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Toronto 2015

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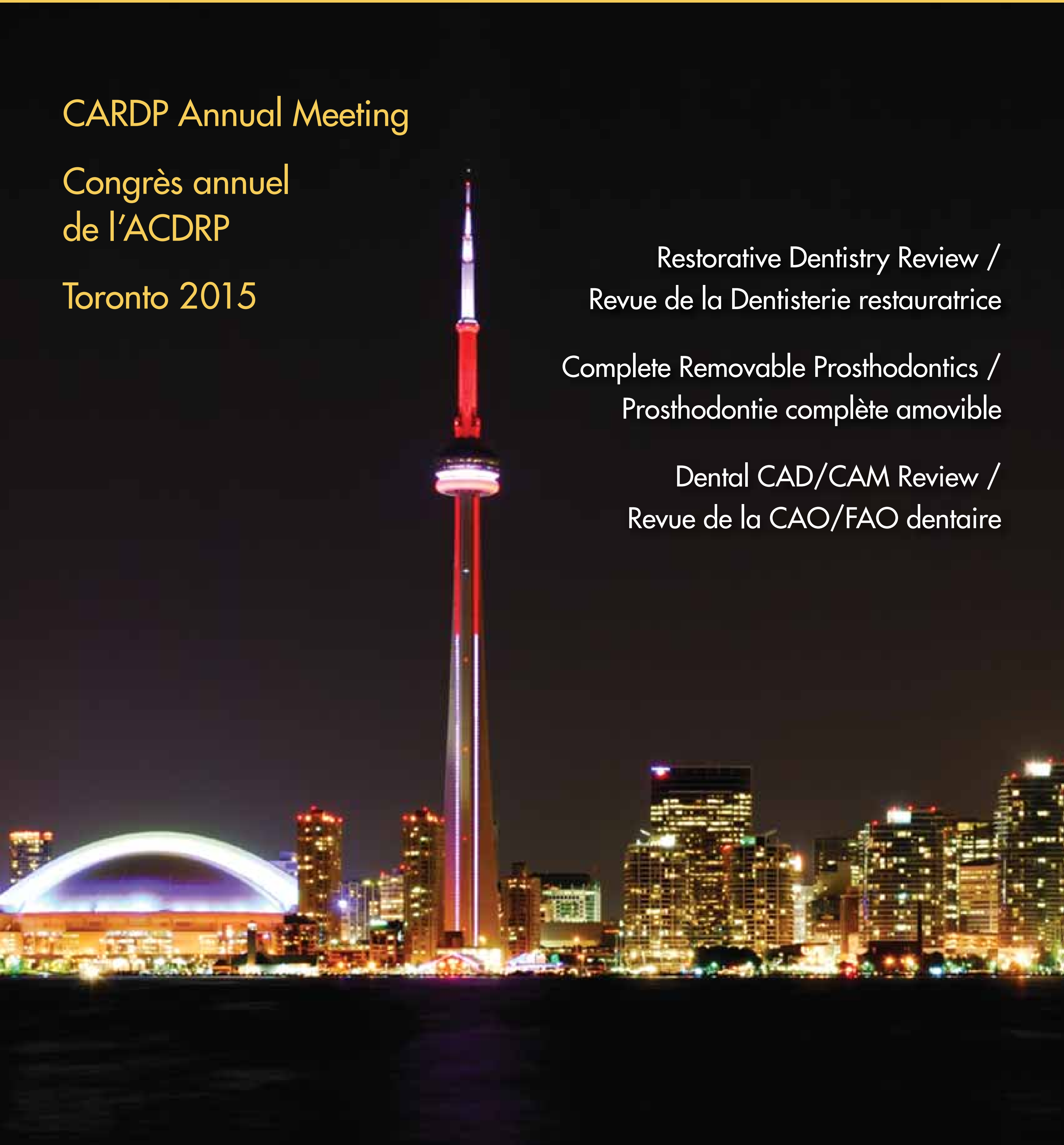

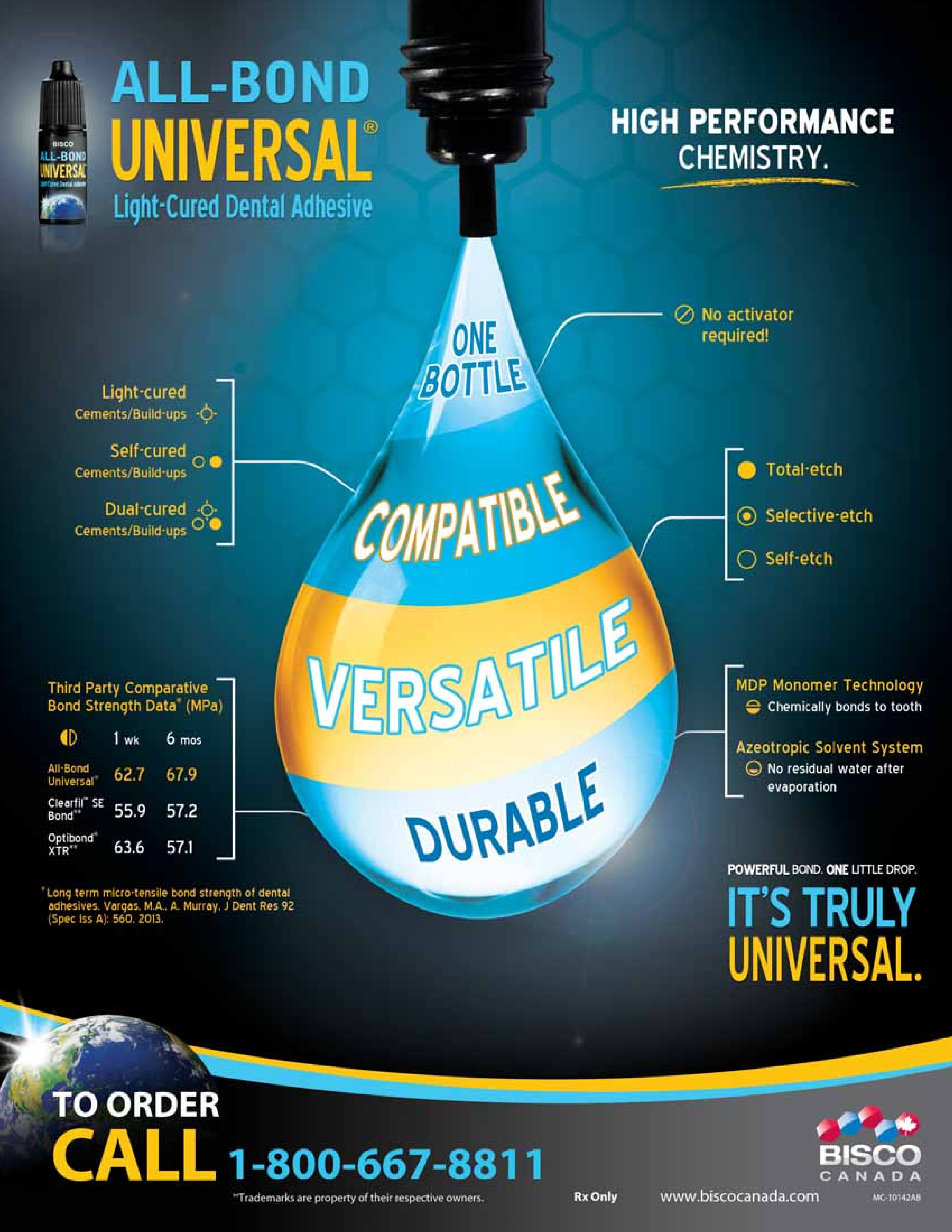

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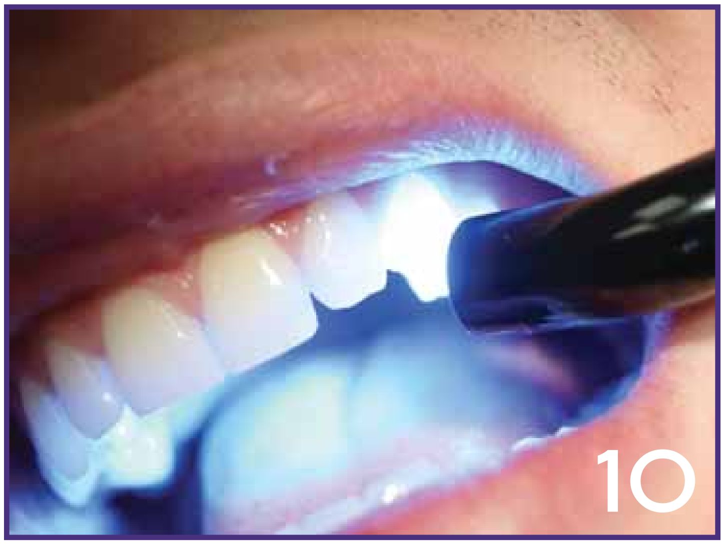
Restorative Dentistry / Dentisterie restauratrice



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Dr. Hubert Gaucher

Revisiting our Journal's Inaugural Message

Some background: I wish to highlight the fact that the Canadian Academy of Restorative Dentistry and Prosthodontics (CARDP) is commemorating the 50th anniversary this year of one of its founding organizations: the Canadian Academy of Restorative Dentistry (CARD). Today, CARDP continues to promote and disseminate excellence in the practice of Restorative Dentistry and Prosthodontics across the nation. It is a Continuing Education driven provider and its Annual Scientific Meetings have earned a well deserved distinction due to the impressive numbers of its high caliber speakers, state of the art meeting facilities, excellent social programs and leading Industry sponsors, all of which encourage affinities among the membership from sea to sea.

In an endeavor to further its commitment to the dental community, CARDP launched its own Official Publication: CJRDP/JCDRP back in 2008. I invite you to revisit excerpts of its Inaugural Message below, that kicked off a tradition of excellence and collaboration.

MESSAGE FROM THE EDITOR-IN-CHIEF

Keeping One's Focus While Multitasking and Sharing the Vision

This, the inaugural issue of the *Canadian Journal of Restorative Dentistry and Prosthodontics (CJRDP)*, reflects some of the diversities, and challenges that we as practitioners must learn to cope with on a daily basis. Members of our Academy, as well as concerned clinicians at large, seek a comprehensive and integrated source of information that can contribute to their professional and personal needs. By its very nature, dentistry challenges us to provide quality care within a framework of multiple inputs and the ever-present competitive edge. Multitasking therefore becomes part and parcel of our clinical skills and any resource that can assist in making our work easier and more fulfilling should be a welcome addition.

…So understanding the needs of our patients is fundamental to our practice. *CJRDP* will keep its "eye on the ball" for you, as we explore information, procedures, technologies, and insights that can empower us.

It is therefore befitting that we underline the important contribution in this article "Relationship Based Dentistry, The 21st Century Formula for Success." Mr. Peter Barry speaks of the day-to-day "people skills" that are essential for our clinical success… – Moving to another article, "Aplasia of the Lacrimal and Salivary Glands: Case Presentation," Dr. Renald Perusse presents a rare case report detailing the genetic origins of the (ALSG) syndrome… – Also, Implant dentistry is well represented in this issue with an article dealing with the "Restoration of Posterior Implants:

Simple Techniques for the Restorative Dentists and Dental Technicians." In this case report, Dr. Doug Lobb summarizes the integration of implant supported restorations to tooth supported ceramic restorations.

By underlining our diversity, we inspire newcomers to join us in our inclusive, quality oriented outlook. In this issue, you will also read about our Academy's mission, historical background, activities and organizational structure.

Come share your vision – Your editorial team awaits your input and extends a heartfelt invitation to all. What are your most reliable sources of information? Where do you learn new procedures? How do you react to new technologies? What are some of your insights on various dental topics? How do YOU conjugate multitasking and focus? We welcome "Letters to the Editor" – Moreover, we offer a "Members News" section as an accessible means of informing and updating your colleagues. Feel free to use these features as often as you like. ***CJRDP's viability is the concern of each member…***

Dr. Hubert Gaucher

We've covered a lot of ground since that first 2008 Issue!

CJRDP/JCDRP Some Facts:

- This Journal remains the only nationally peer reviewed publication exclusively dedicated to Restorative Dentistry and Prosthodontics.
- Scholars and dental practioners alike have contributed original scientific manuscripts.
- We have received author contributions nationally from 8 of the 10 provinces and internationally, 8 countries from 5 continents.
- The paper version of the quarterly CJRDP/JCDRP is circulated to over 13,000 dentists nationwide.
- The current digital version of the Journal and its archives are available at www.cardp.ca
- All regions of Canada are represented on the Journal's Editorial Board.
- The Journal's current Publisher, Palmeri Publishing Inc. (Toronto) is the leading dental Publisher in Canada.

But we have been losing our momentum even though CARDP has a history of volunteerism and, I know for a fact, abounds with talented members.

How to bolster our Journal:

Palmeri Publishing Inc. needs to list our Journal with PubMed/Medline promptly, so that academicians, whose articles are required to be published in such databases, will seek us out.

Along the same lines, a closer collaboration with Academia endorsing our Journal's mission, will cause those dental faculties to enjoy representation on the Journal's Editorial board as well as the specific CARDP/CJRDP Awards for students and Faculty members. To this end, an Academic Liaison has been assigned to actively promote such a partnership.

Then there is the Association of Prosthodontists of Canada (APC) and its provincial counterparts, numerous dental Academies and Associations, Study Clubs, Industry/Dental Laboratory leaders, as well as individual benefactors who are all invited to become corporate supporters and listed endorsers of CARDP's Official Publication, and to voice their respective proposals for the advancement of dental reconstructive research and services nationwide.

And finally, you, our members and readers, far from the least of our assets, are expected to invest a minimal degree of energy and skill in procuring *your* Journal with articles, any length, either referred or authored by yourself, based on your own experiences (review, opinion piece, open letter, case report, clinical tips, scientific manuscript, and so on). You need not be a skilled wordsmith as we have an app for that. ☺ One short paper per annum would suffice.

It's up to you.
Steadfastly yours,

Dr. Hubert Gaucher
Editor-in-chief
hgaucher@sympatico.ca

Comments/Commentaires

Dr. Hubert Gaucher

Revoyons le message de notre journal inaugural

Contexte: Nous soulignons cette année le 50ième anniversaire de l'une des deux académies fondatrices de l'ACDRP, à savoir, l'Académie canadienne de dentisterie restauratrice (ACDR). Aujourd'hui l'ACDRP poursuit toujours la promotion et la diffusion de l'excellence dans la pratique de la dentisterie restauratrice et de la prosthodontie à travers tout le pays. Ses cours d'éducation continue et congrès annuels lui ont mérité une distinction enviable en raison de ses conférenciers de haut niveau, ses installations de fine pointe, ses excellents programmes sociaux et l'apport de ses commanditaires, tous regroupés pour favoriser des affinités parmi nos membres d'un océan à l'autre.

En 2008, par souci d'engagement envers la communauté dentaire, l'ACDRP lançait sa propre publication officielle: le JCDRP/CJRDP. Je vous invite à revoir certains extraits de son message inaugural ci-bas, qui ont donné le coup d'envoi à une tradition de collaboration et de qualité.

MESSAGE DU RÉDACTEUR EN CHEF

Polyvalence et partage de la vision: ne vous laissez pas dérouter

Ce numéro inaugural du *Journal canadien de dentisterie restauratrice et de prosthodontie* présente la diversité ainsi que les défis que les dentistes doivent relever tous les jours. Les membres de notre Académie, ainsi que tout autre clinicien, recherchent une source d'information détaillée et intégrée pouvant répondre à leurs besoins professionnels et personnels. De par sa nature, la médecine dentaire nous oblige à prodiguer des soins de qualité tout en tenant compte de multiples critères et de la concurrence omniprésente. La polyvalence devient donc une partie essentielle de nos compétences cliniques, et toute ressource apte à nous aider à faciliter et valoriser notre travail est appréciable.

Saisir les besoins de nos patients constitue le fondement de notre pratique. *Le Journal canadien de dentisterie restauratrice et de prosthodontie* demeurera donc vigilant pour vous, en explorant l'information, les procédures, technologies et connaissances dentaires pouvant enrichir l'exercice de notre profession.

Il est indiqué de souligner la contribution importante de M. Peter Barry dans son article: "Relationship Based Dentistry, the 21st Century Formula for Success" (La dentisterie fondée sur les rapports humains, la formule gagnante du 21ième siècle) qui discute de nos capacités compatissantes en situation clinique. Dans un autre article, du Dr Ronald Pérusse cette fois-ci: "Aplasia of the Lacrimal and Salivary Glands: Case presentation" (Aplasie des glandes lacrymales et salivaires: rapport de cas), l'origine génétique de ce syndrome rare est détaillée. Aussi, la dentisterie implantaire est représentée dans ce numéro avec "Restoration of Posterior Implants: Simple Techniques for the Restorative Dentists and Dental Technicians" (Restauration des implants postérieurs: techniques simples pour dentistes en restauration et techniciens dentaires) dans lequel le Dr. Doug Lobb résume l'intégration des restaurations implanto-portées aux restaurations en céramique sur dentition naturelle.

Vous trouverez aussi dans ce Journal, l'historique, la structure et les activités de notre Académie. En mettant en évidence la diversité de nos intérêts, nous attirerons de nouveaux membres qui s'associent à notre vision inclusive.

Venez partager cette vision avec votre équipe de rédaction. Quelles sont vos sources d'information les plus fiables? D'où proviennent vos nouvelles techniques? Que pensez-vous des dernières technologies? Comment conjuguez-vous la polyvalence dans votre pratique?

Exprimez-vous dans vos Lettres au Rédacteur. Par ailleurs, la section accessible «Nouvelles des membres» renseigne et tient vos collègues à jour sur les faits qui vous intéressent. Servez-vous de ces fonctions à volonté. ***La survie du JCDRP concerne chacun de nos membres…***

Dr Hubert Gaucher
Rédacteur en chef

Nous avons fait beaucoup de chemin depuis cette première parution!

JCDRP/CJRDP Quelques données:

- Ce Journal demeure la seule publication nationale revue par des pairs qui se dédie exclusivement à la dentisterie restauratrice et la prosthodontie.
- Académiciens et praticiens également ont contribué des manuscrits scientifiques originaux.
- Le Journal a reçu des articles d'auteurs provenant de 8 des 10 provinces au pays, et de 8 pays sur 5 continents.
- La version papier de notre périodique trimestriel est distribuée à plus de 13 000 dentistes au Canada.
- La version numérique actuelle ainsi que les archives du Journal se trouvent en ligne à www.cardp.ca
- Toutes les régions du Canada sont représentées sur le Comité de rédaction.
- La Maison d'édition de notre Journal, Palmeri Publishing Inc. (Toronto) est chef de file en matière de publications dentaires au Canada.

Or nous perdons notre vitesse de croisière malgré nos antécédents de bénévolat et, j'en sais quelque chose, nos membres fort talentueux.

Comment appuyer notre Journal:

Palmeri Publishing Inc. se doit de lister notre Journal dans PubMed/Medline dans les meilleurs délais, afin que les académiciens, dont les articles sont tenus d'être publiés dans de telles banques de données, nous côtoient.

Dans la même veine, une collaboration étroite avec le milieu universitaire qui appuie la mission de notre Journal, offrira en échange aux facultés dentaires, de jouir d'une représentation sur le comité de rédaction, en plus des prix d'excellence aux étudiants et enseignants. À cette fin, une personne de notre Académie est assignée en liaison avec les facultés dans le but de promouvoir des partenariats.

Puis il y a l'Association des prosthodontistes du Canada (APC) et ses contre-parties provinciales, les nombreuses académies et associations dentaires, les clubs d'étude, les représentants de l'industrie dentaire et les laboratoires, ainsi que les bienfaiteurs et mécènes, qui peuvent tous être invités à devenir membres corporatifs listés de l'ACDRP, à soutenir notre Journal officiel et à exprimer leurs propositions respectives pour l'avancement de la recherche et des services en dentisterie de reconstruction à l'échelle nationale.

Et en toute fin, mais non les moindres, vous, membres et lecteurs, avez la tâche d'investir un effort minimal pour *votre* Journal en fournissant au moins un article par année, si court soit-il, signé ou encore référé par vous. Il peut s'agir d'une revue, d'une opinion, d'une lettre, d'un rapport de cas, de trucs du métier, de manuscrit scientifique, ainsi de suite. Ne vous préoccupez pas de la prose; nous avons une application pour ça! ☺

Il n'en tient qu'à vous.
Votre dévoué.

Hubert Gaucher
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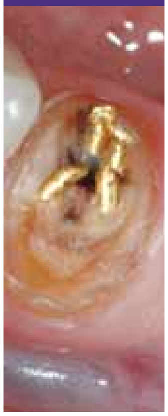
Comments/Commentaires



Dr. Dennis P.A. Nimchuk,
DDS, FRCD(C), (Certified Prosthodontist)

Iatrogenically Induced Pulpitis as a Consequence of Operative Dentistry – Preventive and Remedial Considerations

Pulpite induite Iatrogéniquement, comme une conséquence de la dentisterie opératoire – considérations préventives et correctives

Abstract

A significant percentage of teeth require endodontic therapy after dental restorative and other treatments. This article will discuss the potential for inducing adverse effects from: tooth preparation, pin placement, the application of curing lights, the use of resin based composites and bonding agents, air-syringe dessication, hyper-occlusion and the effects of chemical treatments during bonding and graft regenerative processes. Also discussed and recommended are mediative protocols that can minimize or prevent adverse effects.

Key words

Iatrogenically Induced Pulpitis, Pulp Morbidity, & Effects on Pulpitis from: Tooth Preparation, Light Curing, Direct and Indirect Pulp Capping, Threaded Pin Placement, Chemical Treatments, Tooth Whitening, Adhesive-Based Restorative Procedures, Cementum Conditioning, Traumatic Occlusion

Introduction:

While bacterial infection of the dental pulp is the primary reason for pulp inflammation and necrosis, it is estimated that a significant percentage of teeth exposed to dental restorative treatments or other dental interventions will experience iatrogenic pulpitis and that between 9 to 13% of these will experience irreversible pulpitis necessitating either endodontic therapy or tooth extractions.[1]

Pulp Morbidity:

The Dental Pulp is a highly vascular and innervated soft tissue structure whose principle role is tooth formation. Once formed however, the dental pulp continues to provide other important functions such as secretory odontoblastic activity that can form reparative dentine as a defensive response to attrition, caries and other erosive effects.[2] This highly innervated tissue also acts as an oral governing agent on noxious stimuli such as excessive thermal and acidic encounters. Because the dental pulp is encased within the non-resilient housing of dentine and enamel it is particularly vulnerable to inflammatory processes that can build up and lead to cellular hydraulic compression, morbidity and necrosis.

Effects of Tooth Preparation on Pulpitis:

Crown preparation and caries removal can place the pulp at risk a number of ways. High speed stripping of hard tooth tissue has the potential of elevating pulp temperature beyond a threshold of tolerance resulting in a disturbance of microcirculation, vascular stenosis and thrombosis.[3,4] When coronal tooth reduction encounters dentine, the dentinal tubules will be opened and a

Résumé

Un nombre important de dents demande une thérapie endodontique après la restauration dentaire, et d'autres traitements. Cet article parlera des possibilités pour induire les effets contraires, comme : préparation de la dent, placement de tenon, pratique de polymérisation par la lumière, utilisation de composites à base de résine comme agents de collage, dessiccation par air comprimé, sur-occlusion, et les effets de traitements chimiques pendant les procédés de collage et de greffe régénératrice. Également on parlera, et on recommandera, des protocoles médiateurs, qui peuvent minimiser ou prévenir ces effets adverses.

Mots-clés

Pulpite iatrogéniquement induite, morbidité pulpaire, & les effets pulpaires provenant: de la préparation des dents, de la lumière polymérisante, coiffage pulpaire directe et indirecte, tenons vissés, traitements chimiques, blanchiment des dents, procédures adhésives des matériaux, conditionnement du cément, occlusion traumatique

communication with the pulp is created. The deeper the dentine is cut away the more permeable it will become and the more vulnerable the pulp will also become to the ingress of microbial, chemical and physical irritants.[5] Exposure of the pulp to the oral bacterial flora puts it at greatest risk as bacterial contamination can cause severe inflammatory changes, resulting in micro-abcesses and progressive pulpal necrosis.[6]

While the pulp has considerable resilience to recover from irritation, cumulative repetitive injuries from caries, trauma from multiple restorative repair interventions or other traumas such as from occlusion or orthodontics may reduce the threshold of recovery due to the creation of pulpal micro-scarring to the vascular and nerve components of the pulp. An additional insult such as a crown preparation on a prior injured and predisposed tooth may be enough to cascade the pulp into degeneration with ensuing irreversible pulpitis.[7]

Because the removal of tooth material by high and low-speed produces heat from the friction between the bur and tooth substrate, it is prudent to use high volume water and air spray and high volume air suction. (Figure 1) A critical threshold temperature of 41–42°C is irreversibly harmful to pulpal tissue. A temperature rise to this magnitude should not be attainable when normal handpiece cooling water temperature of 30–34°C is effectively utilized.[8] According to Attrill et al., the maximum intrapulpal rise in temperature recorded for teeth prepared without water spray was 24.7°C, but only 3.9°C in teeth prepared with water spray.[9] (Figure 2)

According to Zach and Cohen doing in vivo studies, an intra-pulpal temperature increase of 5.5°C for 10 seconds caused histological changes in the pulp tissues, approximately 15% of which became irreversible pulpitis. When intra-pulpal temperature increases were sustained at 11.1°C for 10 seconds, there was approximately 60–70% irreversible pulpitis.[10] When using water spray in an in vitro study measuring intra-pulpal temperature increase with a 0.5 mm residual dentin thickness, Firoozmand found temperature increases of 1.8°C, 1.4°C, and 0.7°C, with a low-speed handpiece, high-speed handpiece, and laser, respectively.[11] These values are well below the physiologic

Figure 1: 4 Ports of Spray

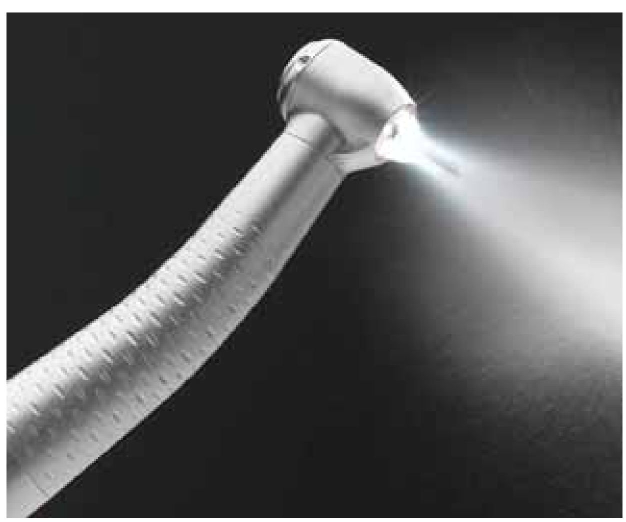


Figure 2: Spray from 4 Ports

5.5°C threshold described by Zach and Cohen so it is unlikely that thermal pulpal damage will occur unless the water spray is turned off or unless the water spray is diminished by close proximity suctioning or by water flow obstruction.

According to Baldissara, Catapano and Scotti who evaluated clinical and histological criteria, the main cause of postoperative inflammation or necrosis of the pulp is injury to the dentine.[12] It is apparent that the closer the cutting gets to the pulp the greater will be the heat effect induced.

Diamond burs generate more heat than carbide unless the carbide is worn. The difference of carbide vs. diamond selection however, appears not to be significant, if water is used.[13] However, the practice that is most likely to induce pulp damage from frictional heat arises when a worn carbide bur is used without water spray to remove last vestiges of caries and hard affected dentine, close to the pulp. This frequently used practice of shutting off water when close to the pulp can generate a significant amount of thermal injury, particularly if sustained for more than 10 seconds.[9] A more suitable and safer method of removing last vestiges of caries is by using a sharp spoon excavator.

The removal of deep caries itself has the potential for allowing microrganisms to be breached into the pulp chamber, creating a non-resolving pulpits.[14] Proliferation of bacteria in the superficial aspect of pulp tissue disorganizes the odontoblast layer and kills cells either by direct toxic action or by excessive acute inflammatory response. In some instances the pulp can withstand the microbial insult and odontoblasts will respond by deposition of new tubular dentin and deposition of mineralized intra-tubular plugs.[15]

A systematic review of MEDLINE indicates that utilizing a stepwise evacuation of dental caries that is very close to the pulp, along with a treatment lining is effective for pulp preservation by reducing bacteria and by promoting remineralization of the carious dentine.[16] The stepwise protocol, at the first visit, recommends not removing the last remnants of decay but recommends placing a layer of CaOH or other similar material prior to making a provisional restoration. Approximately nine months later, the site is re-entered and the residual caries is removed, allowing time for a reparative dentine bridge to be established.

Effects Of Light Curing on Pulpitis:

Light-curing of resin-based products also generates heat and has the capacity to increase the intra-pulp temperature high enough to induce damaging effects to a vital pulp.[17,18,19]

Tosun et al. evaluated the temperature rise in the pulp underneath caries-affected primary tooth dentine during adhesive polymerization and found it could exceed 5.5°C, (the Zack and Cohen threshold).[20] Carious dentine is normally removed during caries excavation, however, affected dentine is not usually removed, so a significant portion of a cavity wall contains caries-affected dentine.[21] This practice is significant because carious dentine or caries-affected dentine has a higher thermal conductivity when exposed to curing light energy and will generate greater heat compared to sound unaffected dentine when at close proximity to the pulp.[22] This is also the case with dental adhesives which exhibit higher temperature rises during polymerization than do the Resin-Based Composite materials (RBC's) which are placed over the adhesives.[20]

The process of light photo-activation of composite restorative materials is multi-factorial and there are several reasons which can contribute to cause a temperature rise inside the pulp chamber and which are sufficient enough to cause pulpal damage.[23,24] Polymerization of light-cured composites generates heat because of the energy absorbed during the irradiation process of the light. This, in combination with the exothermic reaction of addition polymerization that RBC's undergo creates a stepwise elevation of temperature.[25] Heat generation can be variable, depending on the intensity of the light source and on the moderating thickness of bulk placements of composite. The thicker the composite placed the less energy will reach the pulp.[26]

Another variable regarding temperature rise is the composition of the RBC itself and which is dependent on the energy density of the material used. For example Z100 with energy density of 28 J/cm^2 promoted higher temperature increases than Z250 with energy density of 14J/cm^2 when a light source of 700 W was used for the same period of time.[27] The manufacturer, (3M ESPE), recommends a cure time of 40 seconds for Z100 and 20 seconds for Z250.

Although the light source largely determines the temperature rise during curing, the heating effect also depends on the type of curing unit, the quality of the light filter, the output intensity, and the irradiation time.[28] In a study of different types of curing lights comparing LED, Quartz Halogen and Plasma Arc and exposing for the same time intervals, it is the most powerful light, the PAC unit, which registered the greatest amount of heat output.[29] The use of high-intensity PAC lights can cause increased heat generation in the dental materials being cured, potentially leading to pulpal damage. This is notably less so when using LED or QTH lights.[29,30] The practice of doubling up light-curing units to speed up polymerization doubles up the heat and should absolutely be avoided. (Figures 3, 4, 5, 6)

Adequate polymerization is a very important factor in maximizing physical the properties, clinical performance and

Figure 3: High Intensity Curing Lights

Figure 4: Heat Damage From Curing Lights – (a) Prior to Md. ¾ All-Ceramic Crowns.

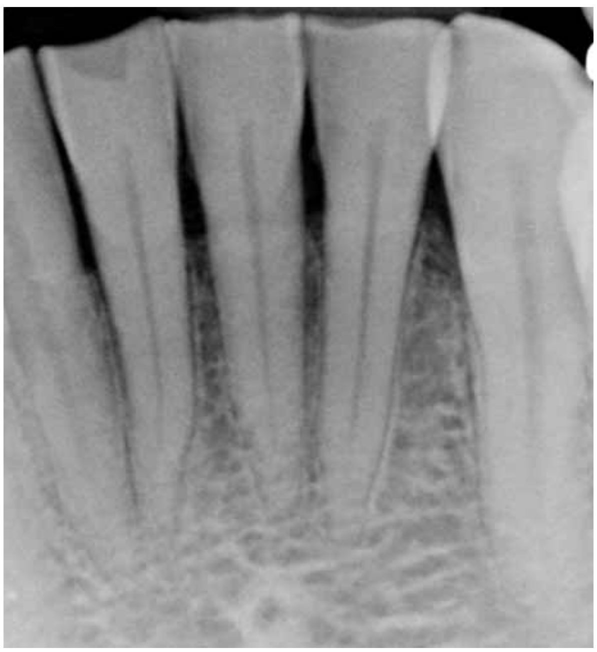


Figure 5: Heat Damage From Curing Lights – (b) Radiograph, prior.

Figure 6: Heat Damage From Curing Lights – (c) RCT's.

the biocompatibility of resin based filling materials as well as resin based luting agents (RLA's). Contemporary luting agents that are used for the cementation of etchable, all ceramic restorations for the most part, are resin-based and are either light-cured or dual-cured. Problems associated with inadequate polymerization include: inferior physical properties, solubility in the oral environment and increased micro-leakage. These factors have the potential to develop recurrent decay and pulpal irritation. As well, when RLA's are not fully polymerized, leachable components such as Bis-GMA, UDMA, TEGDMA, camphorquinone and HEMA may penetrate through dentin tubules and exert potential pulpal injury and inhibit pulp tissue repair, a cytotoxic effect.[31,32] Chen et al. have shown that the resin based components of dentine bonding agents also pose a cytotoxic effect, exerting potentially harmful effects to the pulp.[33]

The degree of conversion (DC), when using light-cured, filled, composite materials or when using light-cured or dual-cured luting agents can be highly variable giving values from 55% to 75% depending on the chemical composition of the material and on the light source used.[34,35,36] If the polymerizing light is impeded by restoration material opacity, or by access, or by bulk, then a dual-cure composite or dual-cure luting cement may be a more appropriate consideration.[37]

Recommendations to Reduce Deleterious Effects to the Pulp During Tooth Preparation and Caries Removal, and When Using Curing Wands During the Placement of Composite Restorations, Dentine Bonding Agents, and Resin-Based Luting Agents.

Dentists should give careful consideration to the manner in which enamel and dentine stripping is made, particularly when tooth reduction approaches the dental pulp. Care should also be given to the choice of LCU when curing light-activated bonding agents and restorations in deep cavities, close to the pulp. Care should also be given to reduce the amount of time curing lights are activated. Most high intensity lights, particularly new generation, high intensity LED's can generate enough heat to burn anaesthetized mucosa if the time exposure is high and there is proximity. Notwithstanding, enough light should be transmitted to accomplish adequate resin polymerization conversion. The following are guidelines that can be used to reduce operative damage to the dental pulp and perhaps the unfortunate necessity to undertake endodontic therapy.

1. *Use new, sharp burs and diamonds for gross tooth reduction and for internal caries removal.*
2. *Use handpieces that have concentric running chucks and use burs that do not wobble.*
3. *Use high-volume water coolant spray along with high volume suction when performing any tooth preparation or caries removal. Do not cut dry!*
4. *Use handpieces with at least 3 or preferably 4 water ports so that if one side is obstructed, coolant will still reach the burr.*
5. *When removing caries near the pulp use sharp spoon excavators rather than burs or diamonds.*
6. *Use a stepwise caries removal protocol when caries is very near the pulp.*
7. *When using bonding agents on dentine that is close to the pulp, keep the curing light further away from the tooth and do interval curing rather than long concentrated exposures.*
8. *Use a pulp-covering/capping agent on dentine when in close proximity to the pulp to reduce the cytotoxic effect of dentine bonding agents and resin based luting agents.*
9. *Use high-energy composites that cure in a shorter time and according to manufacturers recommendations.*
10. *Use moderate energy LCU's; either LED or QTH rather than PAC units but of an output adequate to effect high polymerization conversions.*
11. *Do not use two curing wands simultaneously to accelerate the polymerization process.*
12. *Whenever light exposure may seem to be excessive use, an air syringe and a high-volume suction as a cooling mechanism.*
13. *Place your light wand against your ungloved fingernail bed and expose for 2 or more cycles to appreciate the degree of heat generated.*
14. *Use dual-cure luting agents instead of light-cure luting agents whenever there is doubt about the degree of polymerization conversion.*

Indirect and Direct Pulp Capping:

Direct pulp capping (DPC), is a procedure of covering an area of *exposed* vital pulp with one or more bioactive materials to preserve pulp integrity. The intention is to induce a reparative dentinogenic response to seal off a pulpal wall breach by the formation a bridge of reparative hard tissue.[38] A successfully sealed-off zone of dentine repair can obviate the need for root canal treatment and the possible sequelae of tooth loss. (Figure 7)

The indirect pulp cap, (IPC), is a procedure where an application of a layer of a specific material is made over a deep dentine zone of close, but not actual pulpal exposure in order to protect the pulp against further operative interventions, bacterial ingress or against the potential toxicity from various restorative materials.

The practice of making a pulp cap originated with Philipp Pfaff as far back as 1756.[39] In contemporary practice there are a wide variety of pulp capping materials such as CaOH (Dycal, Kerr-Sybron), (MTA) cement (ProRoot, Dentsply), Biodentine (Septodont) and TheraCal (BISCO Dental Products), that can be utilized. There is considerable research data available regarding the cytotoxicity and antimicrobial activity of these various capping agents as well as their methodology of use. A bioactive pulp capping material optimally should have a requisite biological compatibility *plus* the ability to generate a protective and recuperative response against pulp irritation and pulp

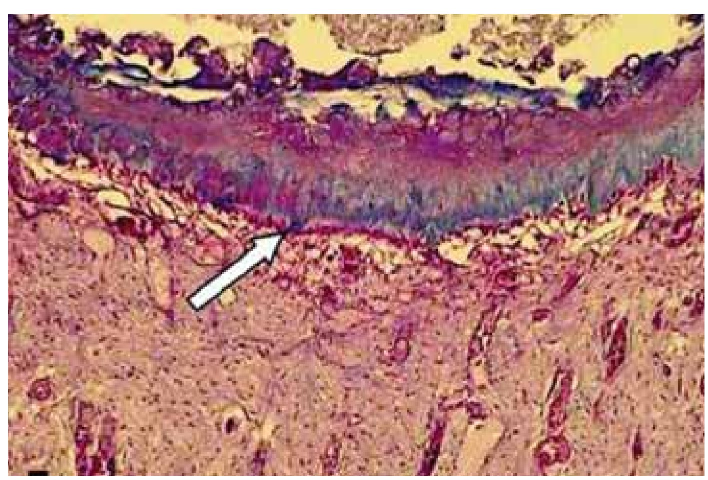


Figure 7: Pulp Cap Repair With Odontoblast Layer Under Repair Bridge (after da Silva Modena).

degeneration.[40,41] CaOH has been used for decades with successful but imperfect or unpredictable results.[42] Currently, there are several new materials that show evidence of stimulating the dentine to develop the bridging of defects by apatite formation and which do so more effectively than CaOH. These materials utilize calcium silicates or calcium aluminates and have been shown to be less cytotoxic and have better antibacterial properties than CaOH. These newer materials are considered to be more bioactive.[41,45]

Dycal has shown an ability to stimulate the pulp to lay down reparative dentine. This however, may not be due to the bio-inductive capacity of the material; rather it is more likely due to the result of a defense mechanism by the pulp induced by the inherent, irritant nature of calcium hydroxide.[43] The toxicity of Dycal, a high alkalinity, self-setting (2.5-3.5 min) radiopaque calcium hydroxide-based material has been employed in direct and indirect pulp-capping procedures and its shortcomings have been well established.[44,45] Dycal, while widely used in dental practice for a very long time as the protective layer of choice, has two additional disadvantages besides its relative toxicity: poor adhesion to dentine and a significant solubility factor that over time creates dissolution. These two factors are responsible for allowing avenues of progressive micro-leakage to the pulp as well as the creation of voids or defects ("tunnel defects") in the reparative dentine under the capping layer.[46]

MTA, Mineral trioxide aggregate, has a composition similar to that of Portland Cement. Both are composed of calcium phosphate, calcium, and silicon oxide. MTA is a powder that contains trioxides and hydrophilic particles that allows the material to set in the presence of moisture. It is applied as a paste or putty depending on how much sterile water it is mixed with. MTA, additionally, contains bismuth oxide, which provides some radiopacity. It has an enhanced interaction with dentine pulp tissue compared to CaOH showing faster and more complete dentine bridge formation[47,48] as well as significantly less cytotoxicity.[45] While MTA has been shown to be a reliable and biocompatible pulp capping and dentin sealing material, its formulation and chemical curing, plus its very long clinical setting time, make it an inefficient material to use routinely for restoration lining or as a pulp capping material.[49]

Biodentine is a powder-liquid material having chemistry similar to MTA. The powder contains tricalcium silicate, dicalcium silicate, calcium carbonate, and zirconium oxide; the liquid contains water, calcium chloride (accelerator), and modified polycarboxylate. Biodentine, like other silicate based materials rates low in cytotoxicity.[45] It does sets somewhat faster than other calcium-silicate cements like MTA, but still takes beyond ten minutes of set time when used as a pulp cap before a restoration can be placed over it. This, in addition to the capsule based tituration preparation makes for clinical inconvenience compared to other materials.

TheraCal is a new category of resin-modified calcium silicates based on a light-cured, resin-based, single-paste system. TheraCal consists of CaO, calcium silicate particles (type III Portland cement), Sr glass, fumed silica, barium sulphate, barium zirconate and resin, containing Bis-GMA, and polydimethacrylate. It is a highly radiopaque lining and capping material designed to release calcium to promote the formation of reparative dentine.[50] The biologic availability of calcium ions supplied from a pulp capping or lining material is integral to stimulating pulp cells to form new mineralized hard tissue. This is the basis of the success of CaOH as well as the more recently introduced silicate based products.[51,52,53] TheraCal shows the highest Ca availability of all tested materials.[54] TheraCal also has distinctive application advantages over other materials in that it is supplied directly from a paste container and then light polymerized to form an almost instantaneous hard, secure and low-solubility barrier over which a restorative material can be immediately placed.

The objective of vital pulp therapy is to maintain the pulp vitality and its function. Several factors influence the success of direct pulp capping such as carious contamination, the age, vitality and regenerative power of the pulp, the materials and technique used to perform the procedure and the ability to control pulp bleeding in a physiologic way. If pulp bleeding cannot be controlled, it is difficult or impossible to create a wound seal that would allow intimate contact of the capping material to the pulp tissue. If a blood clot is left on the surface without direct contact of a bioactive capping material, a chronic inflammatory response impairing the healing process will ensue.[55,56] Control of pulp bleeding is usually attempted by placing a cotton pellet soaked in a solution onto the bleed site. A variety of solutions have been used, including saline, sodium hypochlorite (concentrations ranging from 0.12% to 5.25%), hydrogen peroxide, ferric sulfate and chlorhexidine. Saline or calcium hydroxide solutions are the most benign to the pulp in performed cytotoxicity tests.[57] Saline exhibits the mildest pulp response but is only moderately hemostatic. Sodium hypochlorite is effectively hemostatic plus has the benefit of being antibacterial, but it is more cytotoxic and will induce a pulpal inflammatory response that fortunately in most cases is transient. Chlorhexidine is antibacterial but is not very effective at hemorrhage control. Ferric Sulfate is highly hemostatic but is seriously cytotoxic, creating post-operative pulpal pain and is not recommended.[58] Ankaferd Blood Stopper (ABS) is a new

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hemostatic agent derived from herbal extract that has been shown to be as effective as ferric sulfate. It has been proposed for bleeding control of exposed pulps but there is very little research on it and its cytotoxicity on the pulp is not well established.[59]

Recommendations on Vital Pulp Lining and Pulp Capping:

Dentists should recognize that the dental pulp has good recuperative powers even when it becomes exposed, but they should also be aware that a carious exposure of the pulp significantly reduces the probability of pulp survival and that when bacterial contamination occurs, root canal therapy, should be considered. In the case of an operative created exposure with no contamination, pulp capping can have a high incidence of success, particularly if best protocols and materials are utilized.

1. *If the pulp bleeds, the bleeding needs to be arrested so that the capping material can attach or be secured in a stable way around the perimeter of the exposure. As a first pass, use a cotton pellet moistened with saline solution and very gently compress for a few minutes. If bleeding continues repeat the process using NaOH which is more cytotoxic, but not overtly so, if judiciously used.*
2. *When ready for capping, apply a thin lining of TheraCal which is confirmed to be bioactive, sets immediately on light activation, and has enough stability to receive a hydrophilic self-etching dentine adhesive followed by a restoration directly over it. Blot off moisture but do not dessicate the area before applying the TheraCal layer.*
3. *Do not use high heat generating wands to cure the layer and for the same reason do not exceed the minimal time needed for polymerization. A gentle supplement of air syringe during curing can help keep the heat from the light at minimal.*
4. *As a protective liner use the same protocol as in No. 2 & 3, assuming there is no pulp bleed.*

Effects of Threaded Pin Placement:

Threaded and cemented pins or dentinal micro-screws are commonly used in restorative dentistry to enhance the retention and stability of restorative dental materials. According to Segovic et al. (2002), the insertion of self threaded pins causes micro-cracks in the dentine slightly in excess of 50% of cases. However, there is very little information published on the effects that pin placements have on the dental pulp or on the structural integrity of the tooth or on the significance of the micro-cracks induced. On the other hand, it is reasonable to presume that pin placement into the pulp will create an inflammatory response due to the mechanical insult and it is probable that unless the pin channel is otherwise sealed it may act as a path of ingress for bacterial leakage. If the penetration into the pulp is superficial and the wound in not bacterially infective, it is reasonable to assume that the pulp may respond by creating an isolating, reparative zone of dentine. It is also reasonable to expect that if there is pin perforation into the periodontium there will be a localized inflammatory response that may create a chronic periodontal condition.

Recommendations on Pin Placements:

The use of retention pins to stabilize coronal restorations in vital teeth poses some risks, particularly when they are placed in narrow diameter teeth such as maxillary laterals and mandibular incisors. Careful consideration should be given to the, type of pin placed, the diameter of the pin, the placement location, the number of pins and the risk versus benefit of utilizing pins.

1. *Use sharp drills on ultra-low rpm's to create the pin channel so as not to induce heat or dentine crazing.*
2. *Choose to locate the drill holes at the 4 line angles of the tooth where pin placement will be most remote from the pulp. An exception is the mesial-buccal line angle of the maxillary first molar where there is a pronounced pulp horn.*
3. *Self-shearing, straight pins are imprecise for bottoming out or not. Pins with a coronal depth-limiting flange are more accurate and may be less likely to create dentine stress.*
4. *If a pin must be bent, use a pin-bending tool to minimize the torque that will be transferred to the tooth structure.*
5. *Consider the use of cementable pins that are passive, compared to self-tapping pins. Use a cement that is minimally cytotoxic such as conventional glass ionomer compared to resin. A cemented pin will also create a pin channel seal to resist possible bacterial micro-leakage.*
6. *Follow the contour of the root when aligning the drill to minimize the risk of external perforation. (Figure 8)*

Effects of Chemical Treatments to Enamel, Dentine and Cementum:

The application of chemicals onto and into teeth is an integral part of what clinical dentists do in everyday practice. Tooth whitening is one of the most commonly used examples of chemical application in dentistry. It utilizes hydrogen peroxide or carbamide peroxide in the dental setting, but these agents are also sold over the counter (OTC) for home use. In operative dentistry various other substances are also utilized as conditioning agents to prepare enamel, dentine and cementum for remedial treatment enhancement. Agents such as phosphoric acid and

Figure 8: Four Pins Placed at the Axial Line Angles.

citric acid are used for conditioning enamel and dentine prior to adhesive bonding. Sodium hypochlorite, EDTA and citric acid are commonly used in endodontic procedures. Tetracycline HCl, EDTA and citric acid are used for conditioning cementum prior to connective tissue grafting procedures. Many of these agents are cytotoxic and can possibly be harmful as well as beneficial.

Effects of Tooth Whitening:

It is a widespread elective practice to whiten teeth by applying different agents to the surfaces of teeth for cosmetic purposes. Hydrogen peroxide, sodium perborate and carbamide peroxide are the principle products used for tooth bleaching purposes. Side effects, such as changes in the tooth structure, gingival burns, micro-leakage in restorations, tooth sensitivity and pulpal irritation all have been reported when using these agents.[60,61,62] The greatest negative consequence, however, may arise in utilizing powerful light units to activate powerful 35% to 50% hydrogen peroxide based bleaching agents.[63] Heat application seems to be effective in potentiating the bleaching effect of tooth whitening agents compared to cold light which has been shown to be relatively ineffective.[64] Halogen, LED and LED Laser lights all have the potential to raise the intra-pulp temperature.[63] Temperature elevations of 5.6°C or greater can cause pulpal damage and may result in necrosis in 15% of cases, depending on pulp health its physiological response capacity.[10]

In an in vitro study, Carrasco et al. determined that of the three contemporary light systems tested, the halogen light generated the most heat but when bleaching gel was applied the gel actually acted as a modulator of heat production diffusing its effect. LED and LED Laser units produce notably less heat than halogen. However, the heat increases into the pulp chambers for all units tested, including halogen, were deemed unlikely to be injurious to pulpal health because they did not exceed the 5.6°C threshold even though the in vitro study did not factor on the effect of blood circulation in the pulp chamber which could account for a greater intra-pulp temperature rise than the study showed.[65] The most common effect of tooth whitening is post treatment cervical tooth sensitivity which ranges in incidence from 15 to 78% with the highest rate resulting from the combination of 30% hydrogen peroxide used in combination with heat.[66]

The success of whitening procedures is directly related to the ability of bleaching agents to penetrate enamel and dentine. Recent studies have shown that both hydrogen peroxide and carbamide peroxide are capable of penetrating enamel and dentin and will enter the pulp chamber.[67,68] The higher the concentration of these products and the longer the application, the higher is the penetration into the pulp chamber.[69] While *in vitro* studies show a significant penetration of peroxide into the pulp chamber, in vital pulps it is postulated that pulpal fluid pressure is capable of reducing inward diffusion of these and other chemicals so as to diffuse potentially harmful effects. This factor along with the other defense mechanisms of the pulp are apt to significantly reduce the level of hydrogen peroxide penetrating into the pulp and which therefore are not expected to develop into any permanent, negative outcome.[70]

A number of studies have been made regarding the effect of bleaching agents on the CEJ with analysis of the effects of erosion and abrasion and cervical sensitivity. The majority of studies have shown that at-home bleaching agents based on hydrogen or carbamide peroxide have no harmful effects on enamel and dentin properties. Cervical sensitivity in most instances can be controlled by the application of fluoride or desensitizing agents.[71,72] The greatest post-operative sensitivity is generated by in-office applications of 35% hydrogen peroxide based products particularly when used in combination with heat based curing lights.[73]

Post-bleaching sensitivity differs from dentin hypersensitivity because it is related directly to the penetration through the enamel of the sub-products of the bleaching gels into the dentin and pulp tissue, causing reversible pulpitis and thermal sensitivity, but not causing permanent damage to the pulp. The degree of post- operative pain is dependent on the peroxide concentration, time, frequency of gel application, and the degree of pulp temperature rise with light activation.[74,75]

Recommendations on Tooth Whitening:

Tooth whitening is a socially driven, elective procedure that in most instances is simple and effective and relatively inexpensive. It is therefore a popular treatment that is requested and performed *by most dentists and it is also available as an over the counter product that can be used at home. Because tooth whitening is so common there is the belief that it is absolutely safe. For the most part this is true but vital tooth bleaching can be subject to overuse and abuse.*

1. *Use high concentration hydrogen peroxide bleaching products with care and discretion. Avoid using on adolescents who are more susceptible to post operative sensitivity or on adults with gingival recessions and erosions. Use with rubber dam and soft tissue barrier protection agents.*
2. *Avoid the use of lights that create heat. Recognize that non heat-generating lights have limited benefit.*
3. *Use according to the manufacturers recommendations for duration and frequency. Results are time and concentration dependent, so weaker concentrations over more time may be more appropriate than strong and fast. Do not over-prescribe or abuse these products.*
4. *Use fluoride treatments or other agents to alleviate post-use sensitivity.*
5. *Instruct the patient on proper protocol with take home or OTC products.*

Effects of Conditioning to Enamel and Dentine in Adhesive-Based Restorative Procedures:

Effective adhesion to tooth substrate is the basis for using contemporary composite resins as a restorative material and as a luting agent. This process depends on creating a suitable micro-retentive surface on enamel or dentine. On both enamel and dentine, this works best by conditioning (etching) the surface with a phosphoric acid gel of approximately 32-37% concentration (pH < 1.0) for about 20 seconds and then rinsing with water. On enamel, the phosphoric acid will create an etched micro-retentive surface directly onto the prismatic mineralized surface to which the bonding agent will directly and effectively attach with an adhesive strength of around 45 MPa.[76]

On dentine, which has much greater percentile organic composition, the acid works by removing the smear layer to expose dentinal tubules into which the hydrophilic resin primers will penetrate and then be polymerized creating an adhesive, hybrid zone.[77] An effective hybrid interface in dentine will create adhesive values of around 40 MPa. While the process of conditioning is effective, some concern has to be given to the possibility of a cytotoxic effect when using a relatively strong acid product close to pulp tissue. Conditioning applied for 15-20 seconds onto a very thin layer of dentin only slightly affects the blood supply to the dental pulp; however, prolonged etching time for 60 seconds results in immediate failure of microcirculation in the dental pulp of rats.[78,79] An *in vivo* testing of direct acid etching in deep dentine sites, followed by a bonding agent, creates inflammatory and degenerative pulp responses compared to placing a protective bioactive lining prior to using a self-etching adhesive agent.[80]

Recommendations On Pulp Protection When Dentine Bonding:

Dentine bonding is universally used in dental offices throughout the world because for the most part it is safe and effective. However, there are a number of issues pertaining to bonding in deep dentine or when bonding over an exposed pulp. If the pulp is exposed and there is bacterial invasion, endodontics is almost always a necessity. If the pulp is not exposed it must be protected from the effects of etching, the application of adhesive resins and the future possibility of micro-leakage. Each of these events individually, or together, can be injurious to the pulp. Protection layering over the pulp must also be resistant to degradation due to hydrolysis and the overlying restoration must protect the pulp by creating a dependable perimeter seal that will also resist micro-leakage.

1. *Prior to total-etching or one-step etching onto an exposure or in a deep dentine zone, a thin layer of a suitable biocompatible and bioactive liner such as TheraCal should be used. TheraCal has the ability to rapidly create a hard, well-sealed, light-activated, resinous capsule over the pulp area.*
2. *The best protocol for adhesive bonding over the capped area is with a "total etch" and rinse, 4th generation, bonding which will use a hydrophilic primer for effective penetration of the resin into the exposed dentinal tubules, followed by a secondary hydrophobic layer primer that will give maximum protection against water-tree hydrolytic degradation and then over which a universal bonding agent can be used. It is important that the dentine in this protocol is not dessicated, or the bond will not be very effective.*
3. *Alternatively, an 8th generation single step universal adhesive can be placed over the capped area. The universal adhesives of this generation will help to recondition over-dessicated dentine. This simplified procedure, while not as good as the 4th generation protocol, will deliver very adequate adhesion and protection and will reduce post-operative sensitivity. Two products that are representative of this system are: Bisco Universal Adhesive and 3M ESPE ScotchBond Universal Adhesive.*
4. *When light-wand curing the primer layer and the adhesive layer, remember that output strength of the light, plus*

proximity, plus time, cumulatively can potentiate a harmful effect to the pulp. Short, but adequate exposure time with moderate light output therefore is more suitable. If necessary, air syringe adjunct cooling can be used.

5. *Because 8th generation, single step adhesive agents are only mildly acidic, it is unlikely that peripheral enamel will be etched adequately to create a good marginal restoration bond that will resist micro-leakage. It is therefore recommended that a bead of 37% phosphoric acid gel be applied to regions of enamel that will be in contact with the composite restorative material.*

Effects of Conditioning of Cementum in Periodontal Therapy:

Root conditioning for periodontal treatments is somewhat controversial but remains a standard procedure that is performed prior to applying connective grafts to be able to obtain cementum root coverage with soft tissue. Cementum is a mineralized tissue layer that has as its primary function the insertion of periodontal ligament fibers onto the root surface. This suspensory fiber apparatus acts as a proprioceptive agent that governs the functional and parafunctional forces elicited from teeth to the surrounding alveolar bone.

Root surfaces of periodontally diseased teeth are hyper-mineralized and contaminated with organisms, endotoxins and other biologically active substances.[81] Biomodification of root surfaces and removal of the smear layer and debris is deemed critical for regeneration of the periodontium.[82] Removal of all bacterial components by meticulous root planning is not enough because the resultant and residual smear layer will prevent the new attachment of periodontal fibers and will inhibit the migration and proliferation of fibroblasts.[83]

There are many agents such as phosphoric acid, EDTA, tetracycline HCl and citric acid that can be used for the biomodification removal of the smear layer of root surfaces following debridement. All of these products are effective but Citric acid is the commonly used because it is highly effective, readily available and inexpensive. The most effective concentration and method of applying citric acid gel is to use it at the 25% concentration (pH 2.2) with a brushing technique for 1-3 minutes.[84,85,86]

Citric acid is cytotoxic to the dental pulp. Chan et. al. investigated the cytotoxic and cytostatic effects of citric acid on cultured dental pulp cells which when exposing the cells to pure 1% citric acid (pH = 2.26) for 60s caused immediate cellular death. The authors recommended judicious care of using citric where it can come into direct contact with the dental pulp.[87,88]

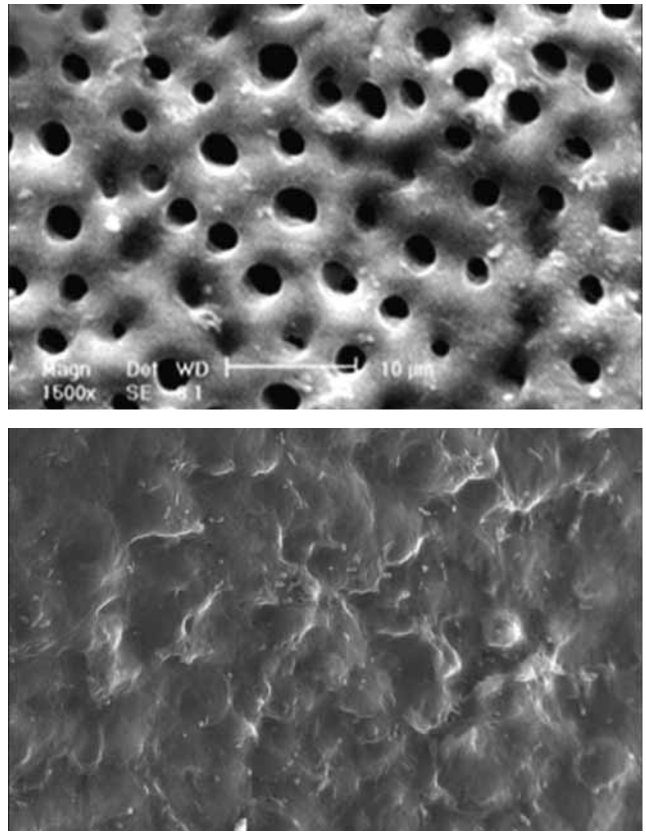

Figure 9: Citric Acid Effect on Dentine (above) and on Cementum (below).

Other authors have shown that citric acid, in low concentration, placed into cavities on the pulp demonstrated transient pulp inflammation but no severe or irreversible damage.[89]

There is little investigation of the effects of very high concentration citric acid with its low pH on the pulp when used as a root surface conditioner but the few available studies indicate that citric acid does not penetrate into the dentinal tubules nor does it alter the collagen content of the roots obtained by scaling and root planning,[89,90] nor does it seem to have an adverse effect on regenerative fiber healing or on bone regeneration.[91] While there seems to be no deleterious effect to the pulp and the vitality of the tooth, low PH citric acid will have an immediate (within 20 s) necrotizing effect on both mucosal flaps and surrounding periodontal tissue so care should be taken to avoid soft tissue contact.[92] (Figure 9)

Recommendations On Using Citric Acid To Condition Cementum:

Epidemiological studies show that more than 50% of the population have one or more sites with recession of at least 1 mm.[93] Loss of gingival root coverage predisposes the root to erosion and to loss of esthetics; so there is an indication and a need and for remedial procedures. The most common, current, surgical method to re-establish lost gingival form and coverage, is by using connective

Figure 10: Occlusal Trauma on 3.1 and 3.2

Figure 11: Periapical Periodontitis From Occlusal Trauma.

tissue grafts harvested from the palate by pouch technique and then installing them over a recipient sites by a tunneling technique so that the graft is covered by a vascularized zone of epithelialized tissue with undetached papillae. Prior to transferring the donor grafts, the exposed root areas are usually conditioned with EDTA, tetracycline HCl or citric acid to enhance the attachment of the graft as per the method described following. Because citric acid can be harmful to the soft tissues due to the low pH, care must be taken to minimally expose it to the soft tissues.

1. *Preparing an optimum surface for graft attachment requires a mechanical debridement of all calculus, plaque and bacterial components from the root surface by using ultrasonic instruments or hand scalers. This is followed by an application of a conditioning medium to remove the smear layer. Studies have shown this is most effectively accomplished by rubbing a 25% concentration of citric acid with a small cotton pellet or with a bonding-application brush onto the root area for approximately 2-3 minutes. It is important to avoid solution contact with the mucosal tissues. Wash with saline and blot dry.*
2. *It is common to apply enamel matrix protein, i.e."Emdogain" (Straumann) to enhance periodontal ligament fibroblast proliferation.*
3. *Apply and position the CT graft and suture to secure the graft.*
4. *Instruct to avoid brushing the site for 1 week and use chlorhexadine as a mouthrinse, bid. Avoid flossing for 4 weeks. Do not probe for 6 months.*

Effects of Traumatic Occlusion On Pulpitis and Pulp Degeneration:

It is recognized that repetitive micro-traumatic forces on teeth can cause tooth migrations and periodontitis. It has also been considered that parafunctional forces, when sustained, may be a contributing factor to pulpitis, and to the pulpal degeneration of teeth along with accompanying apical periodontitis.[94] Review of the literature reveals a paucity of studies about the reaction of dental pulp to occlusal forces but other related traumatic forces such as orthodontic intrusive and extrusive forces have been shown to affect the dental pulp by creating inflammatory vascular changes.[95,96] Orthodontic forces have been shown to cause edema and odontogenic degeneration of the pulp by compromising the apical blood supply.[97,98] Generally, in the first few days after activation of an orthodontic appliance, patients will often suffer transient pulp ischemia, causing pain and discomfort. Usually these symptoms settle within a week, but pulp death following orthodontic treatment is occasionally reported.[99]

Kvinnsland et al. did rat studies creating hyper-occlusion and using fluorescent microspheres to detect blood flow. They found that teeth on the hyper-occluded side had an increase in pulpal blood flow.[100] Lui did a clinical analysis of 19 cases where pulpitis could not be explained except by traumatic occlusion and after he performed occlusal adjustment found that 6 teeth resolved but 13 required endodontic intervention.[101] Shi et al. attributed 100 teeth in 89 cases having pulpitis with apical periodontitis to traumatic occlusion. All teeth were caries free and without dental or periodontal disease but all had distinct evidence of marked occlusal trauma.[102]

Okeson in his textbook, *Management of Temporomandibular Disorders and Occlusion*, states that "On occasion, patients come in with pulpitis that has no apparent dental or periodontal etiology… When all other etiologic factors have been ruled out, one must consider heavy occlusal forces … chronic pulpitis can lead to pulpal necrosis." (Figure 10, 11)

Recommendations On Managing Site-Specific Trauma to Teeth.

Occlusal dysfunction can manifest into a number of pathologic symptoms such as temporomandibular joint disturbances, myofunctional disturbances and disturbances to the teeth and periodontium. Tooth fractures, tooth wear and tooth hypermobility *and periodontitis are common consequences of excessive, ongoing loading on teeth. Occlusal trauma may also create pulpitis, particularly if there are other predisposing conditions such as concomitant periodontal involvements or abrasion into dentine.*

1. *During routine examinations test each tooth with soft percussion to see if periodontal support has been altered and if there is a differentiation of periodontal stability from other teeth. Keeping a finger on one side while gently tapping on the other side can proprioceptively identify changes in the stability of the periodontal membrane. If a particular tooth seems hypermobile consider providing occlusal relief by selective adjustment.*
2. *Identify sites of aggressive individual tooth wear. If there is dysfunctional occlusal trauma and the periodontium is resistant, excessive faceting or wear may indicate a specific site of trauma. Again, selectively adjust the tooth as a preventive therapy.*
3. *Identify sites where opposing occlusal materials are incompatible, such as where antagonistic ceramic or other materials that may be wear resistant are positioned against a natural tooth or restorative material that is less hard and less wear resistant. Selectively adjust the wear resistant material and polish very smooth.*
4. *Consider the use of nocturnal anti-bruxing guards that will splint teeth and provide a platform to create an equilibrated occlusal contact pattern and will ameliorate the wear on the occlusal surfaces of teeth.*

Conclusions:

Operative Dentistry, while well intentioned, may have the adverse effect of creating harm instead of benefit. Procedures that generate excessive heat and materials that are cytotoxic can irritate the dental pulp and create pulpitis conditions that may not be reversible. This is particularly relevant as procedures and materials encroach on and are applied closest to the pulp. This article has attempted to identify those factors that have the potential to create irreversible insult to the pulp and has attempted to provide guidance for minimizing unwanted harmful events.

The extensive Bibliography for this article can be accessed on the digital version of the CJRDP at www.cardp.ca — page 69

L'importante bibliographie pour cet article peut être consulté sur la version numérique du JCDRP à www.cardp.ca — page 69

About the author

Dr. Nimchuk is a Certified Prosthodontist. He has been a director and mentor to over twenty continuing education Study Groups in the field of Fixed, Removable and Implant Prosthodontics. He has been a Honourary Sessional Lecturer at the Faculty of Dentistry, UBC for over 15 years. He has given over 700 lectures worldwide and has authored numerous articles. He is the holder of an "Alumni of Distinction" award from the University of Toronto, Faculty of Dentistry. He is an Associate Editor of The Canadian Journal of Restorative Dentistry and Prosthodontics.

Conflict of Interests: The author reports no conflict of interests

Comments/Commentaires

Reconstruction of the atrophic ridge :
Augmentation versus use of narrow diameter implants

Lecture and Hands-on with Prof. Ziv Mazor, DMD

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Prof. Mazor is an internationally renowned speaker and author in dental implantology, acclaimed worldwide for his innovative approaches in cutting-edge procedures and technologies. Graduated from the periodontal dept. at the Hadassah School for Dental Medicine in Jerusalem, he maintains a private clinic specialized in periodontal and implant dentistry. Engaged in clinical research in the field of Bone Augmentation and Sinus Floor Elevation, he is currently participating in the quest for improving and evaluating new grafting materials, using various growth factors. He is part of the continuing education faculty at the New York University, an Associate Professor at Titu Maiorescu University in Bucharest and conducts advanced international implantology courses and workshops.
Prof. Mazor is an active member in AAP (American Academy of Periodontology), AO (Academy of Osseointegration), EFP (European Federation of Periodontology), ICOI (International Congress of Oral Imlantologists), among others.

Course Abstract:

Current concepts in implant dentistry dictate that implants be placed in relation to the anticipated needs of the restoration, rather than the availability of bone. Achieving a harmonious balance between functional, biologic and esthetic imperatives requires that the alveolar housing be restored to normal parameters of height and width. The maxillary posterior edentulous region presents a challenging condition for dental implant placement. Alveolar bone resorption and increased pneumatization of the sinus cavity reduce the amount of alveolar bone necessary to maintain a predictable implant- supported prosthesis.
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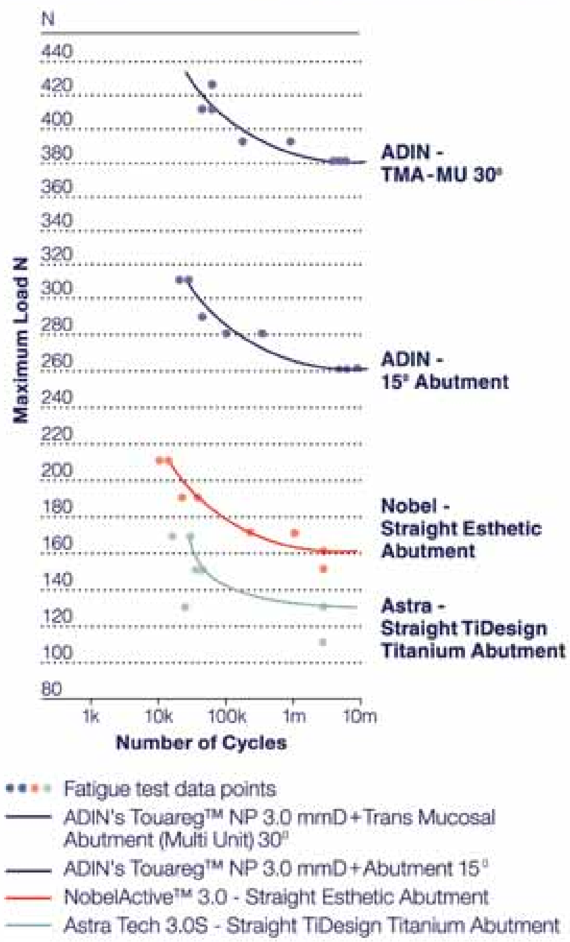

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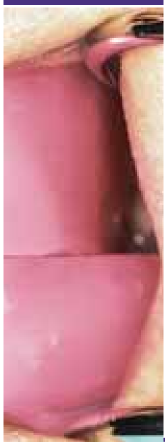

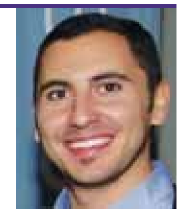

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Occlusal vertical dimension for complete removable dental prostheses

Dimension verticale de l'occlusion pour prothèses dentaires amovibles complètes

Abstract

Statement of Problem: Despite scientific and artistic advances in the restoration of an edentulous mouth, determining the occlusal vertical dimension (OVD) for complete removable dental prostheses continues to be a challenging and subjective task.

Purpose: This article reviews the different methods available to determine the OVD for complete removable dental prostheses.

Material and Methods: A review of the literature was performed to discuss the rationale and applications of the different methods for determining the OVD for complete removable dental prostheses

Results: Several methods for determining the OVD are described with different levels of reliability and complexity. It is difficult to recommend one single method.

Conclusion: A combination of different techniques may provide the most reliable method for determining the OVD for complete dental prostheses.

CLINICAL IMPLACTIONS

The establishment and recording of the OVD for complete removable dental prostheses plays a major role in providing reliable esthetics and function.

Key words Complete removable prostheses, Determining the Occlusal Vertical Dimension (OVD)

Introduction

The occlusal vertical dimension (OVD) is defined in the Glossary of Prosthodontics terms as "the distance measured between two points when the occluding members are in contact".[1] It is established by the natural teeth when they are present and in occlusion. In edentulous patients, the OVD is established by the vertical height of the two dental prostheses when the denture teeth are in contact. The establishment and recording of the OVD is a crucial step in the fabrication of dentures for edentulous patients. It determines the esthetics and occlusion,[2] and it influences the patient's perception and acceptance of the prosthetic treatment.

The purpose of this paper is to review the different methods available to determine the OVD for complete

Résumé

Le problème : Malgré les avancées scientifiques et artistiques dans la restauration des bouches édentées, déterminer la dimension verticale de l'occlusion (DVO) pour des prothèses dentaires amovibles complètes, reste un défi et une gageure.

L'objectif : Cet article passe en revue les différentes méthodes disponibles pour déterminer le DVO des prothèses dentaires amovibles complètes.

Matériel et méthodes : un examen des écrits à ce sujet a été prescrit afin de discuter du rationnel et des applications de ces différentes méthodes, qui déterminent le DVO des prothèses dentaires amovibles complètes.

Résultats : Plusieurs méthodes pour déterminer la DVO sont décrites, à différents niveaux, de fiabilité et de complexité. Il est ainsi difficile de recommander une méthode plutôt qu'une autre.

Conclusion : Une combinaison des différentes techniques peut apporter une méthode des plus fiables, pour déterminer la DVO des prothèses dentaires complètes.

Implications cliniques

L'établissement et l'enregistrement de la DVO pour les prothèses dentaires amovibles complètes, jouent un rôle majeur, en apportant un fonctionnement et une esthétique fiables.

Mots-clés

Prothèses complètes amovibles, Détermination de la Dimension verticale de l'occlusion (DVO)

removable dental prostheses. The first part includes a literature review of the different techniques with their applications. The second part lists the clinical steps involved in determining the OVD.

Some authors[3] classify these methods in a direct and indirect approach, whereas others[4] classify them as mechanical and physiological methods. Nevertheless, they include pre-extraction records, deglutition, physiological rest position, phonetics, esthetics appearance, craniofacial measure, biting force and patient tactile sense, which are all commonly used and described in this review. Also, a brief description of the use of cephalometric radiographs and duplication of old dentures is included.

Pre-extraction records

Pre-extraction records have been used in the assessment of the OVD. Smith[5] studied five methods of making pre-extraction records including the Sorenson Profile Scale, the cardboard profile, the interfrenal distance, measurement between tattoo dots on the gingiva proposed by Silverman[6] and the nose-chin distance measured with a plastic ruler. He found that the OVD could be reproduced with a mean accuracy of 1.1 to 1.4 mm with all records being nearly alike in reliability. According to Smith, the pre-extraction records are reliable enough to give valuable clinical information. Toolson and Smith[7] investigated the Sorenson Profile Scale and the chin-nose methods in terms of simplicity, accuracy and practicality. They concluded that both methods were within reasonable limits when compared to the cephalometric films. Willis[8] recommended the use of the Willis gauge for measuring the vertical height from the undersurface of the chin to the base of the nose. This method introduced inaccuracies because it depended on the operator applying the exact same degree of pressure when the instrument made contact with the skin of the face.[9] Turrell[10] stated that the Willis gauge is so inaccurate as to be almost useless. Wright[11] compared measurements of anatomic landmarks on photographs with measurement using the same anatomic landmarks on the face for many edentulous patients. The method was simple but, the inaccuracy of measures on a movable skin is evident.[3,12] Bissasu[12] published a literature review about the pre-extraction records for complete denture fabrication. He concluded by indicating that pre-extraction records provided a useful guide in determining the edentulous patient's original OVD and that they are preferred, when possible, to arbitrary methods. Turrell[10] reviewed many methods of recording occlusal vertical dimension in edentulous patients and stated that in spite of the problems with most pre-extraction recording instruments, some of them (Dakometer) were more accurate in the assessment of the OVD than numerous post-extraction aids. The Dakometer was used to record the OVD and the position of the maxillary anterior teeth by placing the instruments on the patient's face while the patient closed into maximal intercuspidation. With the instrument in position, the edge of the instrument moved to engage the incisal edges of maxillary central incisors. The measurements were recorded and used as pre-extraction records.[12]

Denture Duplication

Duplicate of existing dental prostheses can be a useful technique if the current OVD and occlusion plane are within normal limits.[13]

Deglutition

Deglutition is another commonly used method in establishing OVD. Shanahan[14] indicated that the mandibular pattern of movement during deglutition corresponds to the OVD. He described a swallowing technique where the soft wax on the occlusion rim is reduced during deglutition to give the correct OVD. Ismail and George[15] tested the accuracy of the swallowing technique for determining and recording the occlusal vertical relation of the jaws. They used Shanahan's technique measures in comparison with lateral head cephalometric radiographic measures. They found an increase of 0 to 5 mm (mean 2.8 mm) in the OVD in edentulous patients when the swallowing technique was used, with a significant correlation between the increased measure and the number of posterior teeth missing before extraction. Malson[16] described a technique consisting of controlling the thyroid cartilage movement during deglutition. When the OVD is correct, the cartilage rises in an uninterrupted fashion before moving back to its original position. When the OVD is increased, the patient leans forward when swallowing and the cartilage moves in 3 steps: upward, plateau and downward. When the OVD is decreased, the patient does not change posture and there is no plateau phase, but there is interposition of the tongue to compensate for the reduced height. Millet[3] mentions that this technique requires a highly experienced clinician and cannot be used in cases of atypical deglutition. Ward and Osterholtz[17] investigated the value of the act of swallowing as a guide to the establishment of OVD and concluded that it should not be used as the only technique to determine the OVD. In addition, they underlined the importance of removal of the existing denture for a period of time before recording of OVD in order to allow for the loss of memory of acquired neuromuscular reflex patterns.

Physiological rest position

Physiological rest position, as defined in the glossary of prosthodontics terms,[1] is "the mandibular position assumed when the head is in an upright position and the involved muscles, particularly the elevator and depressor groups, are in equilibrium in tonic contraction, and the condyles are in a neutral, unstrained position". It is established by muscles and gravity. Two hypotheses about the postural/physiological rest position of the mandible involving an active or passive mechanism have been considered. The active one is the position assumed when the muscles of mastication are in a state of minimal contraction to maintain the posture of the mandible;[18] whereas the passive one states that the elastic elements of the jaw musculature, not muscle activity, balances the influence of gravity.[19,20] Many authors do not accept the concept of a constant rest position in the strictest sense.[21-26] It tends to remain relatively stable for reasonable lengths of time.

Different methods have been described to attempt to determine the physiological rest position. Thompson[27] related variations in rest position to hypotonicity and hypertonicity of the musculature and short (stress, respiration) and long-term variations (mouth breathers). Atwood[24] contended that rest position is a dynamic rather than static concept with inter- and intra-individual variability. In a cephalometric study of the clinical rest position of the mandible, Atwood[22] described a decrease in facial height at rest position after removal of occlusal contacts and reported instability of the rest position. Smith[28] described a method where the patient takes a sip of water and keeps it in his mouth for 2 minutes, to then swallow it. Before the deglutition, and immediately after, the mandible is in rest position. The non-forced respiration method describes the rest vertical dimension being obtained during the terminal movement of the expiration phase.[29] However, this technique is prone to error for edentulous patient who are mouth breathers.

The most common method to determine physiologic rest position is using phonetics. The labial *m* sound is often used to determine the rest position which can be said without the use of teeth. However, the *m* sound leaves the lips in contact and when parted by the dentist, the mandible is depressed and the rest position is lost. Therefore, the sound *m* is often extended to the word *Emma* or followed by the labial *p* sound with the word *Mississipi*, which leaves the lips apart.[10]

Once the rest position is determined using any of these suggested methods, the OVD is obtained by subtracting the value of interocclusal distance from the rest position dimension. Previously known as the freeway space, Sears[30] described a more specific term being "interocclusal space". The interocclusal space is variable depending on numerous factors including gender, age and Angle classification. Several authors estimate an average value of 2 to 4 mm being acceptable for most of patients.[3, 4, 10] Pleasure[31] reports an average value of 3 mm. He describes a method using calipers adjusted to two arbitrary landmarks on nose and chin, using adhesive triangles on skin, to register physiologic rest position. In a backless chair, "the patient may be asked to moisten the lips with the tongue or to sip a little water to induce slight mandibular movements, and thus the regularity of return to the tentative physiologic identified by the caliper setting

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can be checked".[31] When the patient is asked to close to occlusion, there should be a decrease of 3 mm from the rest position corresponding to the interocclusal space. Niswonger[18] describes a similar method of measurement using a jaw relator. This instrument measured the mandibular distance from centric occlusion to rest position. Niswonger studied two groups of subjects presenting a dentition with physiological wear and pathological wear with extremely worn occlusal and incisal edges. He found a constant interocclusal clearance of approximately 3 mm in the majority of the groups. He also found that when the same interocclusal clearance distance of 3 mm was for 50 edentulous patients, the dentures were satisfactory in terms of function and comfort. He believed that the mandibular rest position remains constant throughout life.

The value of the interocclusal space is generally greater for men and in retrognathic mandible with horizontal overlap of 7 to 12 mm (Class II). It is decreased to 1 to 2 mm for the prognathic mandibles (Class III) and elderly because of the increased ligament laxity and anterior head inclination. It is a very important value because it has a direct consequence on the patient's tolerance and stability of the new dental prostheses. For many authors,[3,4,10,15,22,24] the rest position alone is not a reliable basis for the determination of maxillomandibular relations and it should be combined with others methods of evaluations.

Phonetics and the closest speaking space

Phonetics is also used for determining the OVD by using the closest speaking space introduced by Silverman.[32] During speech, the incisal edges of mandibular anterior teeth move within an envelope that corresponds to the phonetic space. When patient pronounces the letter *s* or *yes*, incisal edge of maxillary and mandibular teeth are separated by a distance of 1 mm, which corresponds to the value of the closest speaking space. This phonetic space is relatively precise and constant. During the try-in, this space is checked phonetically and the OVD is adjusted if necessary. Pound[33] describes a similar concept with the space being of 1 to 1.5 mm during pronunciation of *s* sound. These techniques are considered easier and more accurate to record a measurement which relies upon muscular phonetic enunciation when the patient loses voluntary muscular control of the mandible than to record a measurement which relies upon relaxation.[10] It is important to keep in mind that these techniques are mainly used when the anterior teeth are mounted and the wax contour is adjusted adequately to allow proper space and movement of the tongue, in order to assess the pronunciation.

Esthetics

Esthetic appearance is also used to establish OVD. It is based upon the esthetic harmony of the lower third of the face relative to the rest of the face, upon the contour of the lips and the appearance of the skin from the margin of the lower lip to the lower border of the chin, and upon the labiomental angle.[10] This method relies on the clinical judgment and expertise of the clinician. The evaluation is also based on the relaxed facial expression with good tonus of the skin. When the lips are in contact, the muscular activity and tonus of the skin under the lower lip to the chin should be assessed carefully. Several authors described a correlation between different specific facial measurements to determine the OVD. However, these techniques are very subjective considering the significant variations between individuals and the fact that they are an approximation considering the unreliability of facial measurement.[34]

Tactile sense

The patient's tactile sense can be used as a guide for the determination of the OVD. By tactile sense, the patient is supposed to recognize when he/she has reached the degree of jaw opening which was attained when natural teeth were present. Timmer[35] introduced a method using an adjustable central bearing screw attached to both occlusion rims. The screws are adjusted until the patient indicates that the length is just about right. The problem with this method relates to the presence of foreign objects in the palate and tongue space.[4] Also, McGee[36] mentioned that this method transfers the responsibility of registering the OVD to the patient, which tends to register a reduced OVD because they feel more comfortable in that position. Lytle[37] describes a technique using a central bearing device adjusted to different vertical relations permitting the patient to experience and compare different OVDs. This technique relies on the patient's neuromuscular perception.

Biting Force

The anatomy and physiology of the musculature influence the vertical dimension at rest position. Boos[38] describes muscle function and the critical point in the distance from the origin to the insertion at which the muscle can exert the greatest force in contraction. He reports that when the jaws are closed from the physiological rest position, the biting force increases until it reached its maximum value at rest position, and the biting force decreases when the vertical dimension is increased beyond this point. A Bimeter is the instrument used to measure the biting force at different OVD. It is a gnathodynamometer which is a calibrated gauge intended to record pounds of biting force with the main objective to determine the OVD at which the patient could exert the greatest biting force.[39]

Boucher[40] evaluated Boos method using the Bimeter and concluded that it cannot be classified as an objective method for determining the OVD. Moreover, the use of the Bimeter is also limited because of the psychological influences of pain and apprehension.[41]

Cephalometric evaluation

Sheppard and Sheppard[42] compared landmarks on cephalometric radiographs with and without the dental prostheses. They concluded that rest position does not seem suitable for determination of OVD. Atwood[24] reported a variation in measurements, using the cephalometric method, between sittings and within the same sitting as well as with and without wear of dental prostheses.

Figures 1A and 1B

Summary

The best method to use should consider these criteria: repeatability of measurement, adaptability of the technique, type and complexity of the equipment needed, and the length of time required. However, the diversity and number of techniques described in the literature contrast the difficulty identifying the one method answering to all of these criteria. Therefore, a combination of two to three functionally determining methods represents an acceptable compromise to evaluate an OVD compatible with the patient tolerance. Among all the methods, deglutition, phonation and rest position seem to be the most popular among dental health professionals.

Clinical Steps

Following the initial examination and diagnostic steps, diagnostic casts are poured from primary impressions. Custom trays are fabricated and a final impression is made capturing the anatomical structures including the functional periphery. Once the baseplate and wax rims are fabricated, the next clinical steps involve determining the OVD.

Adjustment of maxillary occlusion rim is done following these steps:

- ***Sagittal plan:*** in the anterior region, the wax rim is adjusted according to the esthetic criteria. It has to offer adequate upper lip support including the nasolabial angle. Too much support makes the lip shorter and too little makes it longer (Figure 1A, 1B).
- ***Frontal plan:*** wax rim is adjusted according to the esthetic (Figure 2A, 2B) and phonetic criteria. The incisal show should not be estimated using an average value for all patients (Figure 3). Its value varies in relation to the age, gender and personality of the patient. With age, the maxillary incisal teeth are less apparent, and it is more significant for men compared to women.[43] Generally for elderly women, there is a 1 mm incisal show compared to elderly men with the upper lip covering the teeth completely. Also, the vertical dimension of the wax rim is adjusted according to phonetics. When the patient is pronouncing the phonemes F and V, the inferior "incisal" border of the upper occlusion rim comes in a light contact with the vermillion border of the lower lip. The last step is usually more reliable with the upper anterior teeth mounted

Figures 2A and 2B

Figure 3

Figure 4

Figures 5A and 5B

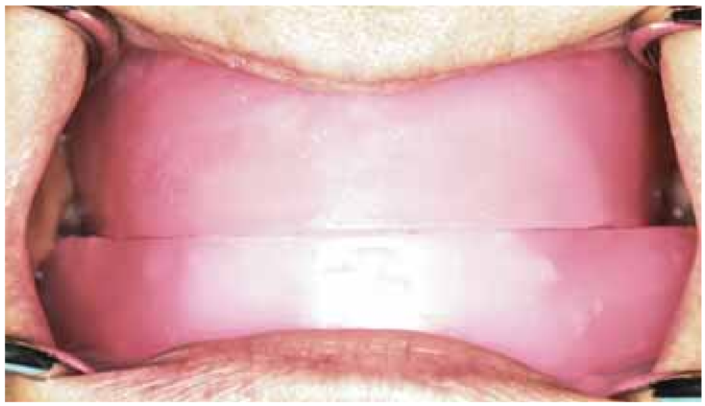

Figure 6

Figures 7A and 7B

- *Horizontal plan:* using the Fox Plane, the occlusal plan should be parallel with the bi-pupillary (Figure 4) and bi-commissural lines. In the posterior region, it should be parallel to Camper plane joining the inferior border of the tragus of the ear to the infra-nasal angle (Figure 5A, 5B).

After that, 2 references points one on the nose tip and the chin are made in order to perform all the different measurements, either directly on the skin or on a piece of tape positioned on the skin.

Then, the physiological rest position is recorded with the patient seated up right comfortably. The patient head should be in the same position for all the measurement to ensure reliability of the measurements. Moreover, it is important to have a thickness of the record base that is similar to the thickness of the final denture base. A thick record base covering the hard palate can influence the rest position.

The adjustment of the mandibular occlusion rim is done by subtracting 2 to 4 mm from the rest position dimension to obtain the OVD. It is important to make sure the record base is stable and well seated for this step. The mandibular occlusion rim is adjusted to the calculated OVD with its occlusal flat surface in complete contact with the flat surface of the maxillary occlusion rim (Figure 6). Facial appearance and esthetics are used as to confirm the estimation of the OVD (Figure 7A, 7B)

Then, the interocclusal space can be verified by phonetics and deglutition. During speech, the occlusal surfaces of the wax rim should not be in contact. In order to do a proper verification, the record base has to be fully retentive and the dimension of the occlusion rim close to the teeth without interfering with important structures such as the tongue. The sounds used are the *S* and *Z*, asking the patient to count from 60 to 70. Also, a brief and practical test is to ask the patient to pronounce O, L, M, S, with the O separating the upper and lower occlusion rims; the L bringing them closer, the M placing the mandible in a position very close to the rest position; and finally, the pronunciation of the S without the occlusion rims touching with an anterior space of 1 mm. The deglutition helps verifying the interocclusal space by using Shanahan's method by placing 2 small balls of soft wax (3mm) on the mandibular occlusion rim in the premolar area and asking the patient to swallow for a couple of minutes. The interocclusal space is correct when there is a very thin layer left, excessive when there is a thick layer and insufficient when no wax is left. The step is usually performed also when the teeth are mounted to confirm the dimensions.

Conclusion

Currently, it is impossible to identify one method for determining occlusal vertical dimension that is repeatable and applicable to all patients. By understanding the application and limitation of the different methods, we can conclude that only a combination of these different techniques would provide a good estimate of the OVD for complete removable dental prostheses.

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Comments/Commentaires

Periodontics For The GP:

A Practical Approach

A Three Day Hands-On Seminar

Dr. Edy Braun, Hon. B.Sc., Cert. Perio, FRCD(C)

Sponsored By: Hu-Friedy

Day 1: Periodontal Disease

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2. Radiographic interpretation, treatment planning, proper sequencing
3. Non-surgical options, chemotherapeutics, lasers
4. Resective surgical techniques
   a) Open flap debridement - flap curettage, distal wedge
   b) Crown-lengthening (esthetic and functional)

Day 2: Regenerative Surgical Techniques

1. Soft-tissue grafting
   a) Free gingival graft
   b) Connective tissue graft
   c) Frenectomy
2. Hard-tissue grafting
   a) Guided tissue regeneration (osseous defects around teeth)
   b) Guided bone regeneration (for implant or pontic site development)

Day 3: Hands-On Surgery and Suturing

1. Practice techniques learned in the first 2 days....
2. Open flap debridement surgery, continuous sling sutures
3. Crown-lengthening surgery, vertical external mattress sutures
4. Ridge augmentation surgery/implant bone graft, split-thickness flap
5. Free gingival grafting and associated suturing
6. Connective tissue grafting and associated suturing

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2015 | CLINICAL PROGRAMS

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TIME	TOPIC	SPEAKER	SPONSOR
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Clinical Program [Room: Butternut / Holly]

TIME	TOPIC	SPEAKER	SPONSOR
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11:00am - 12:00pm	Practice Of Dental Medicine: Are You On Board?	Dr. Jim Hyland, B.Sc.	Oravital
12:00pm - 1:00pm	Exhibit Hall Opens [Donald Cousens 3] - Lunch for Purchase In Foyer		
1:00pm - 2:00pm	Keeping It Simple With Implants	Dr. Les Kalman	Implant Direct Kavo Kerr Group
2:00pm - 3:00pm	Why Use Lasers In Dentistry?	Dr. Stephan Gaines, B.Sc., FWCMID	Biolase
5:30pm - 6:00pm	Exhibit Hall [Donald Cousens 3] - Cocktail Reception - Draw For Prizes		

WIDS / RDH Program [Room: Evergreen]

TIME	TOPIC	SPEAKER	SPONSOR
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10:30am - 11:00am	Exhibit Hall [Donald Cousens 3] - BREAK		
11:00am - 12:00pm	Measuring Business Performance	Dale Tucci	Tucci Management Consultants Inc
12:00pm - 1:00pm	Exhibit Hall Opens [Donald Cousens 3] - Lunch For Purchase In Foyer		
1:00pm - 2:00pm	Whitening Essentials	Beth Ryerse, RDH	Spa-Dent
2:00pm - 4:00pm	Five Behaviours Of A Cohesive Team	Sandie Baillargeon	Dental Office Consulting Services (DOCS)
5:30pm - 6:00pm	Exhibit Hall [Donald Cousens 3] - Cocktail Reception - Draw For Prizes		

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🟢	3:00pm - 4:00pm	"Understanding the Bacterial Twitterverse" or "How microbes can immitate Zombies" - Key Factors to Ensure Your Self-Protection and Preservation	Dean Swift	Micrylium
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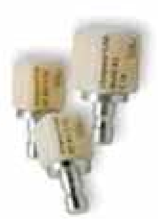

Dr. Begüm Akkayan, DDS, PhD

Dr. Hubert Gaucher, DDS, MScD

CAD/CAM Advances in Prosthodontics

Les progrès de la CAO/FAO en Prosthodontie

Abstract

Highly acceptable clinical treatments of both fixed (FPD) and removable partial dentures (RPD) may be achieved with computer-aided design (CAD) / computer-aided manufacturing (CAM) technology.[1] Laboratory and in-office desktop and Intra-Oral Scanners (IOS) using 3D denture design software modules, advanced CAM block materials and 3D printing methods are rapidly replacing the conventional methods in dental prosthesis fabrication. Direct metal sintering is another innovative manufacturing technology where digital information is used to direct a focused laser beam to fuse metal powder in layers to fabricate a prosthesis. Laser milling applications are also becoming an alternative to conventional machine milling technologies. Continuous improvements in CAD/CAM technologies appear to be promising for ideal manufacturing parameters of achieving dental prostheses and it is very likely that wider acceptance of its use in dentistry will occur in the near future with the motto of 'adding instead of taking away' when referring to 3D printing. The present literature reviews innovative dental technologies and advanced materials and their integration for the fabrication of CAD/CAM dental prostheses.

Key words Dental CAD/CAM: Technologies, Components, Systems, Materials

Digital Workflow Options:

CAD/CAM technologies have started a new age in restorative and prosthetic dentistry by means of standardized production processes and efficient quality management. A prosthetic treatment should be durable, aesthetic, accurate and comfortable to fulfill its function. These requirements should be accomplished by any prosthesis fabrication method. However, as digital dental technology is developing it is constantly providing the practitioner with innovative methods to practice in the field of prosthodontics. In contemporary dentistry, the integration to these digital era technologies is certainly inevitable.

To date, the exponential increase in the application of computer-aided manufacturing in prosthodontics is attributed to continuous systems development and refinement, greater ability for quality control, parallel material development, and the possibility of virtual evaluation.[1,2] Dental CAD/CAM technology has been based on three major production stages. In the first stage, scanners are used to collect data that measure three-dimensional jaw and tooth structures and transform them into digital data sets. Then the design of the prosthesis is completed with customized computer aided design (CAD) software. In the third stage the data is transferred to a computer-aided manufacturing (CAM) software that controls the production unit. The CAM technology is based on two major approaches: the subtractive and the additive methods. The differences reside in the processing protocols, materials used, and their respective accuracy.

Three different production concepts are available for the CAD/CAM fabrication in dentistry depending on the location of the components of the CAD/CAM systems.[2] All components of the CAD/CAM system are located and limited to the dental surgery in the chairside production

Résumé

Des traitements fort acceptables de prothèses partielles fixes et amovibles peuvent être réalisés à l'aide de la technologie, y compris la conception assistée par ordinateur et l fabrication assistée par ordinateur (CAO/FAO). Les balayeurs de table (scanners) en cabinet et en laboratoire dentaire, ou intra-oraux (SIO), utilisant des modules de conception 3D pour prothèses, des blocs de matériaux avancés pour la FAO, ainsi que la technologie imprimante 3D, remplacent rapidement les méthodes conventionnelles pour la fabrication des prothèses dentaires. La fusion directe des métaux est une autre méthode de fabrication innovatrice où l'information numérisée est utilisée pour diriger un faisceau laser permettant la fusion progressive des particules métalliques pour fabriquer une prothèse. L'usinage dentaire au moyen d'un laser devient aussi une alternative aux technologies d'usinage conventionnel. Les améliorations constantes des technologies CAO/FAO permettent d'entrevoir l'obtention de paramètres optimaux en matière de fabrication de prothèses. Il est donc très probable que l'acceptation accrue de cette technologie se répande à court terme en Dentisterie avec la devise «ajoutez au lieu de soustraire» lorsqu'il s'agit de l'imprimante 3D. La présente littérature revoit les technologies innovatrices et les matériaux avancés ainsi que leur intégration pour la réalisation de prothèses au moyen de la CAO/FAO.

Mots-clés

CAO/FAO dentaire: Technologies, Composantes, Systèmes, Matériaux

concept also referred to as a "closed architecture system". Historically, chairside production system was the first CAD/CAM system in dentistry and is currently available in its third product generation. A conventional impression is replaced by an intra-oral camera. The restorations are fabricated at chairside without a laboratory procedure. This saves time and offers the patient indirectly fabricated restorations at one appointment. At present, only two "closed architecture systems" are available. The Cerec IV system (Sirona, Bensheim, Germany) offers this possibility as well the more recently commercialized Planscan E4D (Planmeca, Helsinki, Finland) driven system.

The alternative digital workflow concept is the laboratory production in which the traditional working sequence is followed by the dentist and the laboratory. Both of the above "closed architecture systems" can also be adapted to become what is commonly referred to as the "open architecture systems" described as follows: In this scenatio, the dentist sends the digital impression by Internet to the laboratory where a master cast is fabricated. The remaining CAD/CAM production steps are carried out entirely in the laboratory.[4,5] A variation of this digital laboratory workflow consists of utilizing centralized production milling centers, for instance the 3DCore Centres, for the CAM portion of the workflow with the local laboratory completing the restorations using porcelain veneering in-house. In the event the dentist is sending a conventional elastomeric impression to the local laboratory, these impressions can be scanned either in the dental office or in the laboratory, obtaining a digital model that can also be used to complete the CAD portion of the workflow before forwarding these digital files to a CAM production center via the internet. In summary, the produced data sets are forwarded by the local dental laboratory to the production center for the restorations to be produced with a CAD/CAM device. The benefit of outsourcing CAM production is to be found in the small investment requirement, since only the digitalization tool (desktop scanner) and CAD software have to be purchased.[6]

Scanner, computer aided design software, computer aided manufacturing technology and materials for CAD/CAM processing are the basic components of CAD/CAM systems.

1. Scanners

In the area of dental impressions, conventional impression taking methods are now progressivily giving way to digital impression techniques. Clinicians have various options available with respect to taking impressions. These systems are used to take a digital impression of the teeth instead of conventional chairside materials. The digital workflow and impressions have significantly helped the dentist and labs to establish a more efficient process and to avoid the whole conventional impression taking experience for the patient.

Optical scanners are designed on the principle of triangulation. The source of light and the receptor unit are in a definite angle in relationship to one another. Through this angle the computer can calculate a three-dimensional data set from the image on the receptor unit. White light projections or a laser beam can serve as a source of illumination.

Redcam and Bluecam are the first two optical scanners of the Cerec system. Development of Bluecam followed by Redcam, included significant modifications such as the use of blue instead of infrared light and a new lens configuration. However, the Omnicam is the latest upgrade of the Cerec system. It is differentiated from its predecessors in that it captures data points on a three-dimensional plane with a live video image, thus the problem of blurred pictures is eliminated. All the previous Cerec systems captured data with static images requiring a contrast medium and stitching. Omnicam is a powderless system meaning that no powder has to be placed on the tooth preparation. One of the limitations of the optical scanners of the Cerec system were the so called 'distal shadow phenomenon'. The optical scanner projects a beam at a specific angle with regard to the recording axis and creates a shadow distally to the illuminated object; this shadow appears only at the distal surface. Since the Omnicam uses a 3D video image capture, this parallax error problem has all been eliminated. The camera technology has improved so much that the unit is smaller, more ergonomic and faster. It only takes a couple of seconds to take an image.[8,9]

Lava Scan ST (3M Espe), Trios (3Shape), Everest Scan (KaVo), Es1 (Etkon) and iTero (Cadent) are, among others,[10] the currently available digital impression units with a stand-alone configuration. The operator scans the prepared arch, the opposing arch and the bite using the intraoral wand to take a series of digital images or a digital video. Following the scan, the clinician confirms that the preparation and the other relevant areas on the digital model have been accurately recorded, and that the occlusal clearance is appropriate for the material selected. Then the data is sent through a wireless router to the appropriate model facility or laboratory.[8,9]

Most developed systems offer the unique advantage of being able to determine the exact occlusal clearance through the use of a digital colored map. This is a huge advantage over the traditional physical impression materials, where the exact amount of occlusal reduction cannot, in some cases, be easily verified chairside until after the case arrives at the dental laboratory and is made ready for fabrication of the restoration. Avoiding the need for a second preparation and impression appointment due to lack of occlusal clearance has obvious benefits for both the dentist and the patient.[7] However, caution should be taken by the dentist when using scanners as undetectable preparation margins or subsections and irregularities on the surface of the prepared tooth can be inadequately recognized by many scanners. If sharp incisor and occlusal edges are left, these details cannot be milled exactly. Nevertheless, the rapid progress in technology will ensure that taking the optical impressions will become practical in the clinic in the near future.[2] The stand-alone digital impression units are well-suited for the clinician who wants to integrate digital technologies into their practice, but wants to retain the options and expertise which their dental laboratory can provide.[7]

2. Computer Assisted Design Software: CAD

Design software developments can be traced to the inception of the digital workflow originating from Prof. Dr. François Duret's Henson System (Lyon, France) in the '80s. Remarkably, dental technologists from this original team are still very much involved in the present day CAD developments featured in the Dental Wings Software (Montréal, Canada). This, in itself, reflects the high level of professional commitment and perseverance master technologists have invested in perfecting software interfaces that today are advantageously replacing conventional dental prosthetic methods. Dental Laboratories have a choice of CAD technologies on the market and will voice their respective preference based on many variants such as: accuracy, number of features, user friendly interface, training/support and costs. This remakable evolution and sophistication of design softwares is also observed in the periodic updates offered by "closed architecture systems" previously mentioned. All strive to become more user friendly and intuitive in their applications allowing all members of the dental team to participate in the use of integrated chairside systems.

3. Computer Aided Manufacturing Technology: Available Alternatives

3.1 – Subtractive Technologies:

3.1.1 Machine Milling:

The conventional manufacture of model cast prostheses represents a lot of work for the dental laboratory. The preparation of the cast model and the wax modeling based on this procedure often takes more than one hour and the complete casting procedure including finishing is laborious and time-consuming. In comparison to the conventional fabrication methods, computer-aided manufacturing has the advantage of omitting multiple error-introducing steps such as impression, waxing, and casting. Furthermore, since modelling and production are automated procedures, there is an overall reduction of fabrication time and cost.[1,2,12-15]

The computer aided manufacturing (CAM) technology is based on two major approaches: the subtractive and the additive methods (Figure 1). The differences reside in the processing protocols, materials used, and their respective accuracy.

Subtractive manufacturing method is based on milling the work piece from a larger blank by a computer numeric controlled (CNC) machine. The CAM software automatically translates the CAD model into a tool path for the CNC machine. Due to the unevenness of the features of dental restorations, the milling machines combine burs with different shapes and sizes. The dental CNC machines are composed of multiaxis milling devices to facilitate the 3D milling of dental work pieces.[12,16]

The milling burs move in 3-axis milling systems. 180° rotation of the blank is incorporated within the machine, allowing 3D milling of the internal and external surfaces, producing divergence and convergence of the milled surfaces. However, as the movement is restricted to the milling tool, a large prosthesis cannot be produced by 3-axis machines.[2,12,16] The 4-axis machines allow for blank movements in an additional axis. This is a useful feature for milling a large blank and producing a long span framework. Most recently introduced is the 5-axis machines which enables a rotating path of the milling tool or the blank. This feature facilitates the production of complex geometries and smooth external surfaces.[17] Manufacturing deficiencies such as porosities and inhomogeneous consistencies are reduced to a minimum as the restorations are milled from an industrial grade blank.[14]

A long list of CAM materials are available for processing by CAD/CAM devices depending on the production system. Some milling devices are designed to be used for a wide range of CAD/CAM blocks; others are specifically designed for the fabrication of a certain material. The following CAD/CAM materials are used for the different stages of the fabrication of dental prostheses. Figure 2 illustrates photos of a variety of CAD/CAM blocks available on the dental market.

3.1.2 Laser Milling: Laser ablation technology

As a recently introduced dental milling option, it is described as a “closed loop 3D process” using a laser beam to remove material from polymers, ceramics, or glass ceramic blocks. Dental restorations are thereby created from an open STL file. Obviously, there is no toll wear or breakage, no cooling fluids to manage and important reduced operating costs to be had. The process bypasses the final crystalization steps for glass ceramics allowing for high resolution precision manufacturing of thin edges.[11]

3.2 Additive Manufacturing Method

In prosthodontics, additive manufacturing methods are creating entirely new ways of thinking in terms of design, production, workflow and the products. 3D printing takes the efficiencies of digital design to the production stage. 3D printing extrudes material from a heated nozzle that solidifies as soon as it is deposited on the manufacturing platform. There are a range of materials that can be used for 3D dental printing. This includes thermoplastic materials, such as waxes, resins, or fused filament. Alternatively, liquid ceramic or resin materials with a binder can also be printed.[67-69] By combining oral scanning, CAD and 3D printing, dental labs can accurately and rapidly produce dental models, facial prosthesis patterns, crowns, bridges and even polymer based RPD’s.

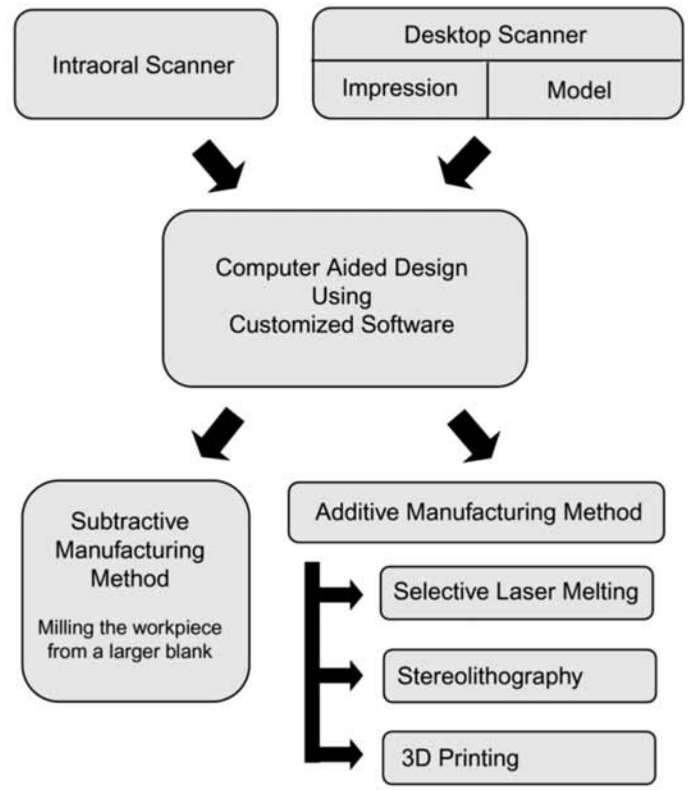

Figure 1 — Schematic representation of Computer Aided Manufacturing Technologies used for the fabrication of prosthesis.

Additive manufacturing is currently an exponentially growing fabrication method and will most likely be used more frequently in dentistry in the future as its accuracy and range of applications develop. Additive methods have the advantage of producing large work pieces with significant surface variation and competitive accuracy that makes them suitable also for manufacturing removable partial denture frameworks. Currently there are 3 main additive manufacturing methods available for use on the dental market; these are selective **laser melting, stereolithography and 3D printing**. Regardless of the method, all share the following features that distinguish them from subtractive manufacturing: Incremental vertical object build-up, no material wastage, large objects produced, passive production-no force application and fine detail production.[10,11,66,69]

Selective laser sintering/melting produces a 3D model by laser sintering or melting a powder, layer by layer using a laser beam. The laser beam locally raises the temperature close to the melting point of the metal particle, to avoid complete melting. After each new powder layer application, the laser melting process is repeated until the 3D object is completed. Selective Laser melting is the only additive manufacturing method that is available to produce RPD metal frameworks.[70] Han et al.[71] introduced a new CAD/CAM software design specifically for RPD framework design and fabrication. Maxillary and mandibular frameworks were designed, manufactured and fitted to dental casts. Metal frameworks were produced using selective laser melting manufacturing method. The frameworks were evaluated by visual inspection and pressure evaluation for movement and were reported as having satisfactory fit on the casts.

The CAD frameworks were also evaluated clinically in some other clinical reports. The treatment plan for a 75-year-old woman included the use of CAD/CAM technology to fabricate the metal RPD framework in a clinical case report.[14] Patient's master casts were scanned and a virtual design was created using the software. The rapid prototype was directly manufactured from chromium cobalt using selective laser melting technology. The framework was fitted to the patient. The accuracy and quality of fit was deemed to be clinically acceptable. Others[21] also reported on the fit of a CAD/CAM framework on a patient. CAD/CAM and rapid prototyping technology were used to develop a pattern that was cast and finished using conventional methods. After trial fitting, the framework was judged to be clinically acceptable.

Laser melting produced significantly improved hardness values for PFM Co-Cr dental alloys compared to casting or milling technologies.[74]

Stereolithography is another additive manufacturing method that produces solid layers using a concentrated ultraviolet (UV) light beam moving on a curable liquid polymer pool. Upon the polymerization of the first layer, the next layer is cured and the process is repeated until the whole workpiece is completed. The workpiece is then rinsed with a solvent and placed in an UV oven to thoroughly cure the resin. The applications of stereolithography in dentistry are production of surgical templates, facial prosthesis patterns, occlusal splints, burnout resin patterns.[12,16] Recently, Wu et al.[15] produced a 3D CAD wax framework by RP using the stereolithography technique. The wax framework was cast with Co-Cr alloy and the fit was reported satisfactory.

Milling accuracy is also dictated by materials' properties when subtractive method is utilized. High material hardness means low machinability and more considerable involved forces.[21] Thus, the substractive system limits the milling process of large sized workpieces like the frameworks of RPD's. For this reason the use of advanced polymers and additive method is a successful alternative for the production of RPD's compared to subtractive manufacturing method.

3.2.1 – 3D Printing and the Production of Digitally Designed RPDs

There are a number of companies on the market integrated with 'Additive Manufacturing Methods' that can be used for different stages of removable partial dentures (RPD) fabrication (Table 1). The initial production of digitally designed removable denture were printed in wax and cast using conventional methods.[75] 'Visijet' material of 3D Solutions[74] (TX, USA) and 'True Cast' material of Stratasys[77] (MN, USA) produce digitally fabricated waxup frameworks of RPD's using their company's corresponding 3D Printing technologies. Stratasys also introduced a photopolymer material 'Polyjet' to the dental market to be used for RPD framework ready for casting. Proto3000[78]

Table 1 : Companies integrated with 'Additive Manufacturing Methods' that can be used for different stages of removable partial dentures (RPD) fabrication.

Company Name	Manufacturing Method	Dental Materials Used	Manufactured Dental Product / Products
3D Solutions (TX, USA)	3D Printing	Visijet	Wax up for RPD framework
DWS – DFAB (Vicenza, Italy)	Desktop & Chairside 3D Printing	Temporis	Light curable material
Envision TEC (Gladbeck, Germany)	3D Printing	E Partial (EC 1000)	Photopolymer RPD framework ready for casting
EOS GmbH (München, Germany)	Direct Metal Laser Sintering	EOS Cobaltchrome	Metal framework of partial denture
Stratasys / Objet (MN, USA)	3D Printing	True Cast Polyjet	Wax up for RPD framework Photopolymer RPD framework ready for casting

is an Ontario, Canada based 3D Engineering company with numerous partnerships that integrate CAD-RPD software, materials, milling, 3D Printers and a strategic alliance with the emerging worldwide 3DCore CAD/CAM manufacturing centres. The options of denture fabrication has therefore been taken to the next level with open-architecture scanners with powerful new denture design software capabilities and with the introduction of new materials to be used, to create a fully digital, machine-produced partial-denture product.

Alternatively, EOS GmbH[79] (München, Germany) uses one of the innovative additive manufacturing processes. The freedom of design of the modeling software

Figure 2 — Some examples of the CAD/CAM blocks available on the dental market.
1. Glass based ceramic 2. Infiltration ceramic 3A. Bilayered zirconia 3B. Monolithic zirconia 4. Glass based leucite reinforced 5. Composite resin-temporary restoration 6. Metal blocks 7. Advanced polymer 8. Glass based lithium disilicate reinforced.

can be used to full capacity and further implemented for manufacturing. The technique uses 3D data source directly from the patient's mouth as the basis for the manufacturing process. Software functions of the new CAMbridge 2012 RPD module from 3Shape (Copenhagen, Denmark) is used. The resulting virtual model is sliced and the digital information is utilized to direct a focused laser beam to fuse metal powder in successive layers until the prosthesis is complete. The technique has been named as the Direct Metal Laser-Sintering (DMLS) process by the company. This is a selective laser melting method. EOS Cobaltchrome is the powder metal certified for this procedure. It is a fine grained, biocompatible material free from nickel, beryllium and cadmium producing a metal framework with a fine-grain structure. It also allows the production of RPD's to be comparatively low cost.

The production of RPD's via DMLS is very accurate, making laboratory work easier. The denture is produced to an accuracy of ±20 μm and is of a consistently high quality. The digital production method saves a lot of time; the design for the RPD is ready in around 15 minutes with only a few mouse clicks. As a result, high-strength, rigid and filigree geometries can be produced and casting errors can be eliminated.[79]

Also the EnvisionTEC Company[80] (Gladbeck, Germany), 'Perfactory 4 DDP' 3D printers deliver labor and material cost reduction as well as higher clinical quality and consistency throughout the manufacturing process. One of the materials they use is named as 'E-Partial'. It is a photopolymer developed for the creation of removable partial dentures. E-Partial exhibits superior stiffness, with a tensile strength of 57 MPa, it is resistant to higher temperatures. E-Partial material maintains flexural strength to ensure clasp flex without breakage. The stiffness of E-Partial allows for production of a very hard retention grid and super tight thin clasps with the perfect fit every time once casted from metal alloy.

In addition, DWS (Digital Wax Systems)/DFAB[81] (Vicenza, Italy) is another patented 3D Additive Manufacturing system. It is a company developing stereolithographic technology. It is an ultrafast, desktop size additive manufacturing system fully compatible with the majority of intraoral scanners and open dental CAD/CAM solutions. The most specific feature of the system is that it has 2 versions; desktop and chairside and it is the only chairside 3D Printer available on the market. The compact form and the affordable price make DFAB desktop is the ideal rapid manufacturing solution for dental clinics. High quality, long-term temporary crown and bridge restorations can be fabricated form the light curable 'Temporis' material during a single appointment.

Of interest, AREVO Labs[29] (CA, USA) is another company with the patent pending 3D Printing technology combining the benefits of printing complex geometries with reinforced materials that have excellent resistance to high temperatures and chemicals. The 3D printed parts optimized for superior properties result in lighter but stronger parts with unmatched mechanical properties. Although the company's 3D printing process is not yet available to the dental market, the company uses two advanced polymer materials; KetaSpire PEEK (Solvay, Brussels) and AvaSpire PAEK (Solvay, Brussels).

4. CAD/CAM Materials Used in Prosthodontics

4.1 Metal blocks

Chrome cobalt and titanium alloys are processed using dental milling devices. Milling is anticipated to eliminate waxing, investing, and casting of prostheses which are assumed to improve the overall precision. However, studies have shown that the restorations produced by conventional methods exhibited better fit than milled restorations. Tan et al.[18] found that milled titanium crowns exhibited a vertical gap of 79.4 μm, while cast noble metal crowns had vertical gap of 23.9 μm. In a similar study, Han et al.[19] compared the marginal accuracy of milled titanium and cast titanium crowns. The cast titanium samples displayed 52-76 μm marginal opening compared to CAD/CAM titanium samples of 60-80 μm.

Procera Cobalt Chromium (Nobel Biocare, Göteborg, Switzerland) Ceramill NP M (Girrbach, Pforzheim, Germany) and Kera C-Disc (Eisenbacher, Main, Germany) are among the chromium cobalt based CAM blocks whereas Procera Titanium (Nobel Biocare, Göteborg, Switzerland) Ceramill Ti (Girrbach, Pforzheim, Germany) and Kera Ti5-Disc (Eisenbacher, Main, Germany) are titanium blocks. Considering the difficulty of milling in metal blocks and causing more excessive milling bur wear and tool failure,[20,21] metal blocks that are initially manufactured in a partially sintered state were later developed. The restorations are enlarged by the inLab CAD/CAM system; they are individually processed and finally densely sintered when partially sintered metal blocks are used. InCoris CC block (Sirona, Bensheim, Germany) Ceramill Sintron (Girrbach, Pforzheim, Germany) and Crypton blank (Degudent, Frankfurt, Germany) are some of the examples in this group.

4.2 Composite Resin – Temporary Restoration Blocks

Residue-free resin blocks can be milled instead of wax pattern fabrication to be used for the lost wax technique in the casting technology. The conventional wax-up methods require considerable human intervention and manipulation of materials that also exhibit dimensional shrinkage and/or expansion. This can lead to increased processing errors; however the implementation of automated design and fabrication techniques would facilitate the production of more accurate reliable prosthesis.[12,22]

Highly cross-linked microfilled acrylic polymer blocks are also used for long-term temporary full and partial crowns and FDPs. Vita CAD-Temp (Vita, Bad Sackingen, Germany), is offered as a monocolor block that comes in four shades or a multicolor form with four shade layers for more esthetic cases. Telio CAD (Ivoclar Vivadent AG, Schaan, Liechtenstein) is another millable cross-linked polymethyl methacrylate block. The block is a part of the Telio system, which includes a self-curing composite, desensitizer, and cement. It is available in five shades. Both temporary materials are recommended by the manufacturers for up to 1 year of clinical service.[23]

Fiber reinforced resin blocks developed by RTD company (RTD, St.Egreve, France) are one of the recent developments in CAM technology. These blocks are composed of 75% multiaxial glass fiber and 25% epoxy resin matrix by weight. They are indicated to be used for long term temporary crown, bridge and post-core restoration alternatives. The manufacturer reports biomechanical properties compatible with dentin, aesthetic shades and low costs compared to ceramic blocks as the benefits of their product.[24]

Everest C-Temp (Kavo, Biberach, Germany), Cercon base cast (DeguDent, Hanau, Germany), ZENO PMMA (Wieland Dental, Pforzheim, Germany) and ArtBlock Temp (Merz Dental, Lütjenburg, Germany) are the other CAM resin blocks used for temporary restorations.

4.3 Composite Resin – Permanent Restoration Blocks

The industrial fabrication of the composite block potentially offers a significant clinical advantage to what may be expected of a typical composite that is placed incrementally and cured intraorally. Paradigm MZ100 (3M ESPE) composite resin blocks have been available for over ten years as permanent restoration blocks.[25] Fasbinder[26] reveals a much different clinical result for prepolymerized blocks of composite that are used by chairside CAD/CAM systems in comparison to what many dentists would believe to be the outcome for compositionally similar materials used in a traditional restorative technique.

4.4 Advanced Polymer Blocks

Poly ether ether keton (PEEK) (Juvora Dental Disc, Juvora Dental Ltd., Lancashire, UK) is a polymer from the group polyaryletherketone (PAEK) which is a relatively new family of high-temperature thermoplastic polymer, consisting of aromatic backbone and molecular chain, interconnected by ketone and ether functional groups.[27] PEEK material is an aromatic, semi-crystalline polymer that has been in use as a material for implants in different fields such as orthopedics and oral and maxillofacial surgery for more than ten years already. The thermoplastic production procedure ensures that virtually no residual monomers are released. Due to its semi-crystalline character, the material remains mechanically stable even in an aggressive environment like the oral cavity.[28] The material is presented for the use of dental market with the motto of 'Let us define and customize not only the geometry, but also the density, stiffness and elasticity or modulus of the final product as desired'.[29]

This material has been used successfully for production of RPD's using subtractive manufacturing methods. PEEK blanks[30] (Juvora Dental Disc, Juvora Dental Ltd., Lancashire, UK) are available for CAD/CAM production since September 2012. The blanks are sourced from biomaterials of the company Invibio Biomaterials Solutions (Invibio Ltd, Lancashire, UK) that have been successfully used in medical technology for more than a decade. In a clinical case reported by Siewert[28], 12 units, for a 4 implants-supporting framework was milled from PEEK material (Juvora Dental Disc) in one-piece. The clinician described the PEEK material suitable as a framework material due to its superior physical features for the fabrication of removable dentures and concluded that its use combined with the digital workflow of CAD/CAM processing will produce efficient and precise outcomes. In another case report by Siewert and Rieger[31], milled PEEK blanks were used as the framework material for both the connecting bar in the maxilla and for the occlusal screw-retained bridge in the mandible. CAD/CAM assisted fabrications of the prostheses were performed and the design data were transmitted to the milling machine. Milling of the frameworks was accomplished from PEEK blanks. The clinicians reported advantages of the treatment modality with PEEK material as avoidance of a galvanic element by using a non-conducting material, the high biocompatibility with the soft tissue when in contact with pure, unfilled PEEK, shock-absorbing properties to protect the implants, optimum elasticity and high patient comfort due to the low prosthesis weight.

It is specified that the melting point of this material is high for polymers (340°C) and allows repeated sterilization of frameworks. The modulus of elasticity is 165 MPa, the elongation at break amounts to 40%, meaning that a sample breaks when it is stretched by 40% of its initial length.[28] The consequence is that the material is flexible under load without fracturing. In a study by Tannous et al.[32] retentive force of clasps made from thermoplastic resins of PEEK were evaluated and they have concluded that the retention of adequately designed resin clasps were within the acceptable amount of retention after 15,000 joining and separating cycles corresponding to 10 years of simulated use.

A PEEK disc was used for the fabrication of a telescopic denture in a clinical case by Aumüller and Eiber-Fäth.[33] The primary telescope was made from zirconium oxide ceramic using CAD/CAM. An impression was taken from the primary telescope and then the master model was prepared and scanned and the secondary construction was designed using CAD software. The secondary structure was milled directly from the PEEK disc and after milling it was reported that the fit was very good. The try-in was found very satisfactory and a good and even friction was provided. The authors reported that the patient was pleased about the light weight and the simple, smooth and tilt-free insertion of the prosthesis.

Due to the elasticity of the PEEK material that is similar to that of cancellous bone, chewing forces acting on the restoration are compensated. In contemporary applications, it is also possible to use the PEEK material by additive manufacturing methods of 3D printing for RPD's. The benefits resulting from the additive manufacturing methods and 3D printing can be combined with those of the digital workflow, such as efficiency and precision when utilizing PEEK material for the fabrication of RPD's. It is obvious that the high-performance polymers have a great future potential with regard to their use as framework materials for RPD'S.

BioHPP[34] (High Performance Polymer) is another brand name material which is also based on PEEK, developed by Bredent (Senden, Germany). It is composed of equally distributed ceramic filler of grain size of 0,3 to 0,5 μm in the partially crystalline polymer matrix. The fine granularity of the filler is the basis for the extremely good polishing properties. It is described as a material particularly well suited for producing prosthetic restorations; fixed dental prosthesis and telescopic works.

4.5 Nano-Ceramic Blocks

Nano-ceramic blocks are based on the integration of nano-technology and ceramics. These blocks are an alternative, monolithic esthetic material that has been recently introduced in a block form for CAD/CAM fabrication using both chairside and laboratory systems. A stated advantage of the material is to offer easier clinical finishing and polishing, without the need for a porcelain oven, with the strength, surface gloss and finish retention similar to ceramic materials.[23]

Lava Ultimate (3M ESPE, Seefeld, Germany) and Vita Enamic (Vita, Bad Sackingen, Germany) are two examples for this category. The blocks consist of 20nm silica and 4 to 11 nm zirconia particles agglomerated in clusters and embedded in a highly cross-linked polymer matrix. With a flexural strength of 200 MPa, the nano-ceramic block has a higher initial strength than feldspathic and leucite reinforced porcelain blocks, as well as veneering porcelains for PFM crowns. The fracture toughness of the nano-ceramic material is reported by the manufacturer to be greater than feldspathic materials and direct composites while being less brittle than feldspathic glass-ceramics, and therefore less prone to fracture during try-in and function.[23,35,36]

4.6. Glass based (Feldspathic) Ceramic Blocks

Glass based systems are made from materials that contain mainly silicon dioxide also known as silica. These blocks are manufactured for the production of inlays, onlays, veneers, partial crowns and full crowns. In addition to monochromatic blocks, various manufacturers offer polychromatic blanks with multicoloured layers for the purpose of full anatomical crowns.[2] Some of the monochrome silica based ceramic examples are VITABLOCS Mark II, (Vita, Bad Sackingen, Germany) , IPS e.max CAD (Ivoclar Vivadent, Schaan, Liechtenstein) and Cerec Blocs (Sirona, Bensheim, Germany).

CEREC Blocs C PC is a widely used example for polychromatic silica based blocks optimized for the use in crowns with their three different layers based on varying degrees of color saturation they can be optimally adapted to characteristic color gradients in restorations with respect to translucency and intensity. No additional glazing is required, making very fast, full ceramic chairside treatment possible and they are also easily polished.[8] VITABLOCS Triluxe/ Forte, VITABLOCS Realife (Vita, Bad Sackingen, Germany) and IPS Empress CAD Multi (Ivoclar Vivadent, Schaan, Liechtenstein) are the other polychromatic CAM block manufacturers.[37]

4.7 Glass Based Blocks Reinforced by Fillers

These CAM blocks contain varying amounts of different types of crystals added to the glass composition. The primary crystal types added as fillers are leucite and lithium-disilicate.[38]

4.7.1 Glass Based Leucite Reinforced Blocks

The two leucite-reinforced glass ceramic materials are IPS Empress CAD (Ivoclar Vivadent AG, Schaan, Liechtenstein) and Paradigm C Blocks (3M Espe, Seefeld, Germany). The current IPS Empress CAD blocks consist of 35% to 45% leucite-reinforced glass ceramic with a fine particle size of 1 µm to 5 µm. The blocks are available in nine shades in either a high translucency or low translucency version. It is offered in a multicolor block form.[39] Paradigm C blocks consist of 30% leucite-reinforced glass ceramic. The block is a radiopaque ceramic; however it is not available in a polychromatic composition.[40]

4.7.2 Glass Based Lithium-disilicate Reinforced Blocks

IPS e.max CAD blocks (Ivoclar Vivadent AG, Schaan, Liechtenstein), also named as high-strength ceramics, was introduced in 2006 as a lithium-disilicate CAD/CAM material with a flexural strength of 360 MPa to 400 MPa, which is two to three times the flexural strength of the glass ceramics.[41-43] Blocks consist of 0.2 µm to 1 µm lithium meta-silicate crystals with approximately 40% crystals by volume. It has gained popularity for use as a monolithic restoration in chairside CAD/CAM systems due to the enhanced strength.[23]

4.8 Infiltration ceramic blocks

Milling blocks of infiltration ceramics are processed in porous, chalky condition and then infiltrated with lanthanum glass. All blanks for infiltration ceramics originate from the Vita In-Ceram system (Vita) and are offered in three variations as In Ceram Alumina (Vita, Bad Sackingen, Germany), In Ceram Spinell (Vita, Bad Sackingen, Germany) and In-ceram Zirconia (Vita, Bad Sackingen, Germany).[2]

4.9 Oxide High performance Ceramic Blocks

Aluminum oxide and zirconium oxide are also offered as blocks for CAD/CAM technology.

4.9.1 Aluminum Oxide (Al_2O_3) Blocks

These blocks are in a pre-sintered phase and are then sintered at a temperature of 1520°C. They are indicated as crown copings in the anterior and posterior area, primary crowns and three-unit anterior FPD frameworks.

InCoris AL (Sirona, Bensheim, Germany), In-ceram AL Block (Vita, Bad Sackingen, Germany) and Procera AllCeram (Nobel Biocare, Göteborg, Switzerland) are the examples for milled aluminum oxide blocks.

4.9.2 Yttrium Stabilized Zirconium Oxide (ZrO_2, Y-TZP) Blocks

First introduced to dental clinics in the late 1990s, yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) has been used alternative for metal frameworks of FDP's due to its biocompatibility and more favorable esthetics. In addition, Y-TZP exhibits significantly higher flexural strength and toughness than earlier known dental ceramics.[44-46]

Crystal phase transformations build up detrimental internal stresses within the ZrO_2 in the temperature range between sintering and room temperature, thus making it unsuitable for construction purposes. However, the addition of Y_2O_3 results in a stabilizing tetragonal phase at room temperature which is considerably more stable, tougher, and stronger. If a crack occurs in Y-TZP material, the surrounding tetragonal crystals turn into a monoclinic structure, resulting in a local volume increase in the crack tip area, preventing further crack propagation.[44,46]

Y-TZP framework processing can take place in two different density stages for dental use. In the first system, frameworks with final dimensions can be milled directly from fully sintered dense ceramic blocks. This system has the advantage of a superior fit, because no shrinkage is involved, but has the disadvantage of inferior machining associated with wear of the tool.[47] It is also time consuming and the surface temperature rise during the long milling process will result with phase transformation to monoclinic phase which exacerbate surface microcracking and low thermal degradation.[48,49] In the second system, frameworks with enlarged dimensions can be milled from partially-sintered blocks, followed by post-sintering at high temperature to obtain a framework with final dimensions and sufficient strength.[47] The sintering procedure will cause about 25-30% shrinkage of the workpiece.[48] This approach has the advantages of quicker milling, reduce cutting forces, increase the tool life, better surface quality, and no moisture absorption of the zirconia blanks.[48-50] This system is currently popular for fabricating zirconia frameworks using the main CAD/CAM systems available in the worldwide dental market.

Generally, a zirconia ceramic crown consists of a zirconia core in the lower part which is further layered with esthetic veneering ceramics to obtain the required esthetics.[51] Many factors must be considered during the fabrication of bi-layered all-ceramic restoration such as design of the framework, differences in thermal expansion coefficients, layering technique and thickness of the core/veneering ceramic, and the expected functional loads. Clinical reports of failed bilayered zirconia-based restorations due to low bond strengths of veneering porcelain to zirconia are commonly reported in the literature that result in premature fractures, cracks and as chip-off fractures.[52-54] Guess et al[53]. reported the shear bond strength of porcelain to metal as 27.6 MPa, whereas porcelain to zirconia was 9.4–11.5 MPa. Rocha et al[55]. reported that an incomplete bond between the veneer and zirconia framework increased the stress in the ceramic veneer and induced veneer failure.

InCoris ZI ceramics[56] (Sirona Dental Systems, Bensheim, Germany) constitute blocks compromised of zirconium oxide ceramics. The manufacturer reports their chemical composition as $ZrO_2+HfO_2+Y_2O_3>99\%$, $Al_2O_3<0.5\%$, other oxides<0.5%.The blocks are tinted in five increasing color intensity. Therefore it is not necessary to carry out subsequent coloring using a submersion solution or liners. A minimum wall thickness of 0.5 mm is recommended as a circular wall thickness in single crowns. They have a fracture toughness of 5.9 MPa and their bending strength is reported to be 1100>MPa by the manufacturer.

Many other millable standard zirconia materials are available such as Lava Frame (3M/ESPE, Seefeld, Germany), Cercon Base (Degudent, Hanau-Wolfgang, Germany), Procera Zirconia (Nobel Biocare, Göteborg, Sweden), IPS e.max ZIRCAD (Ivoclar Vivadent, Schaan, Liechtenstein), DC-Zirkon, Precident DCS (DCS, Allschwil, Switzerland), Everest 2S-ZH (Kavo Dental GmbH, Biberach, Germany), and Prettau (Zirkonzahn GmbH, Bruneck, Italy).

Bilayered zirconia frameworks are usually veneered with the layering technique. Nano-fluorapatite glass-ceramic (e.max Ceram, Ivoclar Vivadent, Schaan, Liechtenstein) is used as the veneering material for layering technique on ZrO_2 blocks (IPS e.max ZirCAD) of the Ivoclar Vivadent company. Press-on technique was used in an attempt to improve the bonding strength compared to the conventional layering technique. Fluorapatite glass-ceramic pressable blocks (e.max ZirPress) are used for this purpose as an alternative technique.[57]

The progress continued with the development of IPS e.max CAD-on technique (Ivovlar Vivadent) as an alternative to both layering and press-on technique. The CAD-on technique combined the advantages of lithium disilicate glass ceramic (IPS e.max CAD, Ivoclar Vivadent) with those of ZrO_2 (IPS e.max ZirCAD, Ivoclar Vivadent) in an innovative way and allowed single crowns and up to 4-unit posterior bridges with outstanding strength to be fabricated. An innovative fusion glass-ceramic; IPS e.max CAD Crystall./Connect (Ivoclar Vivadent) is used for achieving homogeneous glass-ceramic bond between two separately milled structures; the ZrO_2 framework and the veneering lithium disilicate glass ceramic parts. The optimally coordinated CAD-On technique allows a convenient fusion of the IPS e.max ZirCAD framework and the IPS e.max CAD veneering structure.[57]

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Adverse Outcomes

Dr. Lionel Lenkinski,
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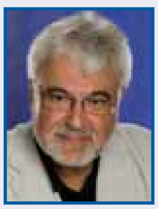

Dr. Bruce Glazer,
BScD, Dip. Prosth

Adverse outcomes take many forms, from serious morbidity following treatment to unmet patient expectations in cosmetic procedures. They know no boundaries, and are common to all aspects specialities and modalities of dental treatment. The lecture will begin by defining adverse outcomes with clinical examples, and move into the prevention and management strategies. The intent is to minimize the impact of these events to both the practitioner and patient. The seed for an adverse event or outcome may be present even prior to the patient presenting themselves in your office and can occur during or after treatment. The presentation will highlight informed consent, post-treatment management communication, and documentation strategies. The requirements under the Regulated Health Professions Act "RHPA", prevailing court jurisprudence will be discussed, as will the appropriate use of the Apology Act. These adverse events can lead to patient loss, RCDSO complains and lawsuits. Further, the new paradigm, one of "shared decision-making", "informed consent" and "informed refusal" will form a part of this session. The necessity of appropriate follow up care, referral and disclosure will be highlighted. Dentists should become well versed in these principles in order to survive in today's increasingly difficult practice environment.

Upon completion of this session the participants will be better able to:

- Understand the need for appropriate communication strategies
- Become aware of the perils of using "Grey Market" dental materials and unlicensed or offshore dental laboratories
- Know the principles of informed consent and informed refusal
- Understanding why documentation and disclosure are required
- Realize why appropriate and available after-hours care and available will resolve many patient issues with post treatment problems
- Effectively appropriate referral strategies to minimize their risk
- Develop pre-emptive and reactive solutions to most adverse events

1:00PM - 4:00PM

New Approaches In Management Of Endodontic Pain – Making Sense Of The Evidence

Pavel Cherkas,
DMD, PhD, FRCD(C)

Dr. Ruslan Dorfman,
PhD, MBA, MSc, BSc

This evidence-based lecture presents a broad overview of contemporary literature, clinical and scientific experience in acute and chronic endodontic pain management. Comprehensive understanding of different pain mechanisms provides an ultimate way for managing dental pain emergencies and post-operative conditions. The latest information on pharmacological and technological approaches will be provided to help clinicians with successful management of different types of endodontic emergencies. What is the best time for treatment of irreversible pulpitis? Can we predict which patients are more likely to experience pain after an endodontic therapy? What doesn't work for post-op pain? What are genetic determinants of pain? What is a personalized medicine concept and how to apply it in dentistry?

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Monolithic full-contour zirconia restorations have been developed to avoid the chipping of the veneering porcelain and improve the mechanical stability.[58] The opacity of Y-TZP is improved and the sensitive manual porcelain work is replaced by digital procedures. However, there was concern about wear of the opposing enamel, because the hardness of Y-TZP was over double that of porcelain. According to the current studies, polished zirconia appears to be wear-friendly with the opposing enamel, even after simulated aging.[59-60]

InCoris TZI blocks[61] (Sirona Dental Systems, Bensheim, Germany) are translucent zirconia ceramic blocks initially manufactured in a partially sintered state, intended for use in manufacturing individually designed fully anatomical restorations after milling and sintering. Their chemical composition is reported to be $ZrO_2+HfO_2+Y_2O_3>99.9\%$, Y_2O_3 5.4%, $HfO_2<5\%$, $Al_2O_3<0.005\%$, $Fe_2O_3<0.02\%$, other oxides<0.2%. Compared to bilayerd zirconia blocks of the manufacturer, they display higher fracture toughness of 6.4 MPa and a lower bending strength of 900> MPa. The aesthetic features of InCoris TZI enable application as fully anatomical crowns and bridges. The advantages of Incoris TZI include; high strength, resistance to corrosion, high translucency and good biological compatibility of the product.

BruxZir Solid Zirconia (Glidewell, California, USA) is one of the most recent monolithic full-contour zirconia CAM materials on the market which recently has also received Health Canada Approval. This highly esthetic restorative material, which displays natural-looking tooth shade characteristics, is specifically designed to satisfy the esthetic and functional requirements of the anterior region of the mouth. The block exhibits substantially higher light transmission in the warm color wavelengths which results in restorations that more closely match the vital translucency of natural dentition. The manufacturer reports the material to be an ideal solution for anterior and premolar single-unit crowns, implants, as well as 3-unit bridges.[62,63] Ceramill zolid (Girrbach, Pforzheim, Germany), Lava Plus High Translucency Zirconia (3M Espe, Seefeld, Germany) and Cercon ht (Degudent, Hanau-Wolfgang, Germany) are some of the other monolithic zirconia blocks available on the dental market.

An in vitro study[64] evaluated the load-bearing capacity of four different zirconia based crowns, including zirconia core with veneer layer produced either by powder build-up or CAD/CAM technique, glazed monolithic zirconia, and polished monolithic zirconia. The results showed that zirconia in bilayer configuration had significantly lower load-bearing capacity than the other crowns' design. However, the fracture loads presented by all groups were between 2051.8 – 3492.5 N range, still higher than maximum chewing forces which is expected to be around 700 N for healthy young adults.[65]

Conclusion

As computer-aided manufacturing technology continues to develop rapidly and already became an integrated part of dentistry, particularly in relation to their treatment simplicity and production time, it is important for clinicians and technicians to be familiar with the use of these systems. The new generation of ceramic materials presents interesting options, both in terms of material selection and in terms of fabrication techniques. A closer understanding of the dynamics of the materials with respect to design of the restoration and the intended use is required to enable these restorations to perform productively. The digital fabrication of dental prostheses relies heavily on the successful combination of 3 main variables which can be listed as; (1) availability and ease of use of customized CAD software to design restorations and models from scanned data (2) a wide variety of advanced materials (3) highly reliable CAM technologies which replicate data accurately. Among the computer aided manufacturing technologies, additive manufacturing methods are creating entirely new ways of thinking in terms of design, production, workflow and the products themselves. It has been reported that they ensure greater contour accuracy much more easily than milling and use a lot less material. It is obvious that as more upgrades become available, the digital fabrication of prostheses will be more commonly preferred for their production. Further clinical trials comparing these advanced materials and technologies are needed to better guide clinicians in their evidence based selection of CAD/CAM options.

The extensive Bibliography for this article can be accessed on the digital version of the CJRDP at www.cardp.ca — page 71

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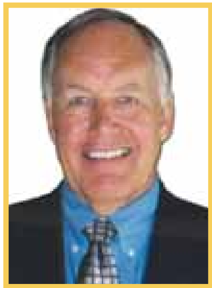
In Memoriam : Dr. John Nasedkin –June 2, 1936 - May 7, 2015

CARDP – Fellow & Life Member



Dr. Nasedkin was born and raised in the small farming community of Beaverlodge, Alberta. He aspired to Dentistry and graduated with a D.D.S. from the University of Alberta in 1959 then obtained a Clinical Fellowship in Dental Medicine in 1961 from the Forsyth Dental Centre in Boston; this was followed by three years of clinical practice in London, England.

In 1979 John obtained his certification in Prosthodontics in BC. He received his Fellowship from the RCD in 2001 after which he became an examiner in Prosthodontics for the RCD for many years.

John loved his profession and was devoted to his patients. He was active in many Dental organizations and founded a very successful "Biology of Occlusion" program for the American Equilibration Society. John had a particular passion for teaching Occlusion and presented programs on Occlusion/TMJ Esthetics in Canada and abroad. He was the section editor of Cranio (The Journal of Craniomandibular Practice) and co-editor of the book, "Occlusion: The State of the Art".

John retired from clinical practice in 1998 but continued to be involved in dentistry as a part-time instructor at the UBC Faculty of Dentistry and as a Practice Coach teaching individual Dentists to perform complex dental rehabilitations.

John was a very involved and loyal member of CARDP who volunteered and presented at several CARDP Scientific Meetings. His cheerful handshake and earnest smile will be missed.

He is survived by his wife Jay, his children Nicola and Andrew, and his grandchildren.

God Bless.

Dr. Dennis Nimchuk
Vancouver, BC
Honorary Member & Past President
Canadian Academy of Restorative Dentistry and Prosthodontics

CARDP 2015 Dental Graduate Academic Award / ACDRP Prix Académique 2015

Dr. Meredith Lowe, 2015 DMD Graduate from the Faculty of Dentistry, Dalhousie University, Halifax, NS, is the recipient of the CARDP Academic Award ($500) presented to the graduating student with the highest mark in Restorative Dentistry and Prosthodontics combined in her graduating class. (This CARDP Academic Award will be offered to all Canadian Dental Faculties in 2016)

CARDP/CJRDP – ACRDP/JCDRP 2014 Young Author Award

CARDP MEMBERS: Drs. Doug Hamilton, Frances Power, Mary Currie, Kelvin Afrashtehfar (Award recipient), Harry Rosen (Professor Emeritus, McGill University) and Jay McMullan at Kelvin's Montréal presentation.

Dr. Kelvin Afrashtehfar, Graduate Student/Research Assistant, Prosthodontics and Restorative Dentistry Division, Faculty of Dentistry, McGill University, Montréal, Qc, (Right) receives in April 2014 the **Young Author Award** ($1,000) from CARDP's Past President Dr. Jay McMullen (Left). This original scientific article can be accessed at www.cardp.ca (CJRDP Section, Vol.7, No.4, 36-43 – Winter 2014)

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2015 Annual Scientific Meeting Program

October 1th – 3rd, 2015, Toronto, Ontario

Inspiring Excellence

The 23rd Annual Scientific Meeting of the Canadian Academy of Restorative Dentistry and Prosthodontics (CARDP) will be held at the Hotel Intercontinental (Front Street) in Toronto on October 1-3rd, 2015. As President, it is my pleasure to extend a personal invitation to you to attend and experience our unique blend of superb continuing education, camaraderie and social events.

As befits the preeminent Canadian Dental organization promoting excellence and education in Restorative Dentistry and Prosthodontics our organizing committee has designed an outstanding and diverse program that will include a hands-on component for members on Thursday, five world class speakers on Friday as well as fourteen leading clinicians addressing clinically relevant topics on Saturday. The educational program is well balanced with our social events ensuring a fantastic weekend.

CARDP is proud of our history and the continued dedication of our members to the art and science of Restorative Dentistry and Prosthodontics. It is our mission to promote excellence in all aspects of our personal and professional lives. We are committed to the highest standards of professional ethics and are leaders in promoting unbiased, outstanding continuing education. Our academy journal (The Canadian Journal of Re-storative Dentistry and Prosthodontics – CJRDP) is peer-reviewed and read nationwide. Conference information as well as digital back issues of our journal can be viewed on our website www.cardp.ca.

We look forward to seeing you in
Toronto October 1-3rd, 2015.

Sincerely,
Ian W. Tester DDS, MSc
CARDP President

Le 23e Congrès annuel de l'Académie canadienne de dentisterie restauratrice et de prosthodontie (ACDRP) aura lieu à l'Hôtel Intercontinental (rue Front), à Toronto, du 1er au 3 octobre 2015. À titre de président, j'ai l'honneur de vous inviter personnellement à vivre une expérience enrichissante et prendre part à une combinaison unique de superbes formations continues, dans un esprit de camaraderie, et d'événements sociaux.

À l'image de notre organisation dentaire, chef de file au Canada pour la promotion de l'excellence et de l'éducation dans le domaine de la dentisterie restauratrice et de prosthodontie, notre comité organisateur a conçu un programme exceptionnel et diversifié incluant un volet pratique pour les membres, le jeudi, cinq conférenciers de renommée internationale, le vendredi, et 14 cliniciens réputés qui aborderont des sujets cliniques dignes d'intérêt, le samedi. Le programme éducatif sera agrémenté d'événements sociaux, vous promettant ainsi un week-end fantastique.

L'ACDRP est fière de notre histoire et du dévouement continu de nos membres à l'art et à la science de la dentisterie restauratrice et de prosthodontie. Notre mission est de promouvoir l'excellence dans tous les aspects de nos vies personnelles et professionnelles. Nous avons pris l'engagement de mener nos activités en fonction des normes professionnelles et éthiques les plus rigoureuses et sommes leaders en matière de formation continue impartiale et d'exception. Le journal de l'académie (le journal canadien de dentisterie restauratrice et de prosthodontie – JCDRP) est révisé par des pairs et lu à l'échelle du pays. Vous pouvez obtenir plus d'information sur les conférences et consultez les éditions numériques précédentes de notre publication sur notre site Web, à l'adresse www.cardp.ca.

Au plaisir de vous rencontrer à
Toronto du 1er au 3 octobre, 2015.

Veuillez agréer mes salutations distinguées,
Ian W. Tester DDS, MSc
Président de l'ACDRP

FOR MORE INFORMATION AND REGISTRATION / POUR PLUS D'INFORMATION ET POUR S'INSCRIRE: WWW.CARDP.CA

Time	Thursday, October 1st
9:00 am — 5:00 pm	**Hands on Course — Dr. Basil Mizrahi** Topic: Acrylic Temporary Crowns. Advanced techniques to allow you to get more out of your temporary crowns and let them aid you in the treatment of complex cases.

Time	Friday, October 2nd
8:20 am	**Dr. Ian Tester** – CARDP President, Dr. Kim Parlett & Dr. Tony Mancuso – Scientific Program Chairs
8:30 am	**Dr. Terry Donovan** — Clinical Analysis of Contemporary Ceramic Systems
9:30 am	**Dr. Kim Kutsch** — Dental Caries: A Disease of Choice?
10:30 am — 11:00 am	**Refreshment Break with Sponsors** – Exhibit Hall
11:00 am	**Dr. Glen Johnson** — New Dental Adhesives and Crown Cements – What should you use and why?
12:00 Noon — 1:30 pm	**Luncheon with Sponsors** — Exhibit Hall
1:30 pm	**Dr. Carlo Ercoli** — Complex implant reconstructions: surgical and prosthetic perspectives
2:30 pm	**Dr. Basil Mizrahi** — Biomechanical and Aesthetic Precision in Complex Fixed Prosthodontics
3:30 pm — 4:00 pm	**Refreshment Break with Sponsors** — Exhibit Hall
4:00 pm — 5:00 pm	**Dr. Van Haywood** — Tooth Bleaching Techniques: The pre-bleaching exam and single dark teeth

Time	Saturday, October 3rd
8:30 am — 8:50 am	**Dr. Peter Fritz** — Supportive Implant Therapy: A Step By Step Protocol To Maintaining Implants
8:50 am — 9:10 am	**Dr. Kristina Perschbacher** — Leukoplakia: Hyperkeratosis to Carcinoma
9:10 am — 9:30 am	**Dr. Susanne Perschbacher** — Panoramic radiography: shedding light on the shadows
9:30 am — 9:50 am	**Dr. David Psutka** — TMJ Surgery. State of the Art and Science
9:50 am — 10:10 am	**Dr. Michelle Lee** — Surgical Strategies to Manage the Labially Positioned Dental Implant
10:10 am — 11:00 am	**Refreshment Break with Sponsors** – Exhibit Hall
11:00 am — 12:00 Noon	**Dr. Keith Phillips** — Expedited Implant Strategies for the Terminal Dentition
12:00 pm — 12:30 pm	**Pre Lunch Reception with Sponsors**
12:30 pm — 2:00 pm	**CARDP Members & Guest Luncheon**
2:00 pm — 2:20 pm	**Dr. Oliver Pin Harry** — Short Implants: Scientific Rationale and Clinical Applications
2:20 pm — 2:40 pm	**Dr. Izchak Barzilay** — Wide body implants: what are they good for?
2:40 pm — 3:00 pm	**Dr. Jim Soltys** — The 1 — wing inlay/Maryland bridge; an implant alternative
3:00 pm — 3:20 pm	**Dr. Nancy Dubois** — Prosthodontic Treatment Planning for Obstructive Sleep Apnea (OSA) Patients
3:20 pm — 3:40 pm	**Dr. Brent Winnett** — Screw vs. Cement-retained Implant Prosthodontics: the Practical Reality
3:40 pm — 4:00 pm	**Dr. Uche Odiatu** — Exercise is Medicine: The right Rx for the Dental Professional
4:00 pm — 4:10 pm	**Dr. Ian Tester** — Meeting Conclusion **Dr. Terry Koltek** — Halifax 2016 Annual Meeting Announcement & Video

Programme scientifique du Congrès annuel 2015

Toronto, Ontario — 1er au 3 octobre

« Inspirer l'excellence »

Heure	Jeudi 1er octobre
9 h — 17 h	**Cours pratique — Dr Basil Mizrahi** Sujet : Couronnes provisoires en acrylique. Technique avancée visant à rehausser et à maximiser la fonction des couronnes provisoires dans le traitement de cas complexes

Heure	Friday, October 2nd
8 h 20	**Dr Ian Tester** – président de l'ACDRP, Dr Kim Parlett et Dr Tony Mancuso, coprésidents du programme scientifique
8 h 30	**Dr Terry Donovan** — Analyse clinique des systèmes céramiques contemporains
9 h 30	**Dr Kim Kutsch** — La carie dentaire : à qui la faute?
10 h 30 — 11 h	**Pause avec les commanditaires** – Salle des exposants
11 h	**Dr Glen Johnson** — Nouveaux ciments et agents de scellement dentaires — Lesquels devrait-on utiliser et pour quelles raisons?
12 h — 13 h 30	**Dîner avec les commanditaires** — Salle des exposants
13 h 30	**Dr Carlo Ercoli** — Reconstruction implantologique complexe : perspectives chirurgicales et prosthétiques
14 h 30	**Dr Basil Mizrahi** — Précision biomécanique et esthétique des prothèses fixes complexes
15 h 30 — 16 h	**Pause avec les commanditaires** — Salle des exposants
16 h — 17 h	**Dr Van Haywood** — Techniques de blanchiment dentaire : l'examen préliminaire et la dent noircie

Heure	Samedi 3 octobre
8 h 30 — 8 h 50	**Dr Peter Fritz** — Soins de maintien des implants : Protocole étape par étape du maintien des implants
8 h 50 — 9 h 10	**Dre Kristina Perschbacher** — Leucoplasie : hyperkératose, signe avant-coureur du carcinome de la cavité buccale
9 h 10 — 9 h 30	**Dre Susanne Perschbacher** — Radiographie panoramique : toute la lumière sur les ombres
9 h 30 — 9 h 50	**Dr David Psutka** — Chirurgie de l'ATM : à la fine pointe de l'art et de la science
9 h 50 — 10 h 10	**Dre Michelle Lee** — Stratégies chirurgicales de gestion de l'implant dentaire en position labiale
10 h 10 — 11 h	**Pause avec les commanditaires** – Salle des exposants
11 h —12 h	**Dr Keith Phillips** — Stratégies d'implantologie accélérées pour les cas de dentition terminale
12 h —12 h 30	**Réception avec les commanditaires précédant le dîner**
12 h 30 — 14 h	**Dîner des membres de l'ACDRP et des invités**
14 h —14 h 20	**Dr Oliver Pin Harry** — Implants courts : justifications scientifiques et applications cliniques
14 h 20 — 14 h 40	**Dr Izchak Barzilay** — Implants à corps large : quelles sont leurs applications?
14 h 40 — 15 h	**Dr Jim Soltys** — Le pont Maryland à une aile : une solution de rechange à l'implant
15 h —15 h 20	**Dre Nancy Dubois** — Élaboration du plan de traitement prosthodontique pour les patients souffrant d'apnée obstructive du sommeil (AOS)
15 h 20 —15 h 40	**Dr Brent Winnett** — Prothèses implantaires vissées ou scellées : la réalité pratique
15 h 40 —16 h	**Dr Uche Odiatu** — L'exercice est la meilleure des médecines : le remède des praticiens dentaires
16 h — 16 h 10	**Dr Ian Tester** — Conclusion de la réunion **Dr Terry Koltek** — Annonce du Congrès annuel de 2016 à Halifax et vidéo

2015 Annual Scientific Meeting Program

October 1th – 3rd, 2015, Toronto, Ontario

2015 CONFERENCE PROGRAM

Time	WEDNESDAY, SEPTEMBER 30TH, 2015	LOCATION / SET UP
24 HRS	**Office**	**Simcoe Room**
4:00 PM — 5:30 PM	Journal Meeting	President's Suite
6:00 PM — 11:00 PM	CARDP Executive Dinner Meeting	Sapphire Room- Upper Level – Boardroom 20

Time	THURSDAY, OCTOBER 1ST, 2015	LOCATION / SET UP
24 HRS	**Office**	**Simcoe Room**
6:45 AM — 5:00 PM	Full Day — Hands On Course	Off Site U of T Sci Can — Kingsway Room Meet in Lobby InterContinental Hotel at 8:00 am
7:30 AM — 4:00 PM	Golf at Hamilton Golf and Country Club	Meet in Lobby InterContinental Hotel 7:30 am
10:45 AM — 3:30 PM	Sailing on Lake Ontario	Meet in Lobby InterContinental Hotel 10:45 am
8:00 AM — 11:59 PM	Scientific Set-up	Ballroom "B"
8:00 AM — 6:00 PM	Trade Show Set-up	Ontario/Niagara & Lower Lobby
11:00 AM — 8:00 PM	Registration	Lower Lobby Foyer
6:00 PM — 10:00 PM	Eat, Meet & Greet, Welcome Buffet with Sponsors	Ontario/Niagara & Lower Lobby
7:00 PM — Finish	APC Executive Meeting	High Park Room
5:00 PM — 7:00 PM	APO Annual General Meeting – Reception	Ballroom "A"
7:00 PM — 9:00 PM	APO Annual General Meeting - Dinner	Ballroom "A"

Time	FRIDAY, OCTOBER 2ND, 2015	LOCATION / SET UP
24 HRS	**Office**	**Simcoe Room**
7:00 AM — 5:00 PM	Registration	Lower Lobby Foyer
7:00 AM — 8:15 AM	Breakfast with Sponsors	Ontario/Niagara & Lower Lobby
8:15 AM — 5:00 PM	Scientific Sessions	Ballroom "B"
12:00 AM — 4:00 PM	Wine tasting paired with tapas at The St. Lawrence Market (Partners Program)	Meet in Lobby InterContinental Hotel 12:00 pm
10:30 AM — 11:00 AM	Break with Sponsors	Ontario/Niagara & Lower Lobby
12:00 PM — 1:30 PM	Lunch with Sponsors	Ontario/Niagara & Lower Lobby
3:30 PM — 4:00 PM	Break with Sponsors	Ontario/Niagara & Lower Lobby
5:00 PM — 6:00 PM	Wine and Cheese Reception with Sponsors	Ontario/Niagara & Lower Lobby
7:00 PM	Delegate, Speaker & Guest Dinner - CN Tower	Meet in Lobby InterContinental Hotel 7:00 pm

The Canadian Academy of Restorative Dentistry and Prosthodontic is an ADA CERP Recognized Provider. ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP does not approve or endorse individual activities or instructors, nor does it imply acceptance of credit hours by boards of dentistry. The Canadian Academy of Restorative Dentistry and Prosthodontics designates this activity for our Full Day Hands on Course 7, Friday lecture attendance 7.5, Saturday lecture attendance 7 continuing education credits.

L'Académie canadienne de dentisterie restauratrice et de prosthodontie est un prestataire reconnu de l'ADA CERP (American Dental Association Continuing Education Recognition Program). L'ADA CERP fournit un mécanisme de sélection qui permet aux praticiens dentaires de trouver des prestataires de qualité en matière de formation dentaire continue. Il n'incombe pas à L'ADA CERP d'approuver les activités individuelles ou les instructeurs ni de garantir l'acceptation des crédits pour les heures de formation continue par les bureaux d'examen dentaire. L'Académie canadienne de dentisterie restauratrice et de prosthodontie accorde les crédits de formation continue suivants : 7 crédits pour notre cours pratique d'une journée, 7,5 crédits pour assister aux conférences du vendredi, et 7 crédits pour assister aux conférences du samedi.

Programme du Congrès 2015

Heures	Mercredi 30 Septembre	Lieu / Salle
24 heures	**Bureau**	**Salle Simcoe**
16 h — 17 h 30	Réunion du journal	Suite du président
18 h — 23 h	Souper-réunion de la direction de l'ACDRP	Salle Sapphire – Niveau supérieur

Heures	JEUDI 1er OCTOBRE	Lieu / Salle
24 heures	**Bureau**	**Salle Simcoe**
6 h 45 — 17 h	Cours pratique – toute la journée	Hors-site — University of Toronto Sci Can — Salle Kingsway Point de rencontre dans le hall de l'hôtel InterContinental à 8 h
7 h 30 — 16 h	Golf au Hamilton Golf and Country Club	Point de rencontre dans le hall de l'hôtel InterContinental à 7 h 30
10 h 45 — 15 h 30	Voile sur le lac Ontario	Point de rencontre dans le hall de l'hôtel InterContinental à 10 h 45
8 h — 23 h 59	Montage des présentations scientifiques	Salle de bal « B »
8 h — 18 h	Montage de l'exposition	Ontario/Niagara et hall inférieur
11 h — 20 h	Inscription	Foyer du hall inférieur
18 h — 22 h	Réception de bienvenue incluant les commanditaires — Buffet	Ontario/Niagara et hall inférieur
19h	Souper-réunion de la direction de l'APC	Salle High Park
17 h — 19 h	Cocktail du APO AGM	Salle de bal « A »
19 h — 21 h	Souper-réunion de la direction de l'APO	Salle de bal « A »

Heures	VENDREDI 2 OCTOBRE	Lieu / Salle
24 heures	**Bureau**	**Salle Simcoe**
7 h — 17 h	Inscription	Foyer du hall inférieur
7 h — 8 h 30	Déjeuner avec les commanditaires	Ontario/Niagara et hall inférieur
8 h 15 — 17 h	Sessions scientifiques	Salle de bal « B »
12 h — 16 h	Programme pour conjoints/invités	Point de rencontre dans le hall de l'hôtel InterContinental à 12 h
10 h 30 — 11h	Pause avec les commanditaires	Ontario/Niagara et hall inférieur
12 h — 13 h 30	Dîner avec les commanditaires	Ontario/Niagara et hall inférieur
15 h 30 — 16 h	Pause avec les commanditaires	Ontario/Niagara et hall inférieur
17 h — 18 h	Dégustation de vins et fromages avec les commanditaires	Ontario/Niagara et hall inférieur
19 h	Souper à la tour du CN – Délégués, conférenciers et invités	Point de rencontre dans le hall de l'hôtel InterContinental à 19 h

2015 CONFERENCE PROGRAM

Time	SATURDAY, OCTOBER 3RD, 2015	LOCATION / SET UP
24 HRS	**Office**	**Simcoe Room**
7:00 AM — 4:00 PM	Registration	Lower Lobby Foyer
7:00 AM — 7:45 AM	CARDP AGM Member Breakfast	Ballroom “A”
7:30 AM — 8:30 AM	Breakfast with Sponsors	Ontario/Niagara & Lower Lobby
8:30 AM — 4:10 PM	Scientific Sessions	Ballroom “B”
10:10 AM — 11:00 AM	Break with Sponsors	Ontario/Niagara & Lower Lobby
12:00 PM — 12:30 PM	Pre Lunch reception with Sponsors	Ontario/Niagara & Lower Lobby
12:15 PM — 3:30 PM	High Tea at the Windsor Arms Hotel	Meet in Lobby Le Westin 12:15 PM
12:30 PM — 2:00 PM	CARDP Member & Guest Lunch	Ballroom “A”
4:30 PM — 6:30 PM	APC – Annual General Meeting	Kingsway & Wentworth Rooms
6:30 PM — 7:30 PM	President’s Reception	Lower Lobby Foyer
7:30 PM — 12:00 AM	President’s Party — Dinner Dance	Ballroom “A”

Time	SUNDAY, OCOTBER 4TH, 2015	LOCATION / SET UP
24 HRS	**Office**	**Simcoe Room**
9:00 AM — 12:00 PM	Clinic and Essay Meeting & Breakfast	Grenadier – Boardroom 15

Programme scientifique du Congrès annuel 2015 — Programme du Congrès 2015

Heures	SAMEDI 3 OCTOBRE	Lieu / Salle
24 heures 17 h	**Bureau**	**Salle Simcoe**
7 h — 16 h	Inscription	Foyer du hall inférieur
7 h — 7 h 45	Déjeuner des membres de l’ACDRP AGM	Salle de bal « A »
7 h 30 — 8 h 30	Déjeuner avec les commanditaires	Ontario/Niagara et hall inférieur
8 h 30 — 16 h 10	Sessions scientifiques	Salle de bal « B »
12 h 30 — 16 h	Thé d’honneur « High Tea » au Windsor Arms Hotel	Point de rencontre dans le hall de l’hôtel InterContinental à 12 h 15
10 h 10 — 11 h	Pause avec les commanditaires	Ontario/Niagara et hall inférieur
12 h — 12 h 30	Réception avec les commanditaires précédant le dîner	Ontario/Niagara et hall inférieur
12 h 30 — 14 h	Dîner – Membres de l’ACDRP et invités	Salle de bal « A »
16 h 30 — 18 h 30	APC – Assemblée générale annuelle et dîner	Salle Kingsway Wentworth
18 h 30 — 19 h 30	Cocktail du président	Foyer du hall inférieur
19 h 30 — Minuit	Gala du président — Souper et danse	Salle de bal « A »

Heures	DIMANCHE 4 OCOTBRE	Lieu / Salle
24 heures	**Bureau**	**Salle Simcoe**
9 h — 12 h	Déjeuner-réunion sur les cliniques et les conférences	Grenadier – Salle de réunion 15 (Boardroom)

Canadian Journal of Restorative Dentistry & Prosthodontics
The official publication of the Canadian Academy of Restorative Dentistry and Prosthodontics
CJRDP
JCDRP
Journal canadien de dentisterie restauratrice et de prosthodontie
Publication officielle de l'Académie canadienne de dentisterie restauratrice et de prosthodontie

Call for Papers

CARDP's Executive Board has concluded a publishing agreement with Palmeri Publishing Inc. The Academy's Journal (**CJRDP**/**JCDRP**) is published four times a year since 2008 with a circulation of 7,000 up to 13,000. The 2015 Journal Production Schedule is accessible at http://www.cardp.ca/sitedocs/2015%20CJRDP%20Production%20Schedule.pdf

Scientific articles are Peer Reviewed. The Journal welcomes article contributions from its members, guest dentists and dental technologists as well as the dental Industry.

Editor-in-chief: Dr. Hubert Gaucher

Associate Editors: Drs. Maureen Andrea, Emo Rajczak and Dennis Nimchuk

Section Editors: Drs. Kim Parlett, Ian Tester, Ron Zokol, Yvan Fortin, Paresh Shah, Izchak Barzilay, Peter Walford, Allan Coopersmith and Mr. Paul Rotsaert

Academic Liaison: Dr. Peter Taylor

I – Scientific Articles: (Original Research Studies, Reviews, Case Reports): Please refer to these "Instructions to Authors" for details. www.cardp.ca/sitedocs/CJRDP-Guidelines-PPI-PR1.pdf%2002-12.pdf

For Case Reports please review this information: http://www.cardp.ca/sitedocs/CJRDP-Case-Report-Authors.pdf

II – Member News: Please forward any news of interest to the Profession.

III – Young Authors Awards Fund: Financial contributions to this fund will recognize a dentist with 5 years' experience or less or a graduate student in Canada, with a $1,000 award for the best published article of the year.

IV – Dental Student Award Fund: Financial contributions to this fund will recognize a dental student in Canada, who will receive a $500 award for the best published article of the year.

V – Industry News and Product Profile Articles: New dental products, technologies and Industry services are presented to readers using articles that originate from the Industry and that are identified as such. This information is contained in the above "Instructions to Authors" and in the following Journal Media Kit: http://www.cardp.ca/sitedocs/MediaKit-2015-email.pdf

If you have comments or suggestions about submissions or would like to become more involved with the Journal, please contact the Editor-in-Chief:

Dr. Hubert Gaucher
hgaucher@sympatico.ca
Tel: (418) 658-9210
Fax: (418) 658-5393

Demande de communications

L'ACDRP a conclu une entente de publication avec Palmeri Publishing Inc. Le journal de l'Académie (**CJRDP**/**JCDRP**) est publié depuis 2008 et a une circulation de 7 000 à 13 000 exemplaires. Il y a quatre parutions par année. La cédule de production 2015 du Journal est accessible à http://www.cardp.ca/sitedocs/2015%20CJRDP%20Production%20Schedule.pdf

Les articles scientifiques font l'objet d'une revue par des pairs. Le Journal accueille des articles de ses membres, de dentistes et prothésistes dentaires invités ainsi que de l'Industrie dentaire.

Rédacteur en chef: Dr Hubert Gaucher

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Les progrès de la CAO/FAO en Prosthodontie

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