et de dire au revoir aux amis et à Vancouver !

Dr. Dennis Nimchuk, Président du Programme d'Essai
Dr. Ron Zokol, Président du Programme Clinique
Dr. Myrna Pearce, Présidente du Congrès
Dr. Ashok Varma, Président et Directeur de Conférence



Dr. Ash Varma

Vancouver Meeting Invitation

As the president of CARDP for 2013, it is my pleasure to invite you to attend our Annual Scientific Meeting to be held **September 25-28, 2013**. The location of this year's meeting is in the beautiful city of Vancouver, BC, and it will be held at the **Renaissance Harbourside Hotel**. The theme this year is "The Art of What We Know" and will be showcased by our list of excellent speakers.

CARDP has a long-standing reputation of providing top quality programs and speakers, and Vancouver will continue this fine tradition. There is also an opportunity for a hands-on course prior to the meeting itself, to be held on Wednesday the 25th. Our social program will highlight some of the best features that Vancouver, as well as BC, have to offer, from fine dining to chasing the mighty sturgeon in the Fraser River and golf at the prestigious Shaugnessy Golf Course. We invite you to come join us as we work, play and learn in beautiful BC.

Vancouver in September has some of the most ideal weather of the year and this will be a perfect opportunity to explore the surrounding areas. Trips to Whistler and the West Coast are easily accommodated at this time of year. I encourage you to make time in your schedule to attend this top drawer meeting.

CARDP is an ADA-CERP certified provider of continuing education. Further information is available at www.cardp.ca.

I look forward to the opportunity of personally greeting you in Vancouver this September.

Sincerely

Ashok Varma BSc, DMD
President, CARDP

SCIENTIFIC MEETING INFORMATION AVAILABLE SPRING 2013 AT WWW.CARDP.CA

Invitation à notre congrès de Vancouver

En tant que président de l'ACDRP pour 2013, il me fait grand plaisir de vous inviter à notre congrès annuel du **25 au 28 septembre prochain**. Le congrès aura lieu dans la magnifique ville de Vancouver au Renaissance Harbourside Hotel. Le thème de cette rencontre a pour titre «L'Art de ce que l'on connaît» et sera développé par nos excellents conférenciers.

L'ACDRP a toujours eu la réputation d'offrir les meilleurs programmes et conférenciers et cette heureuse tradition sera au rendez-vous à Vancouver. On y offrira aussi un cours pratique pré-congrès le mercredi 25 septembre. Notre programme social ponctuera certains points saillants de Vancouver et de la Colombie Britannique, que ce soit un repas gastronomique, ou la pêche à l'esturgeon dans la puissante rivière Fraser, ou encore le golf au prestigieux parcours du Shaugnessy Golf Course. Soyez des-nôtres pour travailler, vous amuser et apprendre.

Vancouver au mois de septembre jouit d'un climat idéal, ce qui vous permettra l'occasion rêvée pour explorer les régions environnantes. Whistler et la côte ouest peuvent facilement vous accommoder à cette période.

L'ACDRP est certifié par ADA-CERP en éducation continue. Pour de plus amples renseignements, visitez www.cardp.ca

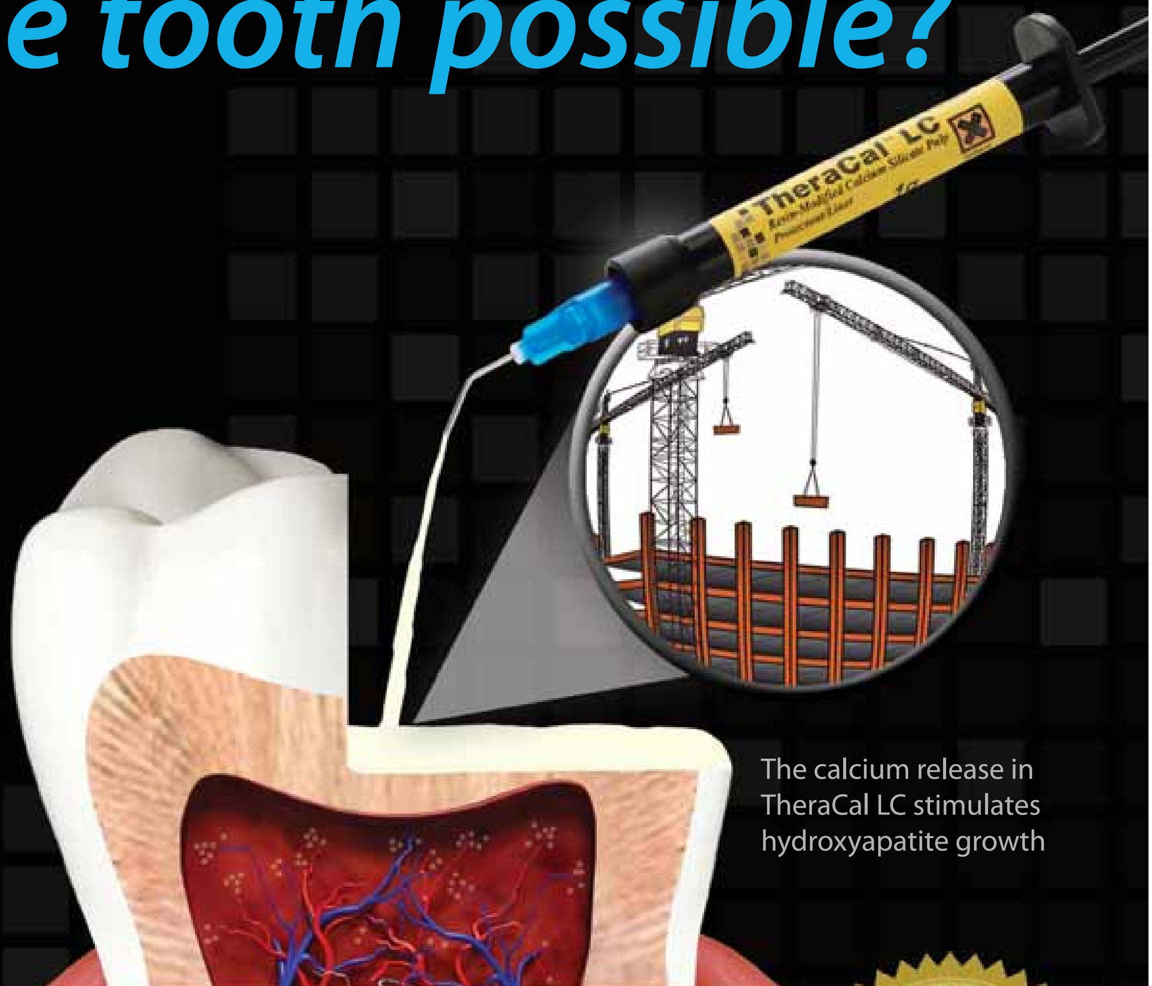
Je vous attends nombreux pour vous accueillir personnellement à Vancouver en septembre.

Sincèrement

Ashok Varma, BSc., DMD
Président, ACDRP

L'INFORMATION AU SUJET DE NOTRE CONGRÈS SCIENTIFIQUE SERA DISPONIBLE AU PRINTEMPS 2013 À WWW.CARDP.CA

Is REGENERATING the tooth possible?



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A review of innovations in the rehabilitation of the atrophic mandible: traditional complete denture procedures, vestibuloplasties and bone grafts

Une étude des innovations dans la réhabilitation de la mandibule atrophique : procédés traditionnels de prothèses complètes, vestibuloplastie et greffes d'os

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Dr. Vikas Gupta

Abstract

The management of the atrophic mandibular ridge has always been a challenge for clinicians because of inadequate retention and support that the ridge offers to the complete denture prosthesis. Preventive procedures in the form of overdenture therapy should always be considered as the first line of treatment whenever the clinical situation permits. The other treatment options available are the various modifications of traditional complete denture procedures. When the complete denture patient is unable to tolerate a prosthesis in spite of all efforts from the clinician, surgical approaches must be resorted to. These approaches include vestibuloplasties and bone grafts. Traditionally, bone grafting procedures have been used to increase the denture foundation area but currently they are used in conjunction with dental implant procedures to provide an adequate implant bed. Other innovations for the augmentation of alveolar bone have been tried, such as the use of various bone growth factors. These have been used independently or along with autogeneous bone grafts for augmentation procedures. This review describes the various aforementioned procedures for the rehabilitation of the atrophic mandible, and describes the advantages and disadvantages of each procedure.

Key words: Atrophic mandible, vestibuloplasties, bone grafts, bone-growth factors.

Introduction

Treatment of the severely resorbed mandibular ridge has been a problem confronting dentistry for many years. Whenever possible, a conservative approach of overdenture therapy should be undertaken, with the objective of preserving the alveolar bone. The complete denture patient with an atrophic mandibular ridge often loses hope of having normal function and does not wear the prosthesis. This is because the complete denture prosthesis in cases of severely atrophic mandibular ridges will lack the necessary retention, stability and support leading to excessive denture mobility, soft tissue ulceration and sometimes, painful neuralgias. The simplest approach to handling this problem is to adequately utilize the totality of available denture supporting tissues by maximizing the denture extensions. It is an understanding of traditional complete denture procedures for maximizing the tissue surface covered by the dentures and making denture

Résumé

La gestion de la crête mandibulaire atrophique a toujours été un défi pour les dentistes à cause de mauvaise rétention, ou mauvais support, offert par la crête pour une prothèse complète. Des procédés de prévention tels que la thérapie de prothèses sur implants, doivent toujours être considérés en premier lieu, pour un traitement, chaque fois que la situation clinique le permet. Les autres options de traitement possible, sont les différentes modifications de processus d'une prothèses complètes traditionnelles. Quand le patient d'un dentier complet ne peut tolérer une prothèse, en dépit de tous les efforts du dentiste, on doit avoir recours aux approches chirurgicales. Ces approches comprennent vestibuloplastie et greffes de l'os. Traditionnellement, les procédés de greffe de l'os ont été utilisés pour augmenter la zone d'établissement d'une prothèse complète, mais actuellement ils sont utilisés en conjonction avec des procédés d'implants, pour fournir un support adéquate à l'implant. D'autres techniques pour l'accroissement de l'os alvéolaire ont été essayées, telle l'utilisation de différents facteurs de croissance osseuse. Celles-ci ont servies indépendamment, ou avec des greffes osseuses autogènes, pour le processus d'accroissement. Cet article décrit les différents procédés, mentionnés plus haut, pour la réhabilitation de la mandibule atrophique, et décrit les avantages et désavantages de chaque procédé.

contours harmonious with the action of the surrounding musculature, which can often help return the denture patient to a state of satisfactory dental function.[1]

Various techniques have been suggested by different authors to deal with the problems of the atrophic mandibular ridge. In the 1930's, Page and Jones proposed the technique of mucostatics.[2] In 1957, Faber proposed the use of metal denture bases to provide the snugness of fit of the mandibular denture base to the underlying tissues.[3]

In 1960, Behrmann wrote on implanting platinum-cobalt magnets to increase the mandibular denture stability.[4] In 1966, Lott and Levin propose the flange technique, with a claim to provide much greater surface area for denture stabilization.[5] In 1969, Strain emphasized on the duplication in the dentures the contours of nature for effective stabilization of the dentures.[6] Levin et. al[7] and Renaud et. al[8] proved that the adaptability of the patient to the loose lower denture and the self-confidence gained by the patient after using the dentures was more important than the special procedures used for denture construction.

When the complete denture patient is unable to tolerate the prosthesis in spite of all clinical efforts, the denture foundation area is indicated to be increased. This can be accomplished with the help of two procedures:

1) Vestibuloplasties
2) Bone grafts

Vestibuloplasties are performed when the available alveolar bone is hidden due to very high muscular and frenal attachments.[9] This procedure essentially involves the detachment of the muscle and frenal attachments and repositioning them lower on the edentulous ridge. These procedures can be performed with or without placement of skin grafts. The vestibuloplasty procedures most commonly used for the mandibular arch are: the transpositional flap vestibuloplasty (lip switch procedure) and the mandibular vestibloplasty.[10]

Bone grafts have traditionally been used for bone augmentation to improve the denture foundation area. They are also used for the preparation of an adequate implant bed, to better receive dental implants.[11] Bone grafting can be classified as autografts, allografts, xenografts or the alloplastic bone substitutes. The autografts are considered to be the gold standard and all other bone grafts are compared to the autografts. Bone grafts can be used alone, or with various other available therapeutic options which aim at enhancing the augmentation of the bone. One such option is guided bone regeneration.[12] This regeneration technique involves the use of a protective membrane over a desired site of bone augmentation in order to prevent the ingress of the connective tissue cells or fibroblasts. Various adjuvant molecules, essentially bone growth factors have also been used either alone or along with autografts or allogenic bone grafts. These include the Transforming growth factors β, Platelet derived growth factors etc. The utilization of these bone growth factors have opened up new arenas in the rehabilitation of the atrophic jaws.[13]

This review presents the various aforementioned approaches to provide effective prosthodontic care to the patient with the atrophic mandible and describes the advantages and disadvantages of each technique.

Search strategy

An electronic search was performed of articles on MEDLINE from January 1980 to June 2012. Key words such as atrophic mandible, mandibular vestibuloplasties, bone grafts were used alone or in combination to search the database. The option of "related-articles" was also utilized. Finally, a search was performed of the references of review articles and the most relevant papers.

Preventive Prosthodontics (Overdenture/Overlay Denture Therapy)

The first approach to tackling the problem of alveolar atrophy should logically be the preservation the residual alveolar bone. The overdenture/overlay denture therapy is the gold standard in this regard.[14] The preservation of the alveolar bone with submucosal vital root retention is also a well documented therapeutic option.[15,16] The physiologic basis of alveolar preservation due to retention of endodontically treated teeth as in the overdenture treatment has been explained with the following reasons. First, the masticatory force is transmitted to the root and the periodontal ligament, thus simulating normal physiologic function. Second, it has been shown that removal of the coronal and pulpal tissues in the apical canal make no change in the proprioceptive response of the patient.[17,18] Thus, the patient is better able to apply appropriate masticatory force without overstressing the tissue. Third, retained roots greatly increase lateral stability of the denture thus reducing trauma to the edentulous ridge.[1]

The claim of preservation of alveolar bone and better proprioception in patients with retained endodontically treated roots has been proven by various studies. Reitz. Et al. conducted a survey of patients undergoing overdenture treatment and analyzed the loss of alveolar bone as well as proprioception in these patients, as compared to the traditional complete denture patients.[19] They found that almost no loss of alveolar bone was observed following a 1 year follow-up in the overdenture patients as compared to an average 4mm loss of alveolar bone in traditional complete denture patients. More definite proprioception was observed when compared to traditional complete denture patients, for light as well as for heavy masticatory force application. Similar results were also observed in a study by Louiselle et. al., who investigated the physiologic basis of overlay denture treatment and found preservation of alveolar bone, better proprioception and an improvement in the periodontal health of the abutment teeth following endodontic treatment of the roots.[14] Crum and Crooney[20] graphically represented a comparison of loss of alveolar bone between the conventional complete denture patients compared to overdenture patients with the help of cephalometric radiographs. They found that the average loss of alveolar bone in the anterior mandibular region was 0.6 mm for the overdenture patients as compared to 5.6 mm for the conventional complete denture patients. Thus, overdenture therapy is a viable treatment option for the preservation of the alveolar ridge and to prevent alveolar atrophy.

Innovations in the traditional complete denture procedures

Various modifications have been suggested by different authors to the traditional complete denture techniques in order to maximize the tissues covered by the denture and to conform the flanges and borders of the denture according to the action of the surrounding musculature. The concept of mucostatics was given by Henry Page and Jones in 1930.[2]

This essentially involves distributing the pressure over the entire ridge by various means. It may involve use of mucostatic impression materials like impression plaster, use of a window in the special tray to minimize the pressure applied over a particular area etc.

In 1957, Faber proposed the use of metal denture bases to improve the snugness of fit over the underlying tissues. Care should be taken that the metal framework should not extend into the undercut areas and should not impinge onto the soft tissues over the mandibular ridge. The metal denture base has a number of advantages over the acrylic denture bases. It does not warp like the acrylic bases, adapts more accurately to the underlying tissue, has less chance of fracture and deformation in function and is a better thermal conductor. The use of metal denture bases can certainly be effective for providing effective complete denture service for the patient with atrophic mandible.[3]

The concept of the implantation of magnets in the jaw was first proposed in 1948. It essentially evolved from the idea to place something in the jaw which could be completely covered, which will not interfere with the physiologic state of the jaw and yet transmit a retentive force onto the denture.[4] Thus, it was theorized to implant a magnet into the jaw, cover it completely by the tissue and place another magnet in the denture, thus creating an attractive force between the two magnets. Various magnetic materials have been used for implantation into the jaw. The most commonly used are samarium-cobalt [21] and platinum-cobalt.

Another technique which has been proposed is the flange technique. This technique essentially involves performing adequate functional movements to obtain the correct flange extensions for the denture in harmony with the action of the peripheral surrounding musculature. The neutral zone technique is also a technique that has been used in the management of the atrophic mandibular ridge. This technique essentially involves the placement of the artificial teeth in a medio-lateral position in the oral cavity such that the outward force by the tongue musculature balances the inward force due to the muscles of the cheek and lips.[22] The two men who probably have contributed the most to this concept are Wil-ford Fish[22] and Russell Tench.[23]

A study by Levin et al[24] concluded that although the correct extensions of the denture border to achieve a maximal tissue coverage is essential for denture comfort, the experience and confidence gained by the denture wearer through the use of dentures seems to be more important for adaptation to the denture rather than any modified techniques used for complete denture construction.

Vestibular extension procedures (Vestibuloplasties)

The vestibuloplasty procedures are carried out when an adequate volume of bone is masked by the very high muscular or frenal attachments. The vestibular extension procedure was originally designed by Kazanjian in the year 1930.[9] In this procedure, a horizontal incision was made on the surface of the lip approximately 1.5 cm from the ridge crest. The mucous membrane was undermined and freed from the periosteum as far down the external side of the periosteum as necessary. The dissected tissue was then sutured to the undisturbed periosteum at the depth of the vestibule. In 1953, Clark[25] varied from the original Kazanjian technique by not elevating the mucosa to the crest of the ridge, and the mucosal flap was sutured through the floor of the mouth to the chin. In 1961, Kethley and Gamble[26] developed the "lipswitch" procedure, which was a variation of the original Kazanjian technique. The mucosa was reflected from the incision in the lip to the crest of the ridge. The periosteum was reflected from the crest of the ridge inferiorly. The mucosal flap was then sutured to the bone and the periosteum was sutured to the lip-thus the name "lipswitch." The disadvantage of this procedure is that nonkeratinized mucosa is used for denture retention but this appears not to be a significant problem.

Another technique which can be employed for vestibular extension is the sub-mucosal vestibuloplasty. This was originally advocated in the maxilliary arch by Mackintosh and Obwegeser.[27] The objectives of the surgical procedure are to provide additional ridge height and a vestibular denture border (reflection) creating freedom from muscle contraction which would, under function, dislodge the denture. These criteria are met by resecting submucous connective tissue, mentalis muscle, the incisive muscle of the lower lip, and the anterior fibers of the buccinator muscle from the crest of the residual ridge and body of the lip and thence to the depth of the newly proposed sulcus.[28] Bolender and Swenson studied the gain in the height of the alveolar bone with these vestibular extension procedures with the help of cephalometric radiographs and found that as much as 7mm of bone height gain is possible when the procedures are appropriately carried out.[29] Thus, vestibuloplasties or vestibular extension procedures may be a viable treatment option for the augementation of the atrophic mandibular ridge, when the adequate ridge volume is masked by high frenal attachments.

Bone Grafts, guided bone regeneration and bone growth factors

1) Bone grafts:

Traditionally various bone grafts and bone substitute materials have been used in order to enhance the amount of alveolar bone for increasing the surface area for complete denture construction. Nowadays, the bone grafting procedures are also used in conjunction with implant therapy for the preparation of an adequate implant bed: that is an adequate height and width of bone to be available for implant placement. Bone grafts are used in conjunction with implant treatment for predictable long term functional and esthetic treatment outcomes.[11] Of the various bone grafts available, autografts are bone grafts which are harvested from the same individual from another site. They are still considered as the gold standard and all other bone grafts are compared to them.[12] However, donor site morbidity, unpredictable resorption, limited quantities available, and the need to include additional surgical sites are drawbacks related to autografts that have intensified the search for suitable alternatives. Bone-substitute materials have increased in popularity as adjuncts to or replacements for autografts in bone augmentation procedures in order to overcome the limitations related to the use of autografts. Bone-substitute materials can be categorized in three groups: *(1)* allogenic, from another individual within the same species; *(2)* xenogenic, from another species; or *(3)* alloplastic, synthetically produced.[11]

Bone grafts provide for bone growth by a mechanism known as osseoconduction.[30,31] in which a grafting material serves as a scaffold for new bone growth. Various other therapeutic options available for augmenting the bone volume are:

(1) osteoinduction through the use of appropriate growth factors,[32]
(2) distraction osteogenesis, by which a fracture is surgically induced and the two bone fragments are then slowly pulled apart, with spontaneous bone regeneration between the two fragments[33,34]
(3) guided bone regeneration (GBR), which allows spaces maintained by barrier membranes to be filled with bone.[35,36]
(4) revascularized bone grafts, where a vital bone segment is transferred to its recipient bed with its vascular pedicle, thus permitting immediate survival of the bone and no need for a remodeling/ substitution process.[37,38]

Literature search reveals a large amount of available data on the various types of bone grafts used in dentistry. There is also an expanse of data available on the use of various techniques of bone grafting. Much of the available literature is in the form of individual case reports and are thus not of much value to draw conclusions regarding the long term predictability of the various bone grafting materials available as well as the advantages of one technique over the other. Thus in this article, discussion regarding the various bone grafting materials available as well as the various bone grafting techniques is based on systematic reviews addressing the following concerns:

1) The efficacy and success of the different grafting materials for the augmentation of edentulous deficient alveolar ridges.
2) The success of different surgical techniques for the reconstruction of edentulous deficient alveolar ridges.
3) The survival/success rates of implants placed in the augmented areas.

Storgard S and Terheyden H[11] performed a systematic review to evaluate the efficacy of different grafting protocols for the augmentation of various localized alveolar defects. The graft materials used in this study were categorized into one of the following groups:
No graft (coagulum), Autograft block (extraoral or intraoral donor site), Autograft particulate, Autograft from bone trap, Allograft (freeze-dried bone allograft [FDBA] or demineralized freeze-dried bone allograft [DFDBA], Xenograft (demineralized bovine bone mineral [DBBM], algae-derived, or coral-derived) , Alloplast (hydroxyapatite [HA], _-tricalcium , phosphate [TCP], bioglass, or calcium sulphate) , Combinations (autograft + allograft, autograft + xenograft, autograft + alloplast, allograft + xenograft, or allograft + alloplast). The authors have analysed the published literature on the use of these various grafts and the subsequent survival of implants in the grafted bone in the following alveolar defects:

1) Fenestration and dehiscence type defects
2) Horizontal ridge augmentations
3) Vertical ridge augmentations

The authors while performing this review have expressed concern about the vast amount of very heterogeneous data available about the various types of grafts used in different localized alveolar defects, thus making it difficult to draw accurate conclusions about the type of graft to be used in a particular clinical situation. But, after analysis of the vast expanse of literature available on the subject, the following conclusions were drawn: In dehiscence-type defects and fenestration-type defects, the best documented augmentation protocols are obtained with DBBM and particulated autogaft. In horizontal ridge augmentations, the best documented grafting protocol includes an intraorally harvested autogenous bone block alone or in combination with DBBM. Augmentations in the vertical dimension have mainly been performed using autogenous bone grafts, either as intraorally harvested blocks or as particulate supported by a space-keeping device.

As far as the survival of implants in these grafted sites is concerned, the observed mean rates of survival in fenestration and dehiscence type defects after bone grafting was 95.4%, and with vertical and horizontal bone augmentation was almost 100%. These results are in accordance with the results of another previously published systematic review.[39] Thus, it can be concluded from the results of these reviews that dental implants can be predictably placed in bone augmented with various types of bone grafts. But the limitations of these reviews were that they did not analyze the effect of whether the grafts were placed in the maxilla or mandible and the anterior or posterior jaw region for augmentation.

Chiapasco M et al.[40] analyzed the literature available on autogeneous onlay bone grafts and addressed issues like post-operative morbidity, resorbtion pattern of the grafted materials and also the survival of implants in the reconstructed mandible. They also analyzed how the timing of placement and loading of implants affected the implant survival in grafted bone.

Postoperative morbidity related to bone harvesting from intraoral sites is mainly represented by temporary neural disturbances involving branches of the inferior alveolar nerve. As reported in the literature, the incidence of neural disturbances related to bone harvesting from the chin ranges from 10% to 50%, whereas those related to bone harvesting from the mandibular ramus range from 0% to 5%.[41,42] For this reason, chin grafts should

be considered with more caution, whereas the mandibular ramus is gaining popularity due to its advantages as compared to the mental symphysis: the quality of bone is similar (relevant cortical component), the quantity may be greater, and the risk of neural damage is lower. In cases of bone harvesting from the iliac crest, temporary pain/gait disturbances were the most frequent complaint. Long-standing pain/gait disturbances were reported only in 2% of the cases[43,44]. In cases of bone harvesting from the calvarium, morbidity was extremely low, almost 0%.[45,46]. Thus, of the various sites available for autogeneous bone grafts, the calvarial grafts are associated with the minimal incidences of post-operative morbidity.

Bone resorption of autogeneous onlay bone grafts has been studied for grafts used in conjunction with conventional complete dentures as well along with dental implant therapy. In the past, before the advent of osseointegrated implants, the reconstruction of atrophic edentulous ridges with onlay bone grafts was criticized because of the relevant resorption that followed prosthetic loading. However, these results were mainly due to the use of completely removable dentures, which adversely affected not only the grafted jaws, but also the non-grafted edentulous ridges. The use of onlay grafts has been reevaluated since the advent of osseointegrated screw-type implants, which seem to inhibit resorption of the residual as well as of the transplanted bone, as demonstrated by a number of publications.[47,48,49] Thus, the use of autogeneous onlay bone grafts along with dental implants is a viable treatment option.

Bone augmentation for dental implant treatment can be vertical as well as horizontal bone augmentation. With regard to vertical bone resorption of onlay grafts, the following conclusions can be drawn.

1) Bone resorption is greater in the first year after the reconstruction and in the first year after loading of implants, with a significant reduction in the following years. There were significant differences in bone resorption based on the donor site. In the case of iliac grafts, resorption rates of the initial graft height 1 to 5 years post-loading of implants ranged from 12% to 60%.[50, 51, 52] In the case of intraoral grafts, there are insufficient data to draw any meaningful conclusion, due to the heterogeneity of the data available. The best results were found for vertical reconstruction with calvarial grafts, where resorption rates ranged from 0% to 15% of the initial graft height[53,54]. This seems to indicate that cortical thickness and density of donor bone are factors which might influence the resorption pattern and as these parameters differ in the various donor sites, thus the amount of resorption also differs.
2) Oversized grafts should be harvested to maintain enough graft volume after the initial resorption phase and the size should be decided according to the available data as to how much shrinkage is expected according to the donor site.
3) If autogenous bone grafts are used, it is highly recommended to use cortico-cancellous bone blocks. Cancellous bone alone and particulated bone, if not some sort of supporting sub-structure, eg: Titanium mesh, do not provide sufficient rigidity to withstand tension from the overlying soft tissues or from the compression by provisional removable dentures, and may undergo almost complete resorption.

There is limited data available regarding resorption of horizontal bone grafts, due to the greater difficulty in measuring this parameter (need for computed tomography or calipers instead of simpler methods such as intraoral radiographs). Only two articles reported data on horizontal bone resorption of the graft, which ranged from 10% to 50%.[50, 51]

When the overall survival of implants placed in reconstructed mandibles was evaluated , (both one stage and two stage placements) it was found that the success rate was 94.8% for a follow up period of 6 to 90 months. Implant survival rate was 91.1% (range 88.2% to 100%) for implants placed in conjunction with mandibular reconstruction and 100% for those placed in a staged approach. All implant losses occurred in patients receiving implants at the same time as reconstruction.

As far as the relationship between survival rate and donor site is concerned, the retrieved data demonstrated that the majority of implant failures occurred in patients reconstructed with iliac grafts (failure rate 17.5%). The failure rate for implants placed in calvarial grafts was 6% and that for implants placed in intraoral grafts was 5.5%. Thus the failures of implants were minimum at sites harvested with intraoral grafts followed by calvarial grafts and maximum for sites augmented with iliac grafts.

Another parameter which needs to be analyzed regarding survival of implants in augmented bone is how the timing of implant placement and loading affect the survival rate of implants. Implant placement both in conjunction with bone grafting and after consolidation of bone grafts have been proposed. The authors who advocate simultaneous implant placement[52,53,54] base their opinion on the fact that resorption of an onlay graft over time is not a linear process but is most pronounced

soon after its transplantation. Simultaneous implant placement will shorten the waiting time before rehabilitation, and so has been theorized to reduce the amount of bone resorption. Those who advocate delayed placement[55,56,57] think that simultaneous placement of implants may expose the patient to some risks. These risks are the following : In the case of wound dehiscence, exposure and infection/necrosis of the bone graft may occur and lead to partial or total loss of the graft. The procedure of immediate implantation into the avascular bone increases the risk of non-integration. Conversely, when a delayed protocol is performed, it will be possible to place implants in a partly revascularized graft. Since the regenerative capacity of bone is determined by the presence of vessels, bone marrow, and vital bone surfaces, a delayed approach will permit better integration of implants (higher values of bone-implant contact) and better stability of implants, as compared to immediate implant placement.[58,59] Despite these considerations, however, much controversy still exists in terms of timing of implant placement in grafted areas, and no concrete conclusions can be drawn from the literature available.

Thus to conclude, due to the heterogeneity of data available about bone grafts and the various adjuvant procedures associated with them, concrete conclusions cannot be drawn about the augmentation of the atrophic mandible with bone grafts. Though although it appears that bone graft procedures can predictably augment the alveolar bone and can be used as adjuncts to dental implant therapy, more conservative options for rehabilitation should be preferred whenever possible and an informed decision made based on the clinical situation of the patient.

Guided bone regeneration

The concept of guided bone regeneration essentially involves the protection of the site at which one desires the bone augmentation to occur, by a protective membrane, which has been theorized to promote the bone growth by preventing the connective tissue cells (fibroblasts) from reaching the site of augmentation.[60] Historically, the concept of GBR has been used in experimental reconstructive surgery since the mid-1950s, for spinal fusion[61] and maxillofacial reconstruction[62,63]. Resorbable and non-resorbable membranes can be used for the guided bone regeneration procedure. Although different non-resorbable and bioresorbable barrier membranes have been developed and their use has been extensively investigated, research is ongoing to develop the 'ideal' membrane for clinical applications. The basic characteristics desired of these membranes are biocompatibility, cell-occlusiveness, space-making, tissue integration, and clinical manageability[64,65]

Of the non-resorbabale membranes, the expanded-polytetrafuoroethylene (e-PTFE, Teflon) have been extensively studied[66] and utilized . Other non-resorbable membranes are titanium-reinforced ePTFE, high-density-PTFE, or titanium mesh. With all non-resorbable membranes, a second surgical procedure is required for removal, which represents a limitation and involves a potential risk to the newly regenerated tissues[67]. Finally, membrane exposure is frequent, increasing the risk of secondary infection[68,69]

Bioresorbable membranes have been developed to avoid the need for surgical removal. Recently, commercially available bioresorbable membranes have also been used for reconstruction of long bone defects in the clinical setting. It has been shown that they enhance bone healing, especially in cases with bone defects > 4 to 5 cm or with significant associated soft-tissue loss, where autologous bone grafting alone is not recommended due to risk of resorption[70], and they also secure the grafting material.[71]

There are two broad categories of bioresorbable membranes: the natural and the synthetic membranes. Natural membranes are made of collagen or chitosan, whereas synthetic products are made of aliphatic polyesters, primarily poly(L-lactide) (PLLA) and poly(L-lactide-co-glycolide) (PLGA) co-polymers.[72]

Barrier membranes are among the most widely studied scaffolds for tissue regeneration, including bone, and the choice of type of membrane depends largely on the required duration of membrane function.[72] Regarding bone regeneration, their use is mainly indicated for bone regeneration in sites where limited mechanical loading exists, such as in cranial, oral and maxillofacial applications. Even though there is extensive research on barrier membranes in animals, human studies are still few. Thus, though the concept of guided bone regeneration has proven useful for bone augmentation, further long-term studies are warranted before definite conclusions can be drawn regarding this therapeutic modality.

Bone growth factors

Growth Factors, GFs, are natural biological mediators that regulate key cellular events that are part of the process of tissue repair and regeneration. After binding of GFs to specific cell membrane receptors of target cells, intracellular signaling pathways are induced, which typically results in the activation of genes that may ultimately change cellular activity and phenotype.

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However, the effect of each GF is regulated through a complex system of feedback loops, which involve other GFs, enzymes, and binding proteins. Recent advances in the areas of cellular and molecular biology allowed better understanding of the functions of GFs and their participation in the different phases of wound healing. *In vitro* and *in vivo* studies have confirmed that GFs can enhance the capacity of tissues to regenerate by regulating cell chemoattraction, differentiation and proliferation.[73,74] As far as bone growth is concerned, GFs serve to stimulate native osteoblast cell migration into the defect site and increase proliferation of these cells to populate the scaffold through specific chemotactic and mitogenic signals.[75] The most commonly implicated growth factors favouring bone growth are the platelet derived growth factors and the bone morphogenetic proteins.

Platelet derived growth factor (PDGF)

PDGF is one of the most commonly implicated growth factor for bone regeneration. In the late 1980's, Lynch and co-workers first discovered in an animal study that PDGF promotes regeneration of periodontal tissues including bone, cementum and periodontal ligament.[76] Since then, numerous studies have been published providing a deeper understanding of the mechanism of action and therapeutic potential of this molecular mediator.[77] This GF is locally released by blood platelets during clotting following soft or hard tissue injury.[78]

Mechanism of action

Once PDGF is released from the platelets, it binds to specific cell surface receptors promoting rapid cell migration (chemotaxis), and proliferation (mitogenesis), in the area of injury.[79] *In vitro* and *in vivo* studies have demonstrated that PDGF is a potent chemotactic and mitogenic factor for gingival and periodontal ligament fibroblasts, cementoblasts and osteoblasts.[76,80-82] Studies with PDGF have demonstrated variable outcome as far as bone regeneration is concerned. The differences in outcomes are thought to be a result in variability in platelet concentration as well as individual patient healing responses. In summary, platelet concentrates provide good handling characteristics alone or in combination with a variety of matrices, however with the primary disadvantage of the technique being the need to obtain blood from the patient and lack of a predictable response following treatment according to current evidence.[83]

To overcome some of these limitations other therapeutic approaches have been developed. Advances in recombinant technology have lead to the synthesis of proteins in a controlled manner, which in turn enables production of concentrated and purified molecules in large quantities. This has led to the development and commercialization of recombinant growth factor/matrix combination products. Recombinant human platelet-derived growth factor (rh-PDGF) was the first recombinant protein to be approved by the US Food and Drug Administration for treatment of chronic foot ulcers in diabetic patients (Regranex, Ethicon Inc. Somerville, NJ).[84,85] Widespread use in this application has established the safety and effectiveness of PDGF for soft tissue regeneration.86 Additionally, rhPDGF for bone regeneration has been rigorously tested in preclinical studies, which indicate that PDGF has the potential to be used to direct and control bone regeneration in humans. In addition, the biomechanical strength of the repair tissue in rhPDGF treated animals was not significantly different from un-operated normal intact bone. Furthermore, when PDGF was injected sub-periosteally in long bones, it induced intramembranous bone formation.[87]

The use of rhPDGF for dental implant site development (i.e. sinus augmentation)[88], horizontal bone augmentation[89] and ridge preservation[90] has been investigated in human studies, however the primary focus of clinical studies using this agent has been in periodontal and peri-implant regenerative indications.[91] An early human clinical trial to evaluate the effect of rhPDGF/IGF treatment applied to osseous periodontal defects was reported by Howell and co-workers.[92] The experimental sites received direct application of the GFs contained in a methylcellulose matrix to improve retention. A statistically significant increase in alveolar bone formation was seen in the growth factor treated sites at nine months post-operatively, as compared to untreated control sites. Average bone height for the PDGF/IGF group was 2.08 mm and 43.2 % osseous defect fill was achieved, as compared to 0.75 mm new bone height and 18.5% fill in the control sites.

Based on the principles of tissue engineering, the use of a growth factor enhanced matrix for periodontal regeneration consisting of rhPDGF-BB in combination with an osteoconductive scaffold (i.e., autograft, allograft, xenograft, or a synthetic matrix, such as beta-TCP) was proposed.[93] Promising clinical results for rhPDGF in combination with osteoconductive matrices in a diverse array of periodontal and periimplant sites suggest that growth factor-enhanced matrices incorporating rhPDGF have the potential to become routine, a standard of care treatment modality in the near future.

Bone morphogenetic proteins

Bone morphogenetic proteins (BMPs) are multi-functional growth factors belonging to the transforming growth factor ß superfamily. Family members are expressed during limb development, endochondral ossification, early fracture, and cartilage repair. Since the discovery of bone morphogenetic proteins (BMPs) as bone inductive proteins by Urist 94 many investigators have shown that BMPs induce stem and mesenchymal cell differentiation into osteogenic cells capable of producing bone.

The general role of BMPs in the process of bone formation during the development and repair of fractures has been well established. BMPs are capable of inducing the formation of bone tissue in ectopic sites and in critical-sized bone defects in several animal models. The bone morphogenetic proteins which are most commonly implicated and are most potent in bone growth are the BMP 2 and 7. The effect of these molecules have been studied individually and together on bone augmentation. Acting together, they are found to be 20 times more potent than acting individually. Though the effect of these BMP's have been extensively studied in animal models, human trials and published literature is limited.

In dentistry, BMPs have been tested in periodontal (regeneration of lost bone tissue due to periodontal disease), implant (increase in bone volume for placement of implants, maxillary sinus augmentation) and restorative-endodontic (pulpotomies) procedures. Several animal studies have been carried out to evaluate the efficacy of BMPs for maxillary sinus augmentation, and studies in both animals and humans have demonstrated similar, but still unsatisfactory, results, when compared to other procedures. Animal assays using rhBMP-2 associated with a carrier (collagen foam) in 3-sided intra-bony defects in dogs have demonstrated an increase in the rate of bone formation without side effects such as ankylosis or apical bone resorption[95]. A clinical trial studying 6 patients (3 of them used as control) indicated that the OP-1 (2.5 mg in 1 g collagen carrier) has the potential to initiate bone formation in the human maxillary sinus within 6 months after a sinus floor elevation operation[96]. However, the behavior of this material is not fully predictable. Barboza et al.[97] have used BMPs as an aid to increase bone crest height prior to the placement of implants. However, Salata et al.[98] in a meta-analysis of 379 scientific reports concerning the use of BMPs on implant dentistry, concluded that the number of studies is too small to establish clinical protocols for the improvement of a recipient bone bed prior to implant placement or to enhance the integration process of an implant. Knowledge of the cellular and molecular basis of BMP signaling pathways and the development of appropriate carriers in the near future, will certainly stimulate a great revolution in dentistry, allowing the predominance of regenerative over cicatricial processes. However, it is clear that well-designed blind and randomized clinical trials are required to identify the effective applications of BMPs in medical and dental clinics.

Conclusion

This review gives a concise and comprehensive overview of the various innovations possible for the rehabilitation of the atrophic mandible. The various possible options range from the modification of the conventional complete denture techniques, to bone grafts and bone growth molecules for the alveolar augmentation. It can be concluded from this review, that each technique has its own advantages and disadvantages and that choosing from one option over another depends on the clinical situation of the patient along with the patients, preference for a fixed or removable prosthesis.

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Author declaration

I hereby certify that this article is not under publication consideration elsewhere, and free of conflict of interest.

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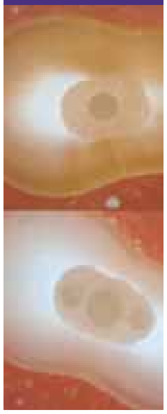

Fracture Strength of Teeth in Oval-Shaped Root Canals Restored with Posts and Accessory Post Systems

Résistance à la rupture des dents dans les canaux radiculaires de forme ovale, restaurés avec des pivots et des systèmes de pivots accessoires

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Abstract

In contemporary restorative dentistry, post-root canal adaptation always represents an important role in successful and long-lasting treatment for the restoration of endodontically treated teeth. In some cases posts have to be placed in wide oval-formed root canal spaces. However, the impact of the treatment outcome of the increasing non-uniform cement thickness around the posts has not yet reached a consensus. The purpose of this research is to assess the treatment outcome of post systems with three different post geometries, combined with/without accessory posts as an alternative technique in the oval-shaped canals. Seventy-two teeth with oval-shaped canals were selected for the study. Crowns were sectioned at the cemento-enamel junction and endodontically treated. The roots were randomly divided into 2 groups of 36 specimens and each group was split into 3 subgroups of 12 as follows; G1-A, Quartz fiber post with double tapered cross-section (QFibDT); G1-B, Quartz fiber post with circular cross-section (QFibCir); G1-C Quartz fiber post with oval cross-section (QFibOv); G2-A Quartz fiber post with double tapered cross-section + two accessory quartz fiber posts (QFibDTAcces); G2-B Quartz fiber post with circular cross-section + two accessory quartz fiber posts (QFibCirAcces); G2-C Quartz fiber post with oval cross-section + two accessory quartz fiber posts (QFibOvAcces). Root canal preparations were performed with low-speed Torpan Drill tips of ISO 90, ISO 100 and ISO 120 in increasing order. All posts were cemented with self-adhesive dual polymerizing resin cement. Two specimens from each group were randomly chosen upon the cementation of all posts and processed for stereomicroscope (SM) evaluation of the fiber post-cemented interface. All sixty specimens were then embedded in auto polymerizing acrylic resin surrounded by aluminum cylinders and light-polymerized composite cores were produced. Pressed all ceramic crowns were cemented on each core. Specimens were secured in a universal testing machine with the use of a device that allowed loading of the specimens lingually at 135 degrees to the long axis. A compressive force was applied at a crosshead speed of 1 mm/min until fracture occurred. The fracture loads (N) were determined and the obtained data were analyzed by 1-way ANOVA with interaction followed by Tukey HSD tests. Student's t test was used for between group comparisons. Representative stereomicroscope images and cement thickness measurements were performed on 2 mm sectioned specimens. Within-group comparisons for Group 1 specimens demonstrated statistically higher fracture strength values for groups cemented with G1-A, DT Light Post (590 N) and G1-B, Match Post (570,9 N) groups compared to G1-C, Ellipson Post group (400,83 N) ($p<.001$). The highest fracture resistance was recorded for G2-A (QFibDTAcces) at 764,18 N, followed by group G2-B (QFibCirAcces) at 726,5 N. Within-group comparisons of these two groups (G2-A, G2-B) resulted in statistically higher fracture resistance of teeth compared to G2-C (QFibOvAcces) at 574,96 N ($p<.001$). Regardless of the post system geometry tested in this study, Group 2 specimens resulted in statistically higher fracture strength values compared to Group 1 specimens according to between group comparisons ($p<.001$). No catastrophic failures were present and there were no root fractures. It can be speculated that when restoring with posts, especially in wide oval-shaped canals, the use of accessory posts reduces the cement thickness around the posts thus increasing the endodontically treated teeth resistance to fractures.

Résumé

En dentisterie de restauration contemporaine, l'adaptation dans le canal d'une dent d'un pivot a toujours joué un rôle important pour le succès de la longévité d'un traitement dans la restauration des dents traitées endodontiquement. Dans certains cas, les pivots doivent être placés dans des espaces de canal de dent de forme ovale, assez ouverte. Toutefois, l'impact de l'issue du traitement pour l'augmentation non uniforme de l'épaisseur du ciment autour des pivots, n'a pas encore atteint un consensus. Le but de cette recherche est d'évaluer le résultat du traitement des systèmes de pivot avec trois géométries différentes de pivot, combinées avec/sans des accessoires de pivots comme autre technique, dans des canaux de forme ovale. Soixante-douze dents, avec des canaux de forme ovale furent sélectionnées pour cette étude. Les couronnes furent sectionnées à hauteur de la jonction cement-émail, et endodontiquement traitées. Les racines furent au hasard divisées en 2 groupes de 36 spécimens, et chaque groupe fut réparti en 3 sous-groupes de 12, tels que suivants : G1-A, pivot en fibre de quartz avec double coupe transversale chanfreinée (QFibDT) ; G1-B, pivot en fibre de quartz avec coupe transversale circulaire (QFibCir) ; G1-C, pivot en fibre de quartz avec coupe transversale ovale (QFibOv) ; G2-A, pivot en fibre de quartz avec double coupe transversale + deux pivots accessoires en fibre de quartz (QFibDTAcces) ; G2-B, pivot en fibre de quartz avec coupe transversale circulaire + deux pivots accessoires en fibre de quartz (QFibCirAcces) ; G2-C pivot en fibre de quartz avec coupe transversale ovale + deux pivots accessoires en fibre de quartz (QFibOvAcces). Les traitements de canaux ont été exécutés avec une pièce à main à vitesse réduite de 90 ISO, 100 ISO et 120 ISO dans cet ordre de croissance. Tous les pivots furent cimentés avec un produit autocollant de résine à polymérisation double. Deux spécimens de chaque groupe ont été choisis au hasard après cimentation de tous les pivots, et soumis à une évaluation stéréo microscopique (SM) des surfaces de fibre post-cimentées. Les soixante spécimens furent alors ensevelis dans une résine d'acrylique auto polymérisante entourée d'un cylindre en aluminium, et des moignons en composite polymérisé à la lumière, furent fabriqués. Des couronnes en céramique pressée furent cimentées sur chaque moignon. Les spécimens furent alors sécurisés dans une machine à tester universel, avec l'aide d'un instrument qui permet un chargement sur le lingual des spécimens à 150 degrés par rapport à l'axe le plus long. Une force de compression fut appliquée en travers, d'une vitesse de 1mm/min jusqu'à ce que fracture s'en suive. Les forces de fracture (N) furent déterminées et les informations analysées par des tests d'ANOVA 1 avec interaction, suivit par Tukey HSD. Des tests par des étudiants furent utilisés, pour comparaison entre les groupes. Des images de représentation stéréo microscopique et des mesures d'épaisseur de ciment ont été effectuées sur des spécimens avec une section de 2 mm. Les comparaisons de spécimens à l'intérieur du Groupe 1, statistiquement, montrent une plus importante résistance à la rupture pour les groupes cimentés G1-A, et aux groupes DT Light Pivot (590 N) et G1-B, Match Pivot (570,9 N), comparés au G1-C et au groupe Ellipson Pivot (400,83 n) ($p \leq .001$). La plus importante résistance à la fracture a été enregistrée pour G2-A (QFibDTAcces) à 764,18 N, suivit par le groupe G2-B (QFibCirAcces) à 726,5 N. Une comparaison interne entre ces deux groupes (G2-A, G2-B), statistiquement, démontra une plus grande résistance à la fracture des dents en comparaison à G2-C (QFibOvAcces) à 574,96 N ($p \leq .001$). Sans tenir compte du système de pivot testé géométriquement dans cette étude, les spécimens du Groupe 2, statistiquement, démontrèrent une plus grande résistance de valeurs de fracture en comparaison des spécimens du Groupe 1, en relation de comparaisons entre tous les groupes ($p \leq .001$). Aucunes défaillances catastrophiques n'étaient présentes et il n'y avait aucune fracture de racine. On peut donc en déduire, qu'une restauration avec des pivots, spécialement dans des canaux de forme ovale, avec l'utilisation de pivots accessoires, réduit le ciment autour des pivots, et ainsi augmente les dents traitées endodontiquement, à la résistance aux fractures.

The primary goals of prosthetic and restorative treatment in endodontically treated teeth are to restore teeth to function and comfort combined with satisfactory esthetics. The materials and techniques change somewhat over time, but not the ultimate goals.[1] In recent years, the choice of materials used in the post and core restoration of endodontically treated teeth has changed from the exclusive use of very rigid materials to materials that have mechanical characteristics that more closely resemble dentin. Clinically irreversible failures displaying catastrophic root fractures resulting with the extraction of the tooth is less likely to occur with fiber-based post systems.[2-5] In this way, a mechanically homogeneous system can also be created.[6,7]

Root fractures have been cited as the most common cause of failure in endodontically treated teeth restored with posts.[2,8,9] Cross-sectional surveys of failed posts have shown that most failures are due to post decementation followed by caries and post fracture.

Ree and Schwartz[1] reported that the long-term success of endodontic treatment is highly dependent on the restorative treatment that follows. Once restored, the tooth must be structurally sound and the disinfected status of the root canal system must be maintained. Radicular and coronal tooth structure should also be preserved to the greatest possible extent during endodontic procedures and post space preparations within the root canals as it weakens the root.[1,4,10]

In some cases the root canals could anatomically be ribbon, ovoid or triangular shaped rather than circular[11] or the preparation of the canal during endodontic treatment may result in a wide oval form[12] or a wide flare.[13] It has been suggested that in the case of non-circular root canals, a possible clinical option might be to only remove gutta-percha and sealer and to use several small posts or to place one master post with a few small accessory posts.[14] Otherwise the clinician inevitably needs to enlarge the canal in such cases in order to provide a rounded-shaped post space to fit a single circular prefabricated post.[15]

Techniques are currently developed focusing on fortifying the post-core-tooth complex especially with oval-shaped root canals. Post space preparation with the specially designed ultrasonic oval tip[9,16,17] (Ellipson Tip; Satelec, Acteon Group, Merignac, France) followed by restoring the root with the same size oval shaped quartz fiber reinforced esthetic post (Ellipson Post; Recherches techniques dentaires, St.Egreve, France) of the same system is a contemporary alternative technique for narrow oval-shaped canals.[9] Study findings[12,18,19] reported that the quality of the root canal space is compromised especially in narrow oval-shaped canals as they are difficult to clean and shape. On the other hand in cases with wide oval shaped canals the literature does not offer a consensus on the ideal post treatment alternative. It is a proven concept that close canal adaptation with minimal tooth structure removal provides a long-lasting treatment. In such oval-shaped canals cement film thickness will inevitably increase around the master post. However, little information is available on the role of cement thickness and its role on fracture strength of endodontically treated teeth.[15,20]

Filling the wide oval-shaped root canal post with fiber strips has been proposed as one of the options, thereby allowing a reduction in cement thickness.[9,21] It was also demonstrated that fiber posts may be relined with composite resin in wide root canals for the achievement of an anatomical post that reproduces the root canal shape, reduces the cement thickness, favours retention of the post and prevents adhesive failures.[7,15,22] Another recent proposal with the same objective is the insertion of quartz fiber reinforced accessory posts (Fibercone; Recherches techniques dentaires, St.Egreve, France) around the master post which maintain an increase in the volume of fibers and a decrease in cement thickness.[9]

However, the impact on the treatment outcome of these new treatment alternatives has not yet been clearly defined. The purpose of this research is to assess the treatment outcome of quartz fiber reinforced post systems with three different post geometries combined with/without accessory posts as an alternative technique in the oval-shaped canals.

Material and Methods

Freshly extracted maxillary canines with similar root dimensions free of cracks, caries, and fractures were used for this study and stored in 0.9% saline solution (Baxter Healthcare Corporation, IL, USA) following extraction. Mesio-distal and bucco-lingual x-rays (Digital RVG; Owandy Crystal-X Easy, Owandy Digital Imaging, USA) of each tooth were taken. The ratio between the long and short canal diameter at 5mm from the apex was calculated; if it resulted ≥2; the canal was assumed to be oval.[12] Seventy-two teeth with oval-shaped canals were selected and teeth were sectioned perpendicular to their long axis at the cemento-enamel junction (CEJ), with the use of a water-cooled diamond bur (R837.014; Diaswiss, Geneva, Switzerland) with an air-turbine at 300.000 rpm. The specimens were then endodontically treated with a step-back procedure with a #45 file (Dentsply Maillefer, Ballaigues, Switzerland). After intermittent rinsing with 3% NaOCl, root canals were dried with paper points (Dentsply Maillefer, Ballaigues, Switzerland) and obturated with lateral condensation of gutta-percha (Dentsply Maillefer, Ballaigues, Switzerland) and eugenol free sealer (AH 26; Dentsply DeTrey, Konstanz, Germany).

The post spaces were prepared 24 hours after completing endodontic procedures. Gutta-percha was removed with a warm endodontic plugger (Kerr Sybron Corp, Romulus, Mich, USA) leaving 3 mm of the endodontic filling in the apical portion.

In all the test groups the post spaces were prepared to a depth of 8 mm using 3 low-speed Torpan Drill tips of ISO 90, ISO 100 and ISO 120 (RTD; Recherches techniques dentaires, St. Egreve, France) in increasing order. The selected quartz fiber reinforced esthetic post size was #1 for all of the post systems used with similar post diameters and composition (Figure 1). These procedures served to standardize the root canal spaces and establish similarity between post diameters and cement thicknesses. The specimens were first randomly divided into 2 groups of 36 specimens (Group 1 and Group 2) and each group was split into 3 subgroups of 12 (Figure 2). Post groups and group codes are listed in Table 1.

Quartz fiber posts with double taper cross-section, (DT Light-Post; Recherches techniques dentaires, St. Egreve, France) were used in the first group (G1-A). Quartz fiber posts with circular section, (Match Post; Recherches techniques dentaires, St. Egreve, France) were placed in the second group (G1-B). Quartz fiber posts with an oval cross-section (Ellipson Post; Recherches techniques dentaires, St. Egreve, France) were used in group 3 (G1-C). One master post was placed in Group 1 test

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ADL 2013 C.E. Program

Wednesday, April 17, 2013

Innovative and Safe Technical Approach for Indirect Sinus Grafting and Implant Placements

There are clinical indications for indirect sinus grafting within the osteotomy prior to simultaneous implant placements. However, this is a blind approach and tactile sense is not reliable to determine if the maxillary sinus membrane has been compromised or perforated. A perforated maxillary sinus membrane may lead to potential sinus infections, loss or unconfined grafting material and potential loss of the implant. This presentation will focus on an innovative and safe technical approach to indirect sinus membrane lifting prior to implant placements. Vertical heights of 3–9 mm utilizing this indirect lifting approach can be achieved without the need for the traditional lateral window approach.

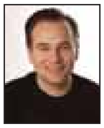
Dr. Mark Lin – B.Sc., D.D.S., M.Sc. (Prosthodontics), F.R.C.D. (C) Assistant Professor, Prosthodontics University of Toronto practiced general dentistry for 13 years then completed his postgraduate training in the specialty of Prosthodontics at the University of Toronto. He currently holds the title as "Assistant Professor" at the faculty of dentistry, discipline of Prosthodontics at the University of Toronto. He maintains a full–time specialty practice as a Prosthodontist at Dr. Mark Lin Prosthodontic Center with focus on full mouth reconstructions, dental implant surgery and implant prosthetics. He is a Fellow and Diplomate with the International Congress of Oral Implantologists (I.C.O.I.). He is an Associate Fellow and Fellow with the American Academy of Implant Dentistry (A.A.I.D.) He is also a graduate and Fellow with the Misch Implant Institute. Finally, he is a Diplomate with the American Board of Oral Implantology/Implant Dentistry (A.B.O.I.).

HiOssen

Thursday, May 2, 2013

Predictable Bone Grafting for Future Implant Placement

One of the main criteria for having successful surgical results in implant dentistry is to have adequate bone. When inadequate bone quantity and quality are present certain forms of bone augmentation are required in order to facilitate future implant placement. This seminar will discuss predictable bone grafting techniques for different situations and areas of the maxilla and mandible. Clinical situations and cases will be shown to demonstrate these grafting techniques.



Dr. Allen Aptekar studied at the University of Toronto, earning his Bachelors of Science degree in Biology. He received his Doctor of Dental Medicine degree with distinction at the University of Saskatchewan College Of Dentistry. Dr. Aptekar then completed a one year hospital residency at Sunnybrook Health Sciences Center and the University of Toronto. He has authored and co–authored several articles in refereed professional dental journals, and is a lecturer in dental implant procedures for dentists and denturists. He practices in the greater Toronto area, with a special interest and focus on dental implantology.

BioHorizons

Thursday, May 30, 2013

Paediatric Dentistry: What every general dentist should know

Everyday scenarios will be explored from our unique risk assessment and preventative programs, restorative options for children, space maintenance, and of course behavior management. Sonia Chung will provide instruction and hands–on opportunities in this session. The topics I will be covering will include:

- Child's first dental visit
- Caries risk assessment
- Behaviour management – non–pharmacologic and pharmacologic techniques
- Dental emergencies – specifically dental infections and dental trauma

Dr. Sonia Sun-He Chung is a certified specialist in paediatric dentistry and a Fellow of the Royal College of Dental Surgeons of Canada. She completed her Honours Bachelor of Science, Doctor of Dental Surgery degree and her specialty training in Paediatric Dentistry at the University of Toronto. After her academic career in Toronto, Dr. Chung pursued a fellowship at The Royal Children's Hospital in Melbourne, Australia.

Dr. Chung returned to Toronto in 2010 and now operates in private practice at her office, Danforth Children's Dentistry, as well as an associate in Scarborough. She teaches at The Hospital for Sick Children and is involved in the Canadian Academy of Pediatric Dentistry and the Ontario Society of Paediatric Dentists.

ADL Dental Laboratories Inc.

Tuesday, June 4, 2013

Criteria for Dental Implant Success

BA discussion of 30 years of dental implant treatment with retrospective data of success rates, what works, what doesn't, reasons for failures, and what can be done to avoid them and/or deal with them. Some cases have been followed for 20 years.

The cases range from the simple to the complex including treatment planning, surgery, and restoration. The approach is based on a prosthetic driven treatment plan based on force resistance and a surgical element based on site preparation to make it possible.

Dr. Jon Perlus is Past President of the Ontario Dental Association and served as a member of the Board of Governors of the Canadian Dental Association.

Dr Perlus graduated from the faculty of dentistry at Mcgill University in 1973 and obtained a Diploma in Periodontics from the University of Toronto in 1975. He has since published articles and lectured on Periodontics and Implant Dentistry in both Canada and the United States and has been a clinical instructor at the University of Toronto both at the undergraduate and graduate program levels. He is a member of the faculty at the Misch International Dental Implant Institute and Adjunct Professor at Temple University. He is in private practice as a specialist limited to Periodontics and Dental Implant Surgery in Toronto and Collingwood, Ontario.

ADL Dental Laboratories Inc.

Wednesday, October 2, 2013

Implant Planning

Dental implants have certainly revolutionized the way clinicians can rehabilitate partially and completely edentulous patients. patient . However, in order to achieve a successful treatment outcome, proper treatment planning is essential not only from a surgical stand point, but especially from a restorative one. In fact, the final goal is to achieve an excellent esthetic and functional result.

Lecture outline:

- Review of the fundamental principles in implant treatment planning for single–tooth and multiple missing teeth
- Learn how to prosthetically drive treatment planning, based on the current scientific evidence.
- Describe the most used implant loading protocols and their application.

Dr. Mario Rotella, is a Fellow of the Royal College of Dentists of Canada (F.R.C.D.(C)), and a certified specialist in Prosthodontics.

He received his Doctor of Dental Surgery from the University of Siena (Italy), and then completed a 2–year Advance Education in General Dentistry program at the Eastman Institute for Oral Health, University of Rochester, Rochester, NY. At the same institution, he completed the 3–year Prosthodontic program followed by a 1–year Implant surgical fellowship, during which he also served as a clinical instructor.

Mario currently works in a private practice in North York. Utilizing his additional implant training, he focuses the specialty of Prosthodontics on reconstructive dentistry. Dr. Rotella has recently joined the Royal College of Dentists of Canada as an examiner in Prosthodontics.

ADL Dental Laboratories Inc.

Thursday, November 14, 2013

Bone Grafting in Maxillofacial Surgery

Bone grafting is a procedure very commonly used nowadays whether for reconstruction of a small traumatic defect of the alveolus, replacement of a resected jaw segment, closure of an alveolar cleft or an oroantral communication, treatment of a comminuted or an inflamed jaw fracture, augment the jaw to allow for an implant placement or simply to cover some exposed implant threads to guarantee the success of the procedure.

The biology of bone grafts as well as the different choices as far as the nature, the origin, the source, the type of the graft as well as the specific indications and the predictability of the procedure will be discussed in this presentation.

Dr. Nick Katsikeris received his Dental Degree and Doctor of Dentistry (PhD equivalent) from the Dental School of the University of Athens. He trained in Oral and Maxillofacial Surgery at the Faculty of Dentistry, University of Toronto, between 1983 and 1986; he taught at the department of Oral and Maxillofacial Surgery at the same Faculty from1986 to 1999. Dr. Katsikeris then headed the Oral and Maxillofacial Surgery clinic in a major hospital in Athens, Greece. In 1991 he received the "Master Teacher Award" at the Faculty of Dentistry of the University of Toronto.

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Registration: 6:00pm – 6:30pm | Lectures: 6:30pm – 8:00pm ■ Cost: $99.00 ■ Dinner included

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Table 1 — Experimental post groups with quartz fiber post systems

GROUP CODE (n=12)	POST MATERIAL CEMENTED	GROUP NAME
G1-A	D.T Light Post	QFibDT
G1-B	Match Post	QFibCir
G1-C	Ellipson Post	QFibOv
G2-A	D.T Light Post & 2 Fibercones	QFibDTAcces
G2-B	Match Post & 2 Fibercones	QFibCirAcces
G2-C	Ellipson & 2 Fibercones	QFibOvAcces

samples whereas in Group 2 two accessory posts (Fibercone, Recherches techniques dentaires, St. Egreve, France) were placed on both sides of the master post used in Group 1. Thus G2-A, G2-B and G2-C test groups were formed. Schematic representation of experimental groups is illustrated in Figure 2.

All posts were cemented with self-adhesive dual polymerizing resin cement (RelyX Unicem, 3M ESPE, Seefeld, Germany) according to the manufacturer's instructions. The cementation procedure started with clicking the flexible root canal shaped application aid (Elongation tip, 3M ESPE, Seefeld, Germany) on the special aplicap of the system (Unicem Aplicap, 3M ESPE, Seefeld, Germany). After activating the aplicap for 2–4 seconds the resin cement was machine mixed for 15 seconds with the capmix machine (Rotomix, 3M ESPE, Seefeld, Germany). Then the application aid was inserted down to the bottom of the root canal and the self-adhesive resin cement was applied by slowly pulling the application aid out of the canal. The posts were seated into the root canal and excess cement was removed. In the second group specimens, 2 accessory posts were placed on both sides immediately after placing the master post. The posts were light polymerized for 40 seconds with the tip of the light curing unit (Optilux 501, Kerr, Danbury, CT, USA) directly in contact with the coronal end of each post. Two specimens from each group with a total of 12 test samples were randomly chosen and categorized for stereomicroscope (SM) evaluation of the fiber post-cemented interface.

All sixty specimens were stabilized on a surveyor (Paraflex, Bego, Bremen, Germany) with vertically moving rods, from the most coronal tip of each master post, with sticky wax. Root surfaces were marked 2 mm below the CEJ were then embedded in auto polymerizing acrylic resin (Meliodent, Bayer Dental, Newbury, UK) surrounded by aluminum cylinders. Following the complete polymerization process of all specimens, the posts were marked at a distance of 4 mm from the CEJ and the

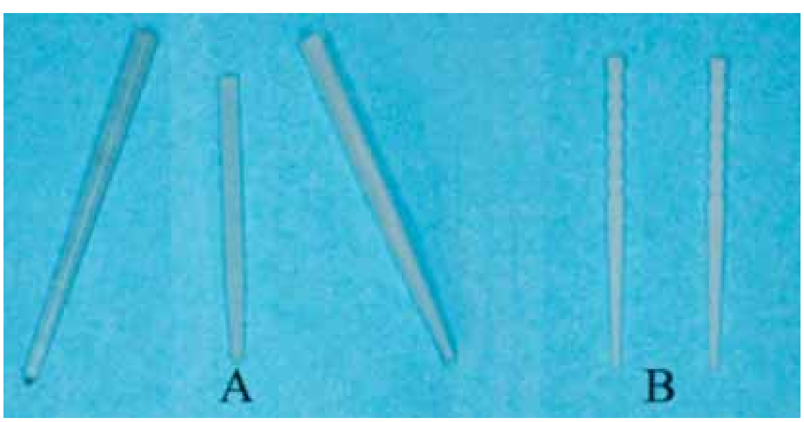

Figure 1 — Post systems used (left to right) (A) D.T. Light Post, Match Post, Ellipson Post (B) Fibercones.

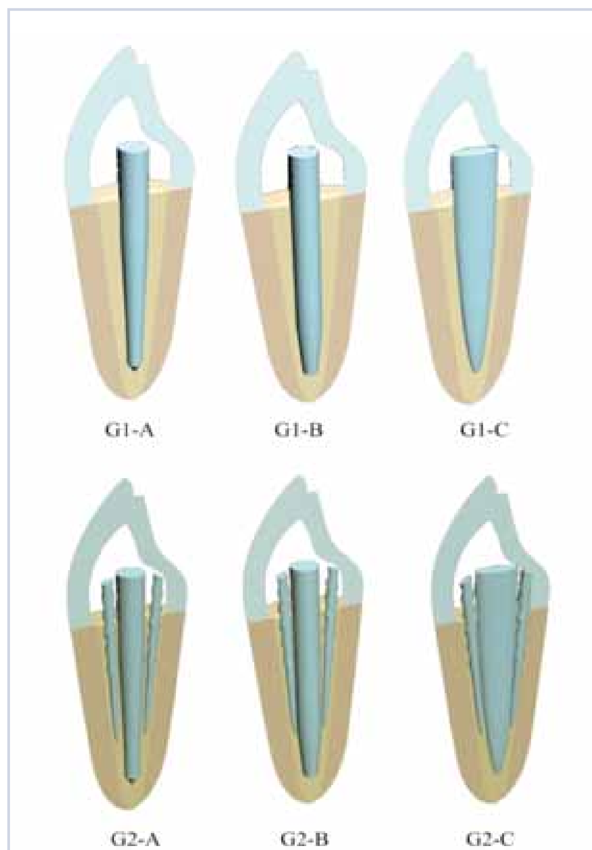

Figure 2 — Schematic representation of experimental groups.

Figure 3 — Specimens were loaded lingually at 135 degrees to the long axis with a compressive force.

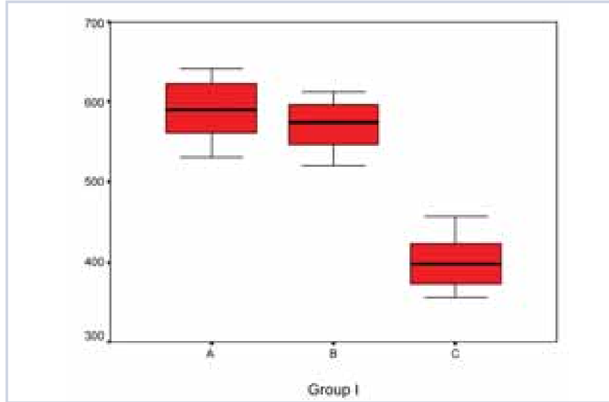

Figure 4 — Mean fracture strength values (N) and trust interval at 95% for Group1 specimens.

excess parts were cut using the special double sided diamond coated disc (Composidisc; Recherches techniques dentaires, St. Egreve, France).

A master core was prepared with the use of the adhesive system (Clearfil S3 Bond, Kuraray Co Ltd, Osaka, Japan). A light-polymerized composite core (Clearfil Photo Core, Kuraray Co Ltd, Osaka, Japan) was fabricated on one of the specimens, and a master core preparation was completed on the composite material with the use of water cooled diamond coated burs. The core portion of the post and core restoration was 6.0 mm in height. A special light transmitting matrix was fabricated from the epoxy resin and all other composite cores were produced using this matrix from the master core preparation according to the method described by Atalay.[23]

A crown was designed on the master composite core specimen in the form of a framework coping using a CAD/CAM device (Cercon Smart Ceramics, DeguDent GmbH, Hanau-Wolfgang, Germany). Sixty polyurethane copings (Cercon Base Cast, DeguDent GmbH, Hanau-Wolfgang, Germany) were milled and all were further pressed from all ceramic ingots (IPS e.max Press, Ivoclar Vivadent AG, Schaan, Liechtenstein). Crowns were cemented on the cores (Clearfil SA Cement; Kuraray Medical Inc, Tokyo, Japan) and were stored in water at 37°C for 48 hours.

Specimens were secured in a universal testing machine (Autograph AG-IS, Shimadzu, Tokyo, Japan) with the use of a device that allowed loading of the specimens lingually at 135 degrees to the long axis. The load head was placed on the specially formed palatal step of the crown (Figure 3). A compressive force was applied at a crosshead speed of 1mm / min until fracture occurred. The fracture loads (N) were determined and the obtained data were analyzed by 1-way ANOVA with interaction followed by Tukey HSD tests. Student's t test used for between group comparisons.

Two specimens from each group were randomly chosen upon the cementation of all the posts and processed for stereomicroscope (SM) evaluation of the fiber post-cemented interface. All 6 specimens for each group were embedded in auto polymerizing acrylic resin surrounded by specially designed two piece aluminum matrix in 30x40x60 mm dimensions. Upon completion of the polymerization process coronal post sections were cut horizontally by double sided diamond disc (Composidisc; Recherches techniques dentaires, St. Egreve, France). The blocks were serially cross-sectioned using a microtome (Isomet 1000; Buhler, IL, USA) with the use of a water-cooled precision cutter diamond blade (Buhler, IL, USA) at a speed of 975rpm. The thickness of each section was 2 mm. Each section was examined under a stereomicroscope (Leica MZ7,5; Leica Microsystems, Cambridge, UK). The cement thicknesses were measured on the perpendicular lines to the tangents as the minimum distance between the cement border and the post perimeter. Representative 1.0x, 2,0x and 3,2x zoom stereomicroscope images and cement thickness measurements were performed with the software (Image Manager; Leica Systems, UK) of the SM.

Results

The fracture strength values (Newtons) and standard deviation (SD) observed after application of compressive loads are presented in Table 2. Significant differences within Group 1 and Group 2 specimens were identified with Anova and Tukey HSD tests (α=.05) (Table 3).

Within-group comparisons for Group 1 specimens demonstrated statistically higher fracture strength values for groups cemented with G1-A, DT Light Post (590 N) and G1-B, Match Post (570,9 N) groups compared to G1-C, Ellipson Posts (400,83 N) ($p<.001$). Mean fracture strength values (N) and trust interval at 95% for Group 1 specimens are displayed in Figure 4.

Table 2 — The mean (SD± Standard deviations) fracture strength values (in Newtons) of the experimental groups and significant differences between groups as identified with Student's t test (α=.05)

	Group 1		Group 2		
	Mean	**SD**	**Mean**	**SD**	**P**
A (QFibDT)	590,00	35,44	764,18	28,57	,000***
B (QFibCir)	570,90	30,02	726,51	40,33	,000***
C (QFibOv)	400,83	33,35	574,96	47,13	,000***

The highest fracture resistance was recorded for G2-A (QFibDTAcces) at 764,18 N , followed by group G2-B (QFibCirAcces) at 726,51 N. Within-group comparisons of these two groups (G2-A, G2-B), in which master posts were used in combination with two accessory posts, resulted with statistically higher fracture resistance of teeth compared to G2-C (QFibOvAcces) at 574,96 ($p<.001$). Mean fracture strength values (N) and trust interval at 95% for Group 2 specimens are shown in Figure 5.

Table 3 —
Significant differences within groups as identified with Anova and Tukey HSD test (α=.05)

Group 1		Group 2	
Group 1	**P**	**Group 2**	**P**
G1-A/G1-B	,207	G2-A/G2-B	,101
G1-A/G1-C	,000	G2-A/G2-C	,000
G1-B/G1-C	,000	G2-B/G2-C	,000

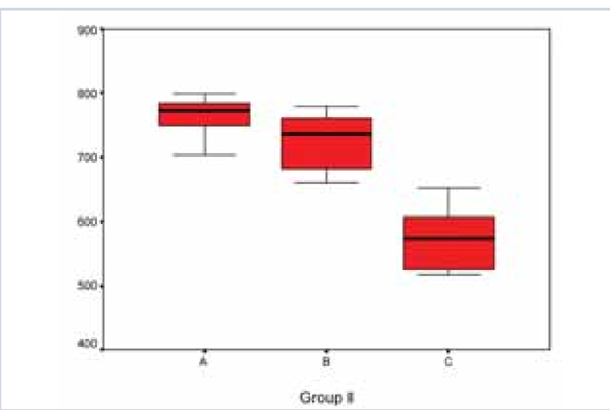

Figure 5 – Mean fracture strength values (N) and trust interval at 95% for Group 2 specimens.

The mean (SD± Standard deviations) fracture strength values (Newtons) of the experimental groups and significant differences between groups were identified with Student's t test (α=.05) and are represented in Table 2. Fracture strength values of groups with accessory posts (Group 2 specimens) were statistically higher, irrespective of the post geometry tested, than those of only one master post cemented group (Group 1 specimens) ($p<.001$). Comparison of mean fracture strength values (N) and trust interval at 95% for all groups are shown in Figure 6.

Representative 1.0x, 2,0x and 3,2x zoom stereomicroscope images were performed with the software (Image Manager; Leica Systems, UK) of the SM. Representative stereomicroscope images of each experimental group can be seen in Figure 7. Representative cement thicknesses were also measured for basic comparisons on the perpendicular lines to the tangents as the minimum distance between the cement border and the post perimeter. Variations in the thickness of the cement with/without accessory posts were displayed distinctly (Figure 8).

Failures in all post groups were recorded as favorable and repairable. No catastrophic failures were present and there were no root fractures.

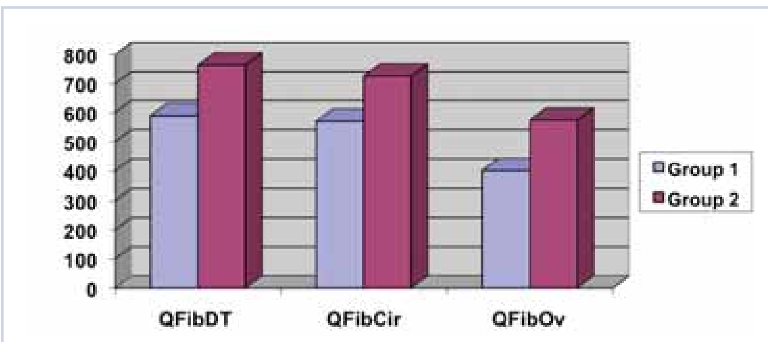

Figure 6 – Comparison of mean fracture strength values (N) and trust interval at 95% for all groups.

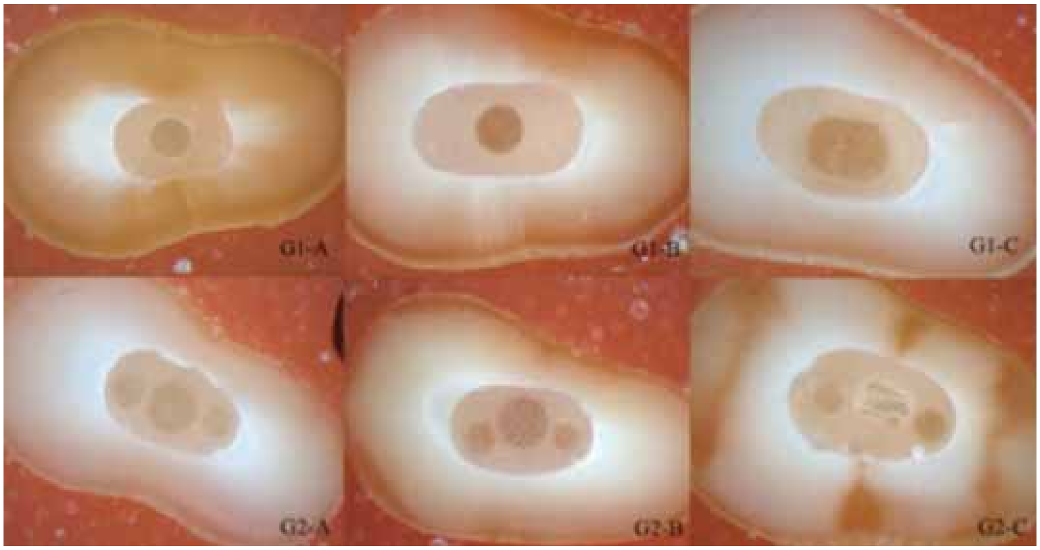

Figure 7 — Representative stereomicroscope images of experimental groups at 1.0x or 2.5x magnifications.

Discussion

Post cementation and bonding within the root is a complex concept due to several invariables: Root canal anatomy and influence of the endodontic procedure,[11,12,24-27] polymerization shrinkage and contraction because of an unfavorable C-factor,[28-30] poor control of moisture and polymerization difficulties in the apical regions.[28,31,32]

It has been reported in former studies that an excessively thick layer of resin cement around a fiber post was an unfavorable factor for long-term success of post supported restorations and this might have some correlation to higher frequencies of post debonding.[9,16,17,33] D'Arcangelo et al.[33] reported that the cement thickness is correlated to the post fitting into post space and has a direct influence on the pull-out strengths of fiber posts. He concluded that the least cement thickness will provide better post adaptation with the canal walls. However, when circular post drills and posts of larger diameter are used in wide oval-shaped root canals, sound dental tissue is sacrificed to adapt the canal shape to the post,[34] thus resulting in decreased root strength.

Grandini et al.[15] stated that if a post does not fit well, the resultant cement layer is too thick and bubbles are likely to be present within it, the post is more predisposed to debonding. Moreover, they reported that the polymerization stress, developing within a relatively thin film of cement, would be minimal and the formation of bubbles or voids, representing areas of weakness within the material, is less likely to occur in a thin layer of cement. Valandro et al.[35] also indicated that less microporosities and polymerization shrinkage will be present in the thinner cement layer. Perez et al.[36] evaluated the influence of cement thickness on the bond strength of a fiber-reinforced composite post system to the root dentin and concluded that increased cement thickness surrounding the post did not impair the bond strength.

Porciani et al.[14] supported the idea that a good post fitting can be achieved when the cement layer is thin and uniform on all canal walls and that the variations in the cement film thickness along the fiber post could result in a non-homogeneous stress distribution throughout the root that this might increase the failure rate of the post in the long term.[37]

In the present study, an attempt was made to restore a wide oval-shaped root canal with posts with minimal tooth structure removal. The effect of post geometry on the resistance to fracture of endodontically treated teeth restored with prefabricated quartz fiber reinforced esthetic post systems was also questioned. Highest fracture strength values with 590 N were obtained for G1-A, QFibDT followed by 570,90 N for G1-B, QFibCir specimes. Within group comparisons revealed no statistical differences ($p>.05$) for these two subgroups in Group 1. However G1-C, QFibOv, specimens with 400,83 N mean fracture strength value of N were found to be statistically different ($p<.001$) from the other 2 groups, G1-A and G1-B. Considering the fact that all post spaces were prepared with a standard set of drills in the present study, statistically different results could be related to the smaller dimensions of the oval post system used. Ellipson posts (G1-C) were manufactured only in one size to fit to the oval post space created by the special ultrasonic oval shaped tip of the system. In order to create a group of posts with the most similar surface areas, the smallest diameters of the post systems were chosen for the other two groups (G1-A, G1-B). Oval posts used in combination with the special ultrasonic tip will perfectly conserve the root configuration in narrow

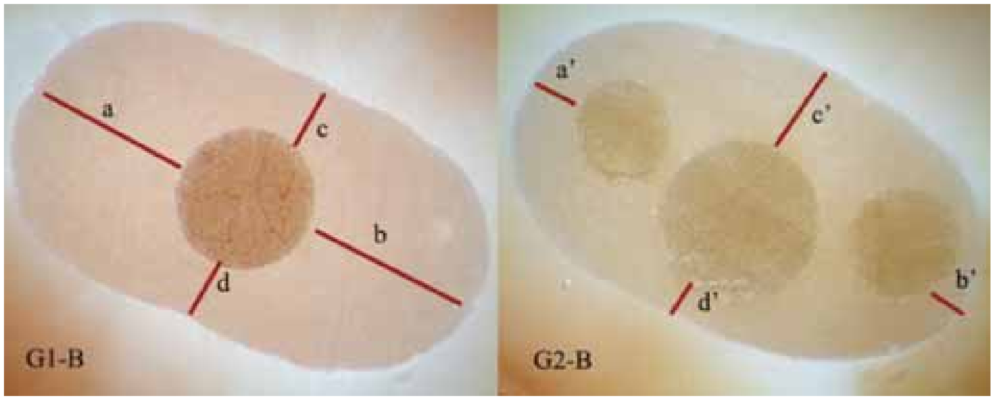

Figure 8 – Variations in the thickness of the cement with/without accessory posts in G1-B/G2-B experimental groups.

oval-shaped canals resulting in a desirable post-root adaptation and superior biomechanical performance.[9] According to the findings of the present study it can be speculated that the oval shaped posts might not provide enough fracture strength in wide oval-shaped root canals due to the increased cement thickness between the post's oval shape and root canal walls.

The mean fracture strength values of specimens in G1-A and G1-B with 590 N and 570,9 N are comparable with the results of the former studies.[4,8,9] No catastrophic root fractures were seen in any Group 1 specimens, supporting the findings that tooth fractures were favourable creating less damage to the root and being repairable due to their modulus of elasticity to dentin when restored with quartz fiber reinforced post systems.[8,24,38,39]

Maccari et al.[13] reported repairable mode of failure with quartz and glass fiber post specimens whereas mostly nonrepairable fractures were observed in cast metal post group specimens in the restoration of endodontically treated teeth with flared canals and no ferrule. Teeth restored with custom made cast posts had a fracture strength twice that of teeth restored with fiber posts according to the results of their study. This finding could be explained by the close root canal anatomy and post adaptation. Adhesive failures are more common in thick cement layer, because of the low mechanical properties of this layer, mainly due to the more stress concentration and polymerization shrinkage thus negatively affecting the longevity of the restorations.[29]

Circular shaped posts usually don't provide a good post fitting with the canal walls especially in wide and oval-shaped canals due to the discrepancies left between the post's circular shape and canal's anatomy when a smaller diameter post system is chosen in order to provide a conservative alternative. Different approaches have been suggested to solve this problem. Braz et al.[40] suggested using a main glass fiber post and three accessory fiber posts as the ideal method of restoration in roots with wide root canals. Newman et al.[41] reported a direct relationship between the proportion of fiber and tooth fracture strength. Bonfante et al.[3] tested an alternative technique where fiber strips were applied around the post to fill the empty spaces in the root canal and increase the amount of reinforcement fibers. The same technique was also proposed by Grandini et al.[22] as a method of relining the fiber posts in wide root canals with composite resins to reduce the thickness of the cement layer, preventing adhesive failures and increasing post retention. According to the results of the present study it can be speculated that in contemporary esthetic restorative dentistry, the use of accessory posts will provide a safe and rigid alternative in those cases by decreasing the cement thickness on mesial and distal sides of the master post cemented and creating a better root canal-post adaptation.

In narrow and oval-shaped root canals the use of circular shaped posts requires the removal of healthy dentin tissue by the use of preformed drills which alters the anatomy of oval canals. There have been different attempts to overcome this problem. To reduce this alteration, a more conservative drill suitable for all canals and a medium grit ultrasonic oval tip were proposed in recent years by the manufacturers.[16,17] Ayad et al.[7] proposed an alternative technique of relining thin-walled roots with composite resin prior to cementation of fiber posts. Porciani et al.[14] suggested the use of combinations of smaller posts when an endodontically treated tooth with a small or medium size root is restored or in oval root canals. They pointed out that this indication will serve to reduce the thickness of the cementation material. Several in vitro studies[42,43] have confirmed the presence of gaps in the interface between the luting composite resin of the fiber post and the root canal wall especially in cases where cement thickness is increased.

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1:00pm - 5:00pm - Surgical Protocol - Surgical Technique - Surgical Components and Armamentarium - Post Operative protocols - Case Review	**1:00pm - 5:00pm** - Post Op Instructions, Patient Protocol, Healing Period, Evaluations, Follow Ups - Final Impressions - Final Prosthesis – Materials, Occlusion - Follow Ups, Recalls	**PM** - Surgical Review LAB : Surgical Phase - Impressions and Retrofit Review LAB : Retrofit Phase - Final Prosthesis Review

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The use of accessory posts combined with the master post will provide a modulus of elasticity able to support occlusal loads with the increased fiber volume in the root canal and also create a thin layer of cement. The significant differences between two main groups of the present study (Group 1 and Group 2) validate these findings ($p < .001$). The results of our study support the use of accessory posts.

Figure 8 visualizes the representative changes in the cement thickness between Group G1-B, QFibCir and G2-B, QFibCirAcces specimens. The cement thickness measurements for G1-B specimen is recorded as a;1215,52 µm, b; 1281,57 µm, c; 470,9 µm and d; 416,97 µm whereas measurements for G2-B specimen displayed a'; 391,25 µm, b'; 202.7 µm, c'; 593,73 µm and d'; 230,59 µm thicknesses. The cross-section stereomicroscope images of the present study revealed a distinct increase in cement thicknesses when no accessory posts were used (Figure 7 and 8). Restoration of endodontically treated teeth with an appropriate post size providing minimal tooth structure removal combined with accessory posts resulted in more uniform and decreased cement thicknesses around the posts.

The fracture strength values supported by representative SM images observed in the present study suggest that the use of accessory posts reduces the cement thickness around the posts thus increasing the endodontically treated teeth resistance to fracture. The use of a prefabricated quartz fiber reinforced accessory post system, especially in wide oval-shaped canals, provides a viable technique for functional recovery and reinforcement of endodontically treated teeth.

Conclusions

1. G1-A, QFibDT and G1-B, QFibCir groups demonstrated higher fracture strength values compared to G1-C, QFibOv group in standardized post spaces restored with one master post ($p < .001$).
2. The within group differences of Group 2 specimens resulted in significantly higher fracture resistance values for G2-A, QFibDTAcces and G2-B, QFibCirAcces groups compared to G2-C, QFibOv group ($p < .001$).
3. Fracture strength values of groups with accessory posts (Group 2 specimens) were statistically higher, irrespective of the post geometry tested, than those of only one master post cemented group (Group 1 specimens) ($p < .001$).
4. The use of accessory posts combined with a master post can be proposed as an effective alternative treatment technique and ensure a better post-cement-root assembly, especially in wide oval-shaped root canals.
5. The use of accessory posts could be proposed as an efficient treatment alternative to reinforce endodontically treated teeth.

Author declaration

The authors declare no competing financial interest with any of the materials used in the present study.

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Preparations, Principles, and Instrumentation for Composite Class II Restorations

Préparations, principes et instrumentation pour restaurations de composite en classe II

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Abstract

A sound restoration cannot begin with a flawed preparation. Amalgam preparations reached consensus more than a century ago. However, after 30 years, posterior composite preparations have not been formulated into a definitive textbook. No one method is accepted by university circles, dental communities, or the majority of the profession. Without consensus on fundamentals, how can a standard of care be defined or measured?

Résumé

Une bonne restauration ne peut commencer par une mauvaise préparation! Les préparations pour plombages ont atteint un consensus il y a plus d'un siècle. Cependant, après 30 ans, les préparations pour composite sur les postérieures n'ont pas encore été formulées dans un manuel, de manière définitive. Aucune méthode n'est acceptée dans les cercles universitaires, les communautés dentaires, ou par la majorité de la profession. Sans un consensus sur les principes de base, comment avoir une norme des soins qui soit définie ou mesurée ?

Studies of posterior composite longevity show variable results; some reveal only 7 years in Class II composite resin restorations years[1,2,3]. Others indicate annual failure rates of 1 to 3 percent[4,5]. Some studies correlate success with number of surfaces[2]. While some branches of the profession claim a near-epidemic of premature failure in Class II composite restorations, other studies show better survival than amalgam[6].The variability of findings suggest that technique variation is defying common outcomes.

Preparation design is seldom detailed in these studies, yet it is describable, measurable, amendable to scientific exploration, and simple enough to develop consensus. This article explores the clinical and scientific evidence for preparation axioms, designs, and instrumentation for simple to extensive Class II direct composites. These concepts and methods have been developed by the author for study clubs mentored in British Columbia since 2004.

The goal of this article is to foster professional debate to potentially resolve current points of dispute regarding posterior composite restorations.

ENAMEL AND DENTIN AXIOMS

All our data on enamel adhesion is laboratory-based on fresh cut facial bovine enamel. To achieve the megapascals promised by these tests, we need to duplicate these conditions clinically. Five enamel axioms, if applied, create optimum enamel adhesion. Figure 1. Similarly, five dentin axioms drive preparation internal form Figure 2. These axioms and resulting methods unify clinical, histological, and adhesive driving forces, and require us to modify and supplement GV Black cavity design. Successfully applied, properly matrixed, well-cured, with correct materials, a long-lasting restoration of almost any size can be delivered.

Figure 1: Enamel Axioms

1. Always fresh cut
2. Always rod ends
3. Always a bevel
4. Thickness for wear
5. Thickness for contraction

Figure 1 — enamel axioms

Figure 2: Dentin Axioms

1. Always fresh cut
2. Rounded internal form
3. Consistent depth for esthetics
4. Sufficient depth for loads
5. Form to spare the bond

Figure 2 — dentin axioms

Figure 3 — amorphous enamel overlying rods

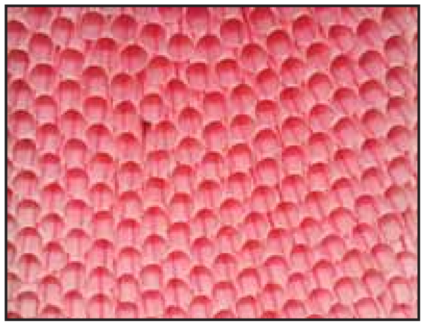

Figure 4 — Schematic of rod ends on an enamel surface

Figure 5 — A rod-end facial surface

1. ENAMEL AXIOM #1: ALWAYS FRESH CUT ENAMEL

Optimum rod-end enamel etching increases surface area ten to 20 fold and penetrates up to 20 microns. Stable, cohesive adhesion grips rod-ends. The surface of mature teeth is an amorphous layer of highly fluoridated, remineralized enamel averaging 10 microns in thickness, as seen in Figure 3. This layer resists etching, particularly in populations where fluoridated toothpaste is commonly used.

It is important, but perhaps less widely understood, that the outer layer of remineralized enamel crystals lack rod structure. Being generated from salivary constituents, this layer is disorganized and not cohesive with underlying enamel rods. When bonded to remineralized enamel, the restoration disconnects from deeper rod-ends. “Prep-less restorations”, i.e., enamel untouched by the operator, are hence categorically inferior in retention and seal not just due to the lack of penetration into this etch-resistance enamel, but also due to underlying structural disconnection from the cohesive rod structure of the tooth. Preserving ten microns of tooth structure in the name of conservatism is misplaced and erroneous design. True conservatism is enduring restoration lifespan, avoiding premature re-treatment.

Therefore this outer layer should be removed by either light air abrasion, rotary carbides (not diamond burs)[7], or ultrasonic instrumentation during preparation. Operator preference, morphology, and clinical contingencies guide the choice: all are effective in removing this 10 micron layer of amorphous enamel.

2. ENAMEL AXIOM #2: ALWAYS BOND ROD-ENDS

The natural resistance of the sides of the rod sheath (rod side) to acid dissolution by virtue of the arrangement of the hydroxyapatite crystal lattice is nature's way of limiting lateral spread of caries. Resin technique must adapt to this biological given.

According to Munichika et al,[8] “When the transverse section or face of the crystal, rather than its side, is exposed to acid, the central core of the crystal is most susceptible to acid dissolution. Resin bond strengths are twice as high when adhering to the acid-etched ends of the crystals as compared to the sides of the crystals”. Therefore, the most tenacious adhesion will be achieved when the enamel surface presents rod ends intrinsically, Figure 4, Figure 5 or they are exposed by a bevel, Figure 6.

3. ENAMEL AXIOM #3: ALWAYS A BEVEL

Bevel options are represented schematically in Figure 7. Besides increased adhesion, bevels decrease micro-leakage[9].

In G.V. Black amalgam Class I and II technique, occlusal margins in preparations are intrinsically obliquely transected, viz., bevelled, because occlusal anatomy itself is inclined. This generates an automatic enamel bevel in the occlusal preparation. But the proximal box walls feature butt margins- 90 degrees to the cavosurface. Relative to this axiom, the occlusal portion is correct, but the box is not.

Therefore, while occlusal portions might deliver a full 30MPa with a high-performance adhesive, only 15 MPa

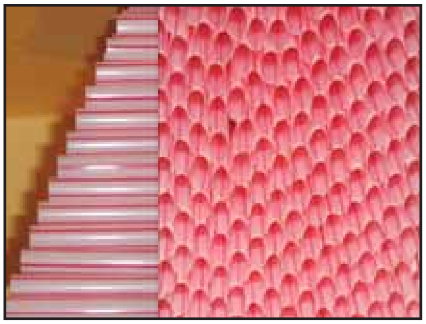

Figure 6 – Schematic of a bevel

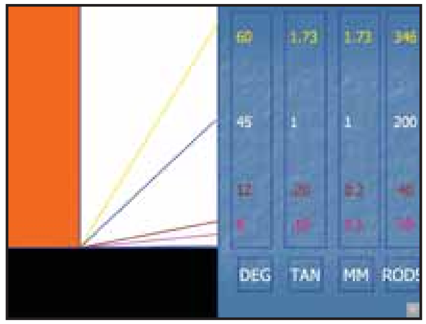

Figure 7 – Bevels and respective tangents, cavosurface footprint and rods consumed

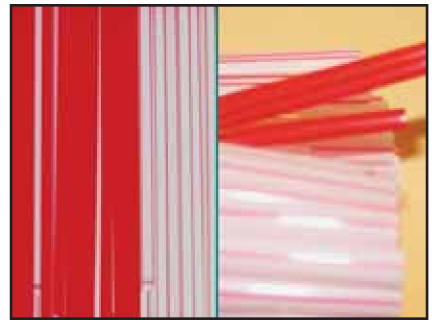

Figure 8 – Enamel "peel". Red = side-bonded rods cohesively separating

Figure 9 – Clinical appearance of adhesive separation or cohesive "peel"

Figure 10 – Bevels of 6,12,45, and 60 degrees located at different heights of the clinical crown

Figure 11 – MOL preparation with 45 degree lingual bevel

will be expected in the proximal box. This weak link jeopardizes the restoration because 15MPa approaches the threshold for de-bond under contraction forces.

To compound the issue, many popular adhesives, both etch-and-rinse or self-etch, deliver less than 30 MPa to enamel, the range being from 17.4 to 32.8. [10,11]

In a GVB box, the enamel on the gingival floor inclines apically, following the orientation of enamel rods as they approach the CEJ. But cold steel margin trimmers are not capable of transecting enamel rods; only of fracturing out weak and unsupported ones. True bevelling of the gingival floor requires cutting rods obliquely with a carbide or diamond instrument.

From the summary of the above points, it can be seen that without bevelling box margins, the floor and walls of GVB boxes hover in the danger zone. Failure in two modes can occur during cure and polymerization:

1. Adhesive Failure: "Separation"

If an overly large increment, generating excessive contractility is placed, the restoration can separate from an under-etched butt margin during polymerization. The resin is sound, the enamel is sound, but a void develops because the adhesive limit is exceeded. White line may be visible. Failure ensues.

2. Cohesive Failure: Enamel "Peel"

The restoration adheres to the immediate enamel sides, but because contraction is not dissipated into multiple rods, as it does when a bevel is engaged, stress concentrates along a single plane of rods. When this tug-of-war exceeds the inherent inter-sheath cohesion of enamel, rods 'peel' apart and enamel self-destructs between contiguous rod sheaths, see Figure 8 This damage may also be visible as white line, but the intrinsic mode is different from separation.

Both modes of failure fail aesthetically, Figure 9 developing brown line and marginal stain. Clinical collapse through leakage, dentin bond hydrolysis, restoration loss, and recurrent decay ensues.

BEVELS DEFINED

Bevels are defined as oblique cuts through enamel extending without interruption from DEJ to cavosurface. Four incrementally increasing bevels are shown in Figure 7.

1. Bevel of 6 degrees – indicated for enamel 1 mm thick
2. Bevel of 12 degrees – indicated for thinner enamel or to resist large resin mass contraction
3. Bevel of 45 degrees – indicated in thin enamel near the CEJ
4. Bevel of 60 degrees – indicated for cosmetic blending

GEOMETRY MEETS HISTOLOGY

Enamel is composed of 30,000 to 40,000 enamel rods per square millimeter of tooth[12]. The number of rods in one linear millimeter of enamel is found by taking the

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Table 1 — Efficacy of 37% liquid phosphoric acid. From Summitt and Robbins pg 214

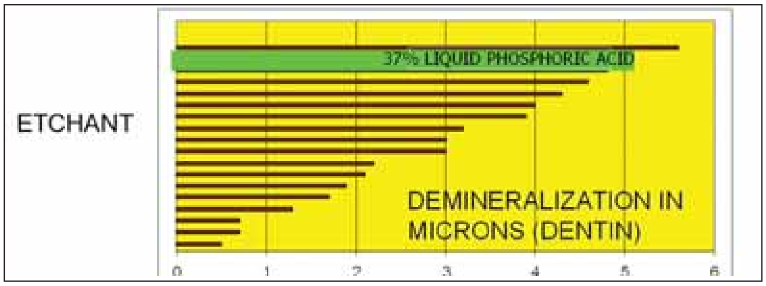
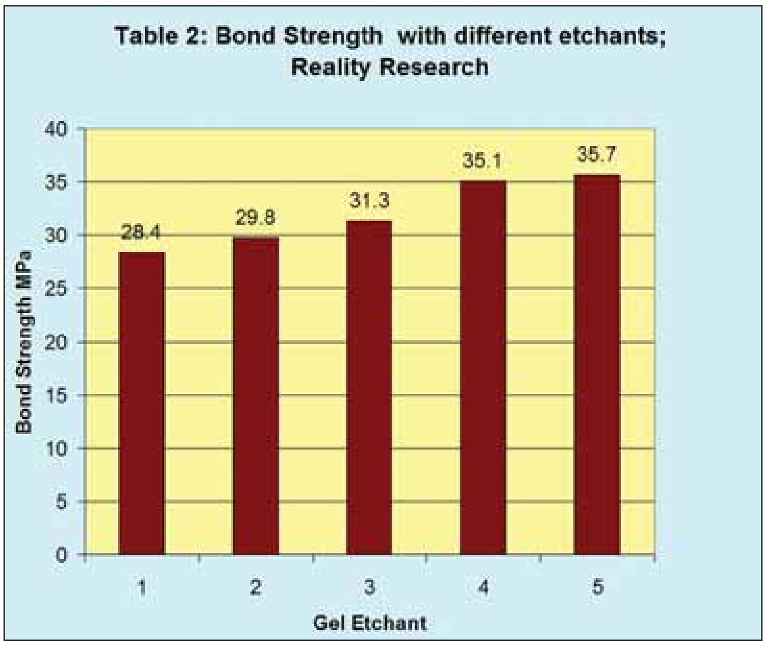


Table 2 — Shear Bond Strength with 5 different etchants using the same adhesive[14]



square root of these figures, namely, 173 to 200 rods per millimeter. When a bevel transects rods from DEJ to a point bevelled one-tenth of a millimeter past a butt margin, 17 to 20 rods – one-tenth this number – are transected. To calculate the angle of the bevel, the tangent function of the bevel is required. A bevel of 6 degrees, tangent = 0.10, cuts 0.10 of a millimeter at the cavosurface (assuming an enamel thickness of 1 mm.), transecting 20 rods. A twelve degree bevel, tangent = 0.20, incurs a cavosurface loss of two-tenths of a millimeter, transecting 40 rods. This is summarized in Figure 7.

In this author's study clubs, stable, functional results with excellent cosmetics over nearly a decade have been clinically achieved using bevels between 6 and 12 degrees – i.e., a cavosurface increase in footprint of only one to two-tenths of a millimeter, assuming enamel 1mm thick. A 45 degree bevel was considered ideal for composite margins at the start of the composite era[12] The tangent of 45 degrees – an isosceles triangle – is 1.0, entails an increase in the enamel footprint of 1 millimeter, transecting 200 rods. At ten times greater enamel loss, this is a clearly unconservative and apparently clinically avoidable price to pay.

Generally, 6 to 12-degree bevels are imparted to surfaces accessible by a FG 7406 carbide, held at ninety degrees to the cavosurface. The tapered bullet – form of this bur, mated to the operator's choice of handpiece angulation, imparts the desired bevel[13]. Due the 12-bladed design and low rake angle, a smooth, consistently bevelled, and easily finished margin is defined. The Class II box does not permit this instrumentation.

A sixty degree bevel is voracious, committing the patient to a facial loss of 1.73 mm, transecting 346 rods. It is rarely necessary except for ultra-critical aesthetic applications.

THE IMPORTANCE OF ETCH:

Etched enamel, properly accomplished, is the principal driver of increased surface area and hence adhesion. Etching increases area by 1000 to 2000 percent[12]. However, proprietary etchants are vastly dissimilar. A range of 1000% in efficacy is noted between etchants in Table 1. Observe that 37% liquid phosphoric acid is superior to most gels.

Confirming the importance of etch as a factor, a recent study by Reality[14] reveals that enamel shear bond strength varied nearly 25% – from 22 to 27 MPa – using five popular gel etchants under the same bonding agent. Table 2

Self-etching adhesives show equally wide variation in pH[15], from 1.2 to 2.7, with commensurate variability in enamel etching efficacy.

Thus, even ideal preparations may under-perform if acid etching falls below criteria, whether embedded in adhesive chemistry, or whether a separate etch-and-rinse protocol.

Being an invisible parameter, the importance of etchants to longevity is often overlooked. Sadly, resin technique refuses to be simple: it is inherently complex and exacting.

4. ENAMEL AXIOM #4: SUFFICIENT DEPTH FOR SERVICE LIFE

Class II occlusal extension, beyond considerations of cariology, is driven by the need to provide longevity. Normal teeth wear at approximately 30 microns per year[16]. Many worn adult dentitions have thinned enamel. Occlusal finish lines placed in thin enamel may wear through to dentin prematurely, necessitating re-restoration. Therefore, enamel thicknesses on the occlusal surface should be thick enough to meet the

Figure 12 — MOL restoration with "wet-pack" placement

Figure 13 — 45-degree bevel made with 0816-016 diamond

Figure 14 — 45-degree bevel polished with Brasseler 286K.018

Figure 15 — MODBs with 45-degree margins at CEJ

Figure 16 — lingual box margins opened with 169L"outside-in" cutting

Figure 17 — disc bevelling wall of incipient box

patient's life expectancy, factored from the above, at an average of 0.3 mm wear per decade. Extension of the occlusal outline into thicker cusp structure may be indicated to achieve this.

5. ENAMEL AXIOM #5: PROPORTIONALITY OF RESIN MASS TO ENAMEL MASS

Meshing with the above is the requirement that large resin masses need to be met with equally robust enamel mass. When enamel is thin, it cannot accept large contraction loads. When thin, finish lines should be moved to a coronal location that has robust remaining enamel. This may require cusp shoeing if no appropriate mass of enamel presents on the occlusal table. If enamel mass is nearly sufficient, bevelling will increase effective area and may suffice to preserve enamel cohesion against contraction. When proportionality cannot be attained, a low-contraction resin placement protocol is indicated to reinforce fragile enamel before contraction by a large contiguous resin mass, or, alternatively, indirect restoration may be indicated.

DIAMONDS VS CARBIDES: THE CONFUSION BETWEEN MACRO-ADHESION AND MICRO-ADHESION.

Many practitioners believe that adhesion for resin restorations is increased by "roughening" the bonding surface with diamond burs. The intuitive sense that a rough surface is more tenacious than a smooth one is misguided. While bondability of a diamond-abraded surface is increased, and is equivalent to air-abrasion in removing amorphous enamel surface[17], the gain in area is insignificant compared to the gain of 1000 to 2000 percent attained through acid etching[12].

Most importantly, this gain in surface area by diamond roughening is obtained at the integrity of the soundness of the enamel layer. The spinning diamond projections of rotary diamond burs shatter, undercut and damage enamel, breaking the cohesion of enamel rods[18]. A sound restoration cannot ensue from a tooth broken by the preparation process: a diamond-abraded margin is less cohesive and weaker[19] as a bonding substrate than one prepared with a spiral-cut, non-crosscut carbide bur, or air-abraded.

MODIFICATIONS OF GV BLACK PREPARATIONS FOR COMPOSITE RSIIN

CLASS II Isthmus and occlusal surface:

No change from GVB method is required; rods are inherently transected and fresh-cut. If the occlusal surface has abundant secondary grooves which are likely to lead to flash that cannot be removed with finishing burs, then these areas should be sandblasted as per axiom #1 to so that flash will be well-bonded where it cannot be finished. Alternatively, the occlusal surface can be re-shaped to improve finishability and promote adhesion. If there are no consequences for occlusal stability, selective and minor plasty of the surface can be accomplished so that flash mates with bur profiles burs, although a less conservative option than air abrasion.

Shoed and replaced cusps: selective bevels

Shoed cusps usually are placed in thick enamel. As can be seen from Figure 10, the number of rod-ends engaged by bevels of varying angles depends on enamel thickness. Hence, very thick enamel can be minimally bevelled; 6 degrees. As the shoe descends the lingual or buccal wall, and enamel thins, the bevel should be increase until one reaches 45 degrees at the CEJ. A facial bevel of 60 degrees is indicated when highly cosmetic blending is sought.

"Wet-Pack" placement to produce a flawless coronal margin

The restorative key to an invisible and hermetically restored posterior bevelled margin as seen in Figures 11 and 12 , is to extrude a small amount of flowable against the matrixed finish line, brush it to place, and remove most of the flowable by repeat cleansing the brush on gauze. Before curing, the final resin is placed and "wet-packed" to close the shoe. Any flowable expressing into the main body of the restoration is removed, to sustain best physical properties, and then cured.

This method readily generates overhang and flash so it is only indicated where safe gingival access is available for final finishing. Minimizing the volume of flowable reduces admixture with resin, which dilutes physical properties of the final resin. Wet-pack is unsound interproximally.

45-Degree chamfer bevels for CEJ gingival margin in large lesions, MODB, open and large Class II box:

Near the CEJ, a 45 degree bevel can be placed using a tapered crown preparation diamond with a "curettage" profile, e.g., a 0816.08C, as seen in Figure 13. This diamond cuts quickly with a light touch, which is then polished with a matching profile crown finishing carbide, e.g. Brasseler 286K.018, Figure 14, to eliminate fractured enamel rods. This margin is very effective as a finish line in the buccal margin of a MODB, Figure 15 or lingual margin of a MODL see Figure 12. The 45 degree bevel meshes with the need to withstand probable high contraction forces developed by a large mass of contiguous resin relative to a smaller remaining amount of tooth structure. However, as seen Figure 10, the footprint of a 45-degree bevel closer to the occlusal surface is much more aggressive. A 45 degree margin produces maximum rod-end bonding surface area and develops a pleasing aesthetic transition from resin to tooth. "Wet-pack" placement is again indicated.

60-Degree Margins.

60 degree margins, sometimes titled "Infinite Margins", are intended for aesthetic blending. Near the CEJ, there is little aesthetic gain from a steeper angle, and one begins to face the difficulty of adapting resin to a fine, acute-angled matrix-to-tooth interface, with resultant bubbles and voids. Wet-pack placement is again the most effective restorative method to avoid this, but better outcomes with 60-degree and greater bevels are best developed freehand, i.e., without a matrix.

CLASS II BOX

The goals of preparation of the Class II box are to:

1. Establish a bevelled enamel margin
2. Open proximal contact without iatrogenic risk
3. Conserve enamel
4. Cut margins that are restorable with conventional sectional matrixes. With sectional systems, this usually means not significantly past the line angles
5. Permit safe final finishing

What is the correct bevel for the proximal wall?

How to instrument the Class II box to meet these goals? The choice of bevel for proximal boxes rides a tightrope: while safely breaking contact, extension is needed to create a bevel to engage sufficient rod-ends to dissipate contraction forces, while conservation of tooth structure to reduce visible exposure and reduce structural loss are fundamental to all operative dentistry. A minimal bevel would be 6 degrees. Relative to an equivalent amalgam preparation, which just breaks contact after hand instrumentation, a 6-degree proximal wall extends wider proximally by a further 0.1, as outlined above, see Figure 16.

Two methods for bevelling conservative proximal walls will be described: 1.Disc, and 2. "Outside-in cutting".

1. Bevelling incipient boxes with discs

When caries is limited and dictates minimal breaking of contact, the marginal ridge is thinned with a fissure bur internally and wall extended until hand instruments can break contact. Then, a stiff paper-backed paper disc

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Figure 18 – two-handed stabilization of disc

Figure 19 – initial cut of "outside-in" cut at occlusal portion of box

Figure 20 – second cut of "outside-in" cut

Figure 21 – third cut of "outside-in" cut at level of gingival margin

Figure 22 – wide boxes cut with 1157 bur

Figure 23 – 56 bur entering box to plane gingival floor

(Moore ½- inch, fine sand) is used to impart a bevel of six degrees to the box wall, working form the gingival/proximal line angle to the occlusal, Figure 17. A moderate speed -6000 rpms- is used in a contrangle, with two handed guidance for safety, Figure 18. Note that enamel in the proximal box thins towards the gingival portion of the box as the gingivo-proximal line angle is approached. Therefore it will cut more readily by disc than the thicker walls more occlusally in the box. This inherently increases the bevel at the gingival relative to the occlusal. This is a desirable correlation between technique and outcome: it exposes more rod-ends at this weak and vulnerable site. Discing requires less than a minute per box.

2. Bevelling medium box by "outside-in cutting", 169L

When caries drives the proximal box wall further towards the line angles than above, but not to the extent that a conventional fissure bur, e.g.,1156 or 1157, can clear contact, a 169L bur is used to break contact. Rather than cut from inside the preparation, the bur is placed externally at the desired exit point of the wall, beginning at the occlusal extent of the box, and cutting obliquely towards the excavated inner form. The apical third of this bur, at less than 0.5 in diameter, is the smallest in the dental inventory - half the diameter of the 1mm 56 series burs. It will cut the least extension possible without the concurrent iatrogenic potential incurred by the converse – cutting outwards from inside the preparation. One or two further successive cuts, dropping towards the intended gingival depth, using the apical third of the bur, aiming to the excavated cavity, breaks contact safely and defines the wall,Figures 19,20,21. Note that this very fine bur needs to be extremely sharp and requires considerable pressure to reach the cutting efficacy experienced with larger diameter burs. A new bur for each box and a concentric handpiece are mandated if safety is to be maintained. This requires less than a minute per box. The 1169L bur is inferior to the 169L for control for this step.

3. Bevelling large box, outside-in cutting, 1156/7

When a pre-existing restoration has committed the wall to a location wide enough to pass a fissure bur such as a1156 or 1157 bur, a bevelled wall can be cut conventionally, Figure 22, either from the outside-in, or inside-out. This takes no longer than conventional treatment.

Gingival Floor: Incipient or Moderate Lesion: Contraction-Driven Instrumentation

The only surface not discussed to this point is the interproximal gingival floor. Box preparation begins as usual with an 1157. The proximal walls are cleared with any of the modes discussed above, and the gingival floor established at the desired height.

A departure from conventional treatment begins by planing the gingival floor with a 56 bur, Figure 23 from wall to wall, which is often uneven following the use of a dome-ended fissure bur. The 56 bur inserts into the smallest of boxes and reaches the gingival margin without extending interdentally to risk unwanted iatrogenic contact with the adjacent tooth. A clean and linear gingival margin at 90 degrees to the long axis of the tooth is thereby easily and safely attained. There is little chance of the bur falling off the floor apically into the gingival embrasure and also limited risk of contacting the adjacent tooth. The resultant gingival margin is clean, linear, with correct extension onto healthy enamel. However, it is not bevelled. Axioms #2 and #3 are violated.

In small- to- moderate boxes no known rotary bur safely imparts a six to twelve degree bevel to the gingival floor. Any bur with a bi-bevel tip of 6 to 12 degrees is too large in diameter to effectively instrument an incipient box or to safely approximate the adjacent tooth. Any bur small enough risks unwanted excursions off the gingival towards the gingivae.

Gingival Box: Theoretical Desiderata

For theory to meet practice, an ultrasonic tip, safe-sided, slightly trapezoidal in outline, approximately 0.75 mm thick with fine diamond coating could be inserted into the box to finish proximal and gingival margins to a 6 to 12 degree bevel. At least two tips would be necessary- one mesial, one distal. This instrument could place the desired bevels on both gingival margin and proximal walls. Unfortunately, such a device does not yet exist.

When it is developed, theory and practice will mesh at the gingival margin like two halves of a zipper. In the interim, the following method is expedient and has shown minimal gingival re-decay over a fifteen year period in clinical practice. The author gives the term “contraction-driven gingival instrumentation” to this method.

Using a sharp H6/7 (off-angle sickle scaler) from beneath the margin,Figure 24 the integrity of the gingival margin is challenged by upward strokes, attempting to collapse enamel rods into the box, mimicking forces of polymerization contraction, see Figure 25 In clinical practice, fragile rods are seen to break free by these upward strokes, even after a margin trimmer has been used. Any resultant defects in the margin are re-planed with the 56 bur, and again up-scaled. Typically, after several rounds of this protocol, the floor robustly survives more up-scaling, is a consistent, matrixable line, and does not shed more rods. Less than a minute is required to instrument a gingival margin in this method.

From a theoretical framework, this method clearly fails to achieve end-bonded rods, achieving only robust rod sides. Is this good enough? The success of this margin in surviving contractile destruction has been optimized by following a “low-modulus lock-down” placement protocol.[20]

First Increment; Low-modulus lock-down

A low modulus first increment complements the fragility of the unbevelled gingival margin. This is accomplished by using a very thin layer of flowable (0.25 mm thick) Figure 26 on the gingival margin and all box internal surfaces. This layer is completely cured- at double the usual increment placement time- before resin is built. The gingival margin is thereby reinforced and locked down structurally against excessive contraction. Analytically, box dentin is “slightly flexible”, at 12 GigaPascals (GPa).The gingival enamel, at 80 GPa, is not. Flowable resins typically have a flexural modulus of about 5 GPa, which can be seen to be twice as flexible as dentin and 16 times more flexible than enamel.

Figure 24 — off-angle H6/7 scaler upscaling gingival margin in “contraction-driven gingival instrumentation”

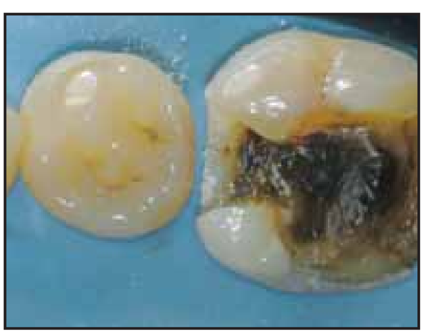

Figure 25 — weak interproximal enamel rods cleaved off by upscalin

Figure 26 — typical stress riser following cusp fracture

Figure 27

The flowable increment ties together all the spatial elements in the bottom 10 percent of the box – gingival enamel, gingivo-proximal enamel, gingival dentin, axial dentin, proximal dentin, with the least contraction possible, due to its low modulus, which offsets high polymerization contraction, typically 4.5%. Also, the volume of the increment is deliberately minimized to lower net contraction. As well, the increment is open on two walls, which lowers its C-factor. This unifying semi-elastic increment is small, but protects the thin and fragile gingival and box line-angle enamel by adhering them to the contiguous dentin of the box, which is greater in area. This protects gingival and gingivo-proximal enamel against contraction-derived destruction during subsequent increments.

Final resins typically lie in the range of 8 to 12 gigapascals, i.e., twice as stiff as flowables. It is for this reason they are not indicated as a first increment against an unbevelled gingival margin.

It should be noted that other components of a sound composite protocol are essential to success; liquid 37% phosphoric acid etch, which is at the 95th percentile of effectiveness in the field of etchants, and is a superior cavity cleanser relative to gel etchants. A primer containing BAC to resist MMP degradation of hybridized collagen[20], a very hydrophobic adhesive with a degradation curve (established after 6 years of thermocycling[21]) resin heated to 54 degrees C[22], and curing at 2200mW[23] for double normal cure times. A longer cure cycle overcomes light intensity fall-off as tip-to resin distance increases, as studied by Price et al[24]. Finally, beyond 6mm of box depth, a dual-cure flowable[25] is used, meshing with a dual-cure adhesive.

None of these steps take extraordinary time but all are critical to optimizing outcomes. Failure to control for many of these parameters contributes to enormous data spread in longitudinal studies of Class II survival. Full discussion of these aspects is outside the scope of this article.

DENTIN AXIOMS:

Factors governing the dentin in preparation are more concise than enamel.

DENTIN AXIOM #1: ALWAYS FRESH CUT OR AIR - ABRADED

This step removes biofilm, etch-resistant fluoridated dentin, and hyper-mineralized sclerotic dentin surfaces. As with enamel, removal of only microns is required.

DENTIN AXIOM #2: ROUNDED FORM, STRESS RISERS

Rounded internal line angles:

Transitions from one plane to another should be rounded. Stress travelling within the resin, like flowing water, should not abruptly change direction over sharp internal form. This compares to the turbulence of a stream flowing over and around rocks: smooth, laminar flow is preferable.

Elimination of stress risers:

Sharp internal form, such as seen after tooth fracture, Figure 27 must be eliminated. This structural principle is widely honoured in diverse engineering applications, from soda cans to airplane wings. Where does a scored utility knife blade break? – where intended, at the scored lines. Similarly, in the structurally imperative world of aircraft safety, a tiny nick in the wing surface mandates panel replacement, recognizing that any flaw in a continuous surface becomes an axis around which repeat flexure takes place, leading to localized fatigue and material failure. Resin is the more fluid element in tooth/resin interactions, because the flexural modulus of most current resins ranges from 8 to10 gigapascals (GPa), compared to the flexural modulus of dentin, which lies in from 12 to 14 GPa, while enamel measures at 80GPa. Because the flexural strength of most hybrids ranges from 85 to 170 (MPa), compared to dentin at 220 MPa, resin is the element moving the most in the restoration. Being the weakest in load-carrying capacity, and flexing the most, it is likely to fail first, and fracture will most likely initiate around sharp internal projections which concentrate stress.

DENTIN AXIOM #3: CONSISTENT AND SUFFICIENT DEPTH FOR AESTHETICS

When treating visible surfaces, consistent axial depth on the facial surface leads to consistent aesthetics. Just as in laboratory ceramics, direct materials need room to develop aesthetics. In outer dentin, pulpal encroachment is of no concern, but stained tooth structure needs depth of overlying resin to be effectively hidden. Figure 15 shows a failure to cover stained tooth structure in tooth #15 due to insufficient depth.

DENTIN AXIOM #4: SUFFICIENT DEPTH TO ACCEPT LOADS

Strength increases as the square of the depth in most load-carrying structures such as beams. The application of this axiom in prep design is pre-emptive: shallow restorations exposed to point loads, for example, the distal marginal ridge of mandibular first bicuspids, may fail at the fossa if the pulpal floor is too shallow. The fossa is where the strain between marginal ridge, which is strained in compression, meets the isthmus, which is strained in tension. A material path in the prep must be provided, of sufficient depth and volume, through which these strains can travel and resolve. Clinical experience and judgment informs the spatial need from case to case, according to the resin selected. Because performance varies as the square of depth, small increases in size can pay large dividends. The flexural strength of hybrid and nano-hybrid resins governs outcomes greatly, and varies from 85 to 166 Megapascals, i.e., 200%, while Flexural Modulus varies from 3.8 to 22GPa, 700%. Therefore, different outcomes will be seen in similar preparations when different resins are placed.

DENTIN AXIOM #5: MECHANICALLY EFFICIENT INTERLOCKS

Adhesion to dentin generally declines over time, so that efficient macro-retentive features such as dovetails and parallel or convergent walls can supplement adhesion and improve durability. Conventional GVB resistance form, e.g., gingival and pulpal floors, relieve adhesives of shear loading Mechanical interlocks and reciprocal retention improve stress transfer from tooth structure to the restoration and reduce cyclic fatigue at the adhesive interface as it ages. This axiom is concisely expressed as "Form Spares the Bond".

DISCUSSION:

Following the axioms detailed in this article, a conceptually sound preparation can be developed for Class II composite resin restorations. If well-isolated, correctly matrixed and cured, a restoration of virtually any size or complexity can be completed in composite resin with satisfactory lifespan, in this writer's opinion and experience. However, results are more easily attained in current clinical practice with indirect methods. Perhaps with more attention paid to the fundamentals of

TABLE OF ETCHANTS FROM SUMMITT

Table 8-3 Etchants ranked by demineralization potency

Etchant	Composition	Etch time (sec)	pH	DID (µm)
				< 2.0
Clearfil CA Agent (Kuraray)	10% citric acid, 20% calcium chloride	15	-0.10	0.5
Gluma 2000 Solution 1 (Bayer)	1.6% oxalic acid, 2.6% aluminum nitrate, 2.7% glycine	15	1.38	0.7
Mirage ABC Conditioner (Den-Mat)	2.5% nitric acid	15	0.42	0.7
Clearfil CA Agent (Kuraray)	10% citric acid, 20% calcium chloride	40	-0.10	0.9
Amalgambond Universal Dentin Activator (Parkell)	10% citric acid, 3% ferric chloride	10	0.59	1.3
Ultra-etch (Ultradent)	10% phosphoric acid	15	1.31	1.7
Ultra-etch	35% phosphoric acid	15	0.02	1.9
				2.0–3.0
Scotchbond Multi-Purpose Etchant	10% maleic acid	15	0.87	2.1
Mirage ABC Conditioner	2.5% nitric acid	60	0.42	2.2
Mirage ABC Conditioner	10% phosphoric acid	15	*	2.2
Ultra-etch	10% phosphoric acid	30	1.31	2.2
All-etch (Bisco)	10% phosphoric acid	15	0.48	3.0
All-etch without surfactantia (Bisco)	10% phosphoric acid	15	0.78	3.0
All-etch	10% phosphoric acid with surfactans	15	*	3.0
Scotchbond Etching Gel	35% phosphoric acid	15	-0.28	3.0
				> 3.0
Aqueous phosphoric acid solution	10% phosphoric acid	15	0.48	3.2
ESPE Etching Gel	32% phosphoric acid	15	*	3.9
Uni-Etch (Bisco)	32% phosphoric acid with surfactans	15	*	4.0
DeTrey Etch	36% phosphoric acid	15	-0.26	4.3
Mirage ABC Conditioner	10% phosphoric acid	30	*	4.5
Etch-Rite (Pulpdent)	38% phosphoric acid	15	-0.29	4.6
Uni-Etch	32% phosphoric acid	15	-0.17	4.8
Aqueous phosphoric acid solution	37% phosphoric acid	15	-0.43	5.0
Kerr Gel Etchant	37.5% phosphoric acid	15	*	5.6

pH = acidity; DID = depth of intertubular demineralization. From Perdigão.
*pH values not available.

preparation, as well as the host of other interdependent technique factors, consistency will develop to provide satisfactory service to dental patients.

Unfortunately, in North America, many patients will never afford indirect dentistry. The bulk of the undeveloped world will also never receive laboratory-based restorations.

Therefore there is a need for the dental profession globally to elaborate a consensual technique for composite resin. Standardization of method is required to guarantee a standard of care. The preparation is the logical starting point in the journey to consistency and longevity, and suffers no product variability. The preceding concepts, instrumentation, and process have proven reliable in the hands of the author and members of his study clubs, and are offered for professional debate and further research.

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About the Author

Dr. Peter Walford, DDS,FCARDP, McGill 1975, is in private practice in British Columbia and mentors study clubs in composite resin technique. Contact at pwalford@telus.net or visit www.peterwalforddentistry.com

CARDP/ACDRP Active Member receives the "2012 Canadian AGD Dentist of the Year"

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- Provide recognition to individuals for outstanding achievement relevant to the dental profession.
- Demonstrate to AGD (Academy of General Dentistry) members and others that the organization values and recognizes
- Motivate AGD members and others to improve and enhance dentistry
- Encourage volunteerism in AGD and the industry through recognition
- recognizes an individual dentist who demonstrates humanitarianism, through contributions
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Criteria

- exhibits dedication to the advancement of the profession
- goal & idea oriented
- knowledgeable in all disciplines of dentistry
- innovative in the promulgation of dentistry clinically and/or acedemically

CURRICULUM VITAE

Antonio Mancuso, D.D.S., M.A.G.D.

Dr. Mancuso graduated from the University of Toronto in 1985 and has maintained a general dental practice in Welland, Ontario ever since.

He is a fellow of the following: – the Academy of Dentistry International, the Pierre Fauchard Academy, and the International Academy for Dental Facial Esthetics. In 2006 he received the award of Master in the Academy of General Dentistry and in 2011 he was recognized with the "Lifetime Learning and Service Recognition Award" by the AGD.

He has published articles for numerous dental journals and has given over 100 presentations to various dental organizations in Canada, the United States and internationally.

From 1999 to 2009, Dr. Mancuso conceived, developed and ran "Millennium Aesthetics" – a live hands-on program that taught dentists and staff aesthetic diagnosis and treatment. Today, he provides this program to dentists in an over-the-shoulder mentorship format.

He is the past Trustee for Canada in the AGD, the Past President of the Ontario AGD and past-Mastertrack Director of the OAGD. He is also the Past-President for the Niagara Peninsula Dental Association – a component society of the ODA. He currently serves as President of the Regional Niagara AGD study club.

CARDP/ACDRP Fellow and Past President receives Full-Time Clinical Instructor Award

2012 marked the seventh time that Dr. Gorman Doyle received the Full-Time Clinical Instructor Award, which is voted on annually by graduating students. In recognition of his long-standing commitment to enhancing student education in clinical dentistry, the Dalhousie Dentistry Students' Society passed a motion to rename it "The Dr. Gorman Doyle Award".

The Canadian Academy of Restorative Dentistry and Prosthodontics
Académie canadienne de dentisterie restauratrice et de prosthodontie

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2013 Annual Scientific Meeting

September 25th – 28th, Vancouver, British Columbia

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TIME		Wednesday, September 25, 2013	LOCATION
9:00 AM	5:00 PM	Hands On Course	Port of New York
6:30 PM	11:00 PM	CARDP Executive Dinner Meeting	Port of Vancouver
		Thursday, September 26, 2013	
7:00 AM	4:30 PM	Sturgeon or BC Salmon Fishing	Meet in Lobby Renaissance Harbourside Hotel 6:45 am
8:30 AM	4:30 PM	Golf at Shaughnessy Golf Course	Meet in Lobby Renaissance Harbourside Hotel 8:15 am
11:00 AM	3:00 PM	Cooking Vancouver	Meet in Lobby Renaissance Harbourside Hotel 10:30 am
12:00 AM	11:59 PM	Scientific Set-up	Harbourside Ballroom I
8:00 AM	6:00 PM	Trade Show Set-up	Harbourside Ballroom II & III
11:00 AM	8:00 PM	Registration	Harbourside Foyer
3:00 PM	Finish	Journal Meeting (TBC)	Presidents Suite
6:00 PM	10:00 PM	Eat, Meet & Greet, Welcome Buffet with Sponsors	Harbourside Ballroom II & III
		Friday, September 27, 2013	
7:00 AM	5:00 PM	Registration	Harbourside Foyer
7:00 AM	8:30 AM	Breakfast with Sponsors	Harbourside Ballroom II & III
8:15 AM	5:00 PM	Scientific Sessions	Harbourside Ballroom I
9:30 AM	3:30 PM	Partner's Program – Vancouver Highlights	Meet in Lobby Renaissance Harbourside Hotel 9:15 am
10:30 AM	11:00 AM	Break with Sponsors	Harbourside Ballroom II & III
12:00 PM	1:30 PM	Lunch with Sponsors	Harbourside Ballroom II & III
3:30 PM	4:00 PM	Break with Sponsors	Harbourside Ballroom II & III
6:30 PM	10:30 PM	Yachting In Vancouver - Sunset Bay II	Meet in Lobby Renaissance Harbourside Hotel 6:00 pm
		Saturday, September 28, 2013	
7:00 AM	12:00 PM	Registration	Harbourside Foyer
7:00 AM	8:30 AM	Breakfast with Sponsors	Harbourside Ballroom II & III
7:00 AM	8:30 AM	CARDP Member Breakfast	Tuscany Ballroom (Main Floor)
8:30 AM	12:00 PM	Scientific Sessions	Harbourside Ballroom I
9:50 AM	10:30 AM	Break with Sponsors	Harbourside Ballroom II & III
12:00 PM	2:00 PM	CARDP Members & Guests Lunch	Tuscany Ballroom (Main Floor)
2:00 PM	4:00 PM	High Tea (Partner's Program)	Fairmont Pacific Rim Hotel
2:00 PM	5:00 PM	Table Clinics	Vistas Ballroom (Top Floor)
6:30 PM	7:30 PM	President's Reception	Vistas Ballroom (Top Floor)
7:30 PM	12:00 PM	President's Gala - Dinner Dance	Tuscany Ballroom (Main Floor)
		Sunday, September 29, 2013	
9:00 AM	12:00 PM	Clinic and Essay Meeting	Port of New York

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VANCOUVER HARBOURSIDE HOTEL

Conference Hotel, Vancouver Renaissance Harbourfront Hotel

The Canadian Academy of Restorative Dentistry and Prosthodontics
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CARDP Annual Scientific Meeting
Vancouver, British Columbia - Wednesday, September 25th 2013

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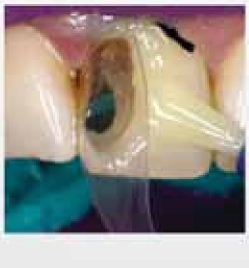
Direct composite restorations are under-promoted and under appreciated in today's world of implants and computer assisted ceramics. Yet direct composites can be the least invasive, most biomimetic and wonderfully aesthetic of all restorations. The challenge is that we must rely on our own hands to create that magic.

Dr. Clark will present creative solutions to overcome the major clinical impediments to modern resin dentistry. This hands on course will include the introduction of the "Injection Molding" composite placement technique with the use of the anatomic Bioclear Matrix. At the completion of this course the participants will:



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By Derek W. Jones,
Chair ISO/TC 106
D.W.Jones@dal.ca

International Dental Standards

Standards dentaires internationaux

This year marks the 50th year since the dental international standards committee (ISO/TC 106) was established in 1962. When ISO/TC 106 came into existence 50 years ago there were nine international dental standards in existence these had been produced by the World Dental Federation (FDI). Much has been accomplished since that time. Currently a total of 47 countries are involved in the work of ISO/TC 106 (26 Participating members and 21 Observer members). The international dental standards committee has input and participation from close to 300 international dental experts from the member countries. The majority of experts and delegates involved with the development of international standards are volunteers appointed by their National Body.

Few members of the public or indeed many dentists fully appreciate the contribution made by (ISO) international dental standards in the safety and quality of dental care.

The dental standards committee (ISO/TC 106) now has a total of nine active sub committees and close to 50 working groups devoted to developing standards for biocompatibility, restorative materials, orthodontic materials and devices, instruments, equipment, oral hygiene products, implant devices and materials, computer aided design and computer aided manufacture (CAD/CAM) as well as the development of terminology and coding systems. In addition to Canada which holds the ISO/TC 106 secretariat, a further four countries hold the secretariats of the nine sub committees, France, Germany, Japan and the United States.

Between 40-50 documents for dental standards development are voted on each year by member body countries during the period between the annual ISO/TC 106 meetings.

In addition to performance standards for burs and dental hand-pieces, extensive coding systems are used to classify rotary instruments with limits for bore sizes and dimensions for discs, wheels and cutting burs.

Did you know that residual monomer in a heat-cured denture base must not exceed a maximum of 2.2% when tested according to the ISO standard. An ISO Standard also specifies the limits for exposure to ultraviolet irradiance from dental operating lights thus protecting both the patient and the dentist. A very important standard (ISO-11143) for Amalgam separators is designed to remove amalgam particles and reduce mass of amalgam (and mercury) entering sewage system.

Did you know that the quality of the smile of your patients and their oral health is facilitated by International Standards? As billions worldwide brush their teeth each day, few are aware of, or have even give thought to, the four International Standards for toothbrushes. Toothbrushes come in all colours, and claim different properties, but how can we make sure that they will perform and not break or fall apart during normal use? Manual toothbrushes should not break or loose bristles while you brush your teeth. This will not happen to brushes that have passed the tests specified in the international standard for manual toothbrushes. This standard outlines pass-fail criteria, physical inspection guidelines, fatigue resistance, chemical challenge, and handle strength requirements and tests, as well as marking, labelling, and packaging guidelines for manual toothbrushes. Dentists understand and appreciate the importance of flexibility for a toothbrush tuft? An ISO standard specifies a test method for determining the resistance to deflection of the tufted portion of manual toothbrushes. A standard for electric toothbrushes deals with the physical properties in order to promote the safety of these products for their intended use. Standards have also been developed for toothpaste, oral rinses, dental floss and dental bleaching products.

Did you know that artificial materials are used to replace the tissues of teeth more than any other part of the human body. Clearly materials selected for use as a replacement for natural dental tissues have a very high demand placed upon their chemical, physical and biological characteristics. These are the parameters that must be addressed in developing standards for these dental restorative materials. The varying pH in the mouth and the stresses of mastication has an aggressive affect on the integrity and wear of materials replacing natural tooth structure.

ISO standards have been developed for, impression materials, investment materials, and model and die materials, casting alloys, ceramics and cements. For a range of dental restorative materials the setting time, strength, colour stability, biocompatibility, expansion and contraction are addressed in the standard specifications. The standards for restorative materials specify various limits for physical and chemical properties. Radio-opacity is a very important aid for dentists in diagnosing recurrent caries this relies on the presence of radio-opaque restorative materials. An improved standard for determination of radio-opacity of restorative materials is currently being developed.

A standard has been produced dealing with implantable materials (resorbable or non-resorbable) for bone filling and augmentation in oral and maxillofacial surgery. A further standard deals with membrane materials for guided tissue regeneration in oral and maxillofacial surgery.

If the product you are using has a statement on the package that it meets the relevant ISO standard, the company's product must have been evaluated to comply with the various specifications.

A million or so dental professionals world-wide each working day are using materials, devices, equipment and procedures that are covered by dental international standards; in addition there are billions of members of the general public who also use over the counter dental hygiene products on a daily basis which are also covered by international dental standards. Clearly the ISO dental committee has made a significant difference to the quality of dental treatment received by millions of people worldwide during the past fifty years.

About the author

Derek W. Jones obtained his B.Sc and Ph.D from the University of Birmingham, UK. Currently Professor Emeritus of Biomaterials, Dalhousie University, Canada. Acts as scientific expert consultant/witness for government agencies, dental profession, national and international private sectors. Derek Jones is a Chartered Chemist (C.Chem) and a Fellow of the following organizations, Royal Society of Chemistry (FRSC), the Institute of Ceramics (F.I.Ceram), Institute of Materials (FIM) and Biomaterials Science and Engineering (FBSE). Conducted research on a wide range of biomaterials and material properties covering ceramics, refractories, hard and soft polymers, composites, dental cement, bone cement, mercury pollution, biocompatibility of materials and synthesis of glass and polymer materials and the release of drugs from biomaterials. Authored or Co-authored over 300 papers and abstracts and contributed chapters and sections on ceramics and biomaterials in eight books. Holds two patents on biomaterials. Has received over $3.25 million in research funding.

Derek Jones has been involved with standards development since 1971, is currently the international Chair of ISO/TC 106 Dentistry 2005-2013, he was Secretary of ISO/TC/SC1 Dental Filling and Restorative Materials from 1979 to 1997, and Chair of ISO/TC/SC1 from 1998-2005. Chair Canadian Standards Association Technical Committee on Dentistry, Chair Canadian Advisory Committee to the International Standards Organization, 1979-2005. Past President Canadian Association for Dental Research (CADR), 1992-95. Past President of the International Dental Materials Group IADR, 1990-91. Chair of the Canadian Dental Association, Dental Materials and Devices Committee, 1993-1998.

Derek Jones has received the following awards:

Wilmer Souder Distinguished Scientist Award, International Association for Dental Research, 1988.

Honorary Doctorate Degree, DO,h.c 1992 University of Umeå Sweden in 1992.

International Fellowship Biomaterials Science and Engineering (FBSE), 1996.

Distinguished Service Award, Canadian Dental Association, 1996.

Honorary Member Association of Prosthodontists of Canada, 2001.

Award of Merit, Canadian Standards Association, 2002.

Honorary Fellow International College of Dentists, 2005.

Honorary Member of CARDP, 1987

Oral lesions: An anatomic approach to differential diagnosis

Les lésions buccales: Une approche anatomique aux diagnostics différentiels

Presenter/Conférencier: Dr. Charles Shuler, D.M.D., Ph.D (Pathology)
Dean, Faculty of Dentistry, University of British Colombia, BC
cshuler@dentistry.ubc.ca

Synopsis by Dr. Heather Carr

Dr. Shuler's presentation provided dentists with a unique outlook on assessment of oral lesions. He noted traditional teaching methods would involve memorization of clinical and histologic pathology slides and the requirement on examinations to give the "correct" diagnosis without any information beyond the image. However, this was not necessarily the best method to diagnose oral lesions when they are observed in a patient. Rather, clinicians should consider a range of all possible conditions to generate a list of differential diagnoses. Subsequently specific procedures can be used to establish the definitive diagnosis. The importance of a dentist having a comprehensive knowledge and ability to recognize differences from the normal characteristics of oral tissues was emphasized.

The first step in establishing a differential diagnosis was termed the **Recognition Phase**. An oral lesion should first be assessed using patient history, careful observation and palpation to identify changes from normal. A thorough head and neck examination would be essential to generate the information necessary to recognized and evaluate oral lesions.

It was stressed dentists should not attempt to make a final clinical diagnosis when initially assessing an oral abnormality.

The second step was termed the **Process of Differential Diagnosis**. At this point, consideration must be given to possible etiologies including developmental (congenital), reactive (inflammatory), neoplastic, trauma and/or local manifestation of a systemic disease. Each of these possible causes should be analyzed considering the normal anatomy and tissue types present at the site where the lesion has been identified. An additional important feature would be the pattern of growth of the lesion.

This assessment will allow the development of a differential diagnosis related to the probable etiology. For example, redness and inflammation would be indicative of a reactive lesion where an uncontrolled growth might indicate a possible neoplastic lesion. The dentist must consider all potential diagnoses from all the individual tissues and possible etiologies. This will allow the development of a more comprehensive differential diagnosis for the lesion being examined and avoid missing a potentially very significant change.

The final step is the establishment of a **Definitive Diagnosis**. A variety of procedures are used to develop a definitive diagnosis from the differential diagnoses previously generated. It may be necessary to refer and/or consult with an oral pathologist. The use of telephone, email and videoconference may also be useful to gain a consultation. Noninvasive procedures such as diascopy, cultures and exfoliative cytology provide important information. Invasive procedures such as a biopsy are often used to determine the definitive diagnosis. A successful biopsy will be representative of the lesion without undermining possible future removal of the lesion. Though increasingly popular, a Velscope should not be a substitute for a thorough exam but rather an adjunct to provide additional information beyond what can be observed during a normal examination. The Velscope has proved useful during surgery to remove oral cancer by providing an improved method to detect the non-cancerous margins of the tumors. The results of the different procedures will allow one to determine the definitive diagnosis and thereafter the appropriate treatments for the condition.

Rather than trying to make a definitive diagnosis for an oral lesion during an initial examination, Dr. Shuler recommended one follow the process of developing a differential diagnosis that would include all of the potential final diagnoses. Once a definitive diagnosis has been reached, it would be possible to determine the suitable course to achieve a definitive diagnosis and ultimately the appropriate treatment.

"New Materials and Technology – Is It Time to Jump In?"

"Les nouveaux matériaux et technologies – le moment est-il venu de nous lancer?"

Presenter/Conférencier: Dr. Jim Kessler, D.M.D.
Director of Advanced Esthetics and Technology,
University of Oklahoma College of Dentistry
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Presentation Synopsis by Dr. Andy Nette

From the outset Dr. Kessler emphasized the need to look at new materials through the lens of proven principles. Because of the barrage of options, particularly with all-ceramic restorations, coupled with the relatively limited clinical experiences we have with these materials, Jim opined that using proven principles is our only standard with which to evaluate these materials. With this in mind, the 'perfect' material for restoring tooth structure should a) not fatigue with function and/or time, b) have a surface hardness and/or wear potential equivalent to or lower than enamel, c) be fracture proof in dimensions of 1mm or less, and d) require familiar fabrication and delivery procedures. Indeed, in 2012, it seems instead, that the perfect material need only be cheap, white and unbreakable!

Dr. Kessler discussed the properties of two Zirconia-based restorations, the Zirconia reinforced/layered restoration, and monolithic Zirconia. There are over 15 clinical studies involving layered zirconia in progress worldwide and bruxism is an exclusion criterion for all of these studies. In spite of this avoidance of parafunctional challenges, the two most frequent modes of failure reported are chipping of the veneering porcelain and de-bonding of the restorations. Therefore, with layered zirconia restorations, careful patient selection, strict quality control on the part of the lab to avoid chipping, and preparations with significant retention and resistance form are recommended. As a positive, zirconia has the advantage of masking a dark stump more successfully than other all-ceramic options. Monolithic Zirconia is not prone to chipping or delamination, but is incredibly hard, will not wear and requires meticulous polishing after adjustments to avoid wear of the opposing dentition.

Terry Donovan was quoted in the discussion of porcelain veneers vs. full porcelain coverage: "One of the most important factors in determining the longevity of a restoration is the amount of tooth structure remaining". Jim pointed out that the most critical tooth structure in an anterior tooth is the lingual, including the cingulum, marginal ridges, and fossa, and this structure is preserved in a veneer preparation. If a veneer fails, it is usually due to veneer breakage; if an all-ceramic full coverage crown fails, it's often the tooth that has fractured.

In summarizing, Dr. Kessler reviewed the most frequent causes of failure for gold restorations, bonded all-ceramics, and cemented high strength all-ceramics. Gold suffers from wear and esthetic unacceptability, and little else. Bonded all-ceramic restorations are prone to fracture of the restoration and possible de-bonding, but otherwise stand up very well. Full coverage, cemented high strength all-ceramics, such as zirconia, most often fail due to reasons relating to the aggressive, retentive, preparations required. Most clinical studies have shown the common modes of failure for these restorations to be; de-cementation, wear of opposing dentition, endodontic/caries issues, periodontal failure and/or tooth fracture.

Given the 'proven principles' of preservation of tooth structure and maintaining the integrity of surrounding/opposing dentition, Dr. Kesslers' presentation left the impression that he favours the use of porcelain veneers, when feasible, to full porcelain coverage, and that gold is still the standard against which we measure new materials.

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