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Occlusion

Dr. Harry Rosen: Dentist and Sculptor/Dentiste et sculpteur

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Where Have All the "Gnathologists" Gone?

We are excited about bringing our readership a forum to discuss occlusion issues as they relate to the practice of dentistry in the 21st century.

Graduating classes are exposed to less and less occlusion related courses than any generation of dentists before them. Young graduates flock to teaching institutes which teach full mouth rehabilitation over the weekend! A trip to your local dental laboratory confirms that 90% of the prosthetics is fabricated on a simple "hinge mount" articulator, similar to a nut cracker!

Why is this? What has happened to the study of occlusion? Why did gnathology become a "four letter word" in organized/academic dentistry? *The Glossary of Prosthodontic Terms* defines gnathology as "the science that treats the biology of the masticatory mechanism as a whole: that is, the morphology, anatomy, histology, physiology, and the therapeutics of the jaws or masticatory system and the teeth as they relate to the health of the whole body, including applicable diagnostic, therapeutic, and rehabilitation procedures."[1]

Could there be a higher ideal for a young graduating dentist or for anyone practicing dentistry for that matter! Major M Ash, Head and Face Medicine 2007:3:1, wrote that the paradigm shift to evidence based dentistry that relates to occlusal therapy (OT), selective occlusal adjustment (OA), and stabilization splint (SS) therapy for TMDs has had an unfavourable impact on the teaching of many of the important aspects of occlusion needed in daily dental practice.[2]

The teaching of occlusion has practically been abandoned in our dental schools because of EBD induced contraindications for OA and SS. He argues that it is important to bring a clinical reality back into the dental curriculum by systematically teaching all aspects of occlusal management. A PubMed search of the topic of dental occlusion from 1990 to the present shows little active research being done. This is particularly evident in North America, as there is a complete lack of any occlusion related research emanating from our academic institutions.

A recent article in a prominent dental journal prompted me to write this first editorial. Titled, *Myths of Orthodontic Gnathology*, Dr. Donald Rinchuse wrote, that although originally founded on scientific principles, the application of the valid gnathologic research to clinical practice has moved away from these founding tenets. He argues that modern clinical gnathology has become a pseudo-science based on mechanistic, perfunctory procedures and instrumentation.[3] In so doing, this article covers many of the issues that are pertinent to not just orthodontics but all dentistry! Without sufficient research, conflicting treatment methodologies and outcomes we struggle with these questions everyday in clinical practice.

The authors are critical of orthodontic gnatholgy and gnathology in general in their article. It leaves the reader questioning the importance of many of the basic standards of treatment that we have become accustomed to! The authors use an extensive list of citations to apply an evidence-based model to their arguments. This list of references has served his biased point of view in several articles previously published by the author. I found his use of the literature to denounce the work of a deceased colleague rather critical and unfair!

We have published this article in its entirety for our membership to consider. (Please access the full text in your e-journal!)

I would remind our readers of a quote by WH. McHorris, "We cannot look back and be damned, nor can we deny the importance of mandibular centricity; instead let us profit from the work of these dental pioneers who have, by the process of elimination, success, and failure, done so much of our work for us. Let us incorporate those truths that have emerged from all the concepts into our diagnostic and treatment objectives, so we may better serve our patients."[4]

My hope is that we will stimulate your interest and be a little controversial and perhaps thought provoking with the possibility, to initiate a dialogue through our journal editorials that our members can benefit from. I hope you will enjoy this issue of the journal as much as we have enjoyed preparing it.

On behalf of the editorial board members, best wishes to all for the Holiday Season!

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Où sont passés tous les « gnathologues »

Nous sommes fiers de pouvoir proposer à nos lecteurs un forum de discussion sur les questions de l'occlusion comme on la conçoit dans la pratique dentaire au 21e siècle.

Les finissants en art dentaire sont de moins en moins exposés à des cours sur l'occlusion comparativement aux générations de dentistes avant eux. Les jeunes diplômés affluent dans les institutions d'enseignement qui offrent des cours d'une fin de semaine sur la réhabilitation de la bouche complète. Une petite visite à votre laboratoire dentaire confirme que 90 % des prothèses sont fabriquées sur un simple articulateur à « axe charnière » semblable à un casse-noisette.

Pourquoi en est-il ainsi? Qu'est devenue l'étude de l'occlusion? Le Glossaire des termes en prosthodontie définit gnathologie comme étant « la science qui traite la biologie des mécanismes de la mastication : ce qui signifie la morphologie, l'anatomie, l'histologie, la physiologie et le traitement des mâchoires ou du système de mastication et les dents en relation avec la santé en général, y compris le diagnostic, le traitement et la réhabilitation »[1].

Existe-t-il un idéal plus absolu pour un jeune dentiste ou pour tous ceux qui pratiquent l'art dentaire? Major M. Ash, médecine cranio-faciale 2007 :3 :1 a écrit que le changement de paradigme vers la dentisterie factuelle qui concerne le traitement de l'occlusion, l'ajustement occlusal sélectif, le traitement au moyen de gouttière de stabilisation pour le trouble de l'ATM a eu un impact défavorable sur l'enseignement de plusieurs des aspects importants de l'occlusion en pratique dentaire de tous les jours[2].

L'enseignement de la science de l'occlusion dentaire a pratiquement été abandonné par nos facultés dentaires en raison des contre-indications liées au traitement de l'occlusion et l'ajustement occlusal sélectif induites par la dentisterie factuelle. Il fait valoir qu'il est important de ramener une réalité clinique au programme d'études en enseignant systématiquement tous les aspects du traitement occlusal. Une recherche PubMed sur le sujet de l'occlusion dentaire de 1990 à nos jours démontre bien que peu de recherche active est faite dans ce domaine. Cela est particulièrement évident en Amérique du Nord, puisqu'il y a une absence complète de recherche liée à l'occlusion qui est effectuée dans nos facultés.

Un article récent publié dans une revue dentaire éminente m'a incité à rédiger ce premier éditorial. Intitulé *Mythes de la gnathologie orthodontique*, le Dr Donald Rinchuse a écrit que même si elle est fondée sur des principes scientifiques, l'application de la recherche valide en gnathologie à la pratique clinique s'est éloignée de ces principes fondateurs. Il argumente que la gnathologie moderne est devenue une pseudo-science basée sur des procédures mécanistes, routinières et instrumentales[3]. Ce faisant, cet article traite non seulement des sujets pertinents à l'orthodontie, mais aussi à tous les domaines de l'art dentaire. En l'absence de recherche suffisante, nous sommes aux prises avec des méthodologies thérapeutiques et des résultats contradictoires chaque jour en pratique clinique.

Ces auteurs examinent d'un œil critique la gnathologie orthodontique et la gnathologie en général dans leur article. Le lecteur doit alors se questionner sur l'importance des normes de base thérapeutiques auxquelles nous sommes habitués. Les auteurs utilisent une liste exhaustive de citations pour corroborer leurs arguments selon un modèle fondé sur les preuves. Les références ont été utiles à cet auteur pour défendre son point de vue biaisé dans plusieurs articles qu'il a publiés. Je trouve que son utilisation de la documentation pour dénoncer le travail d'un collègue décédé plutôt dangereuse et injuste!
Nous avons publié cet article au complet pour que nos membres en prennent connaissance. (Veuillez lire le texte en entier dans le e-journal.)

J'aimerais rappeler à nos lecteurs une citation de WH. McHorris : « Nous ne pouvons pas regarder en arrière et s'en ficher, ni nier l'importance de la relation centrée; au lieu de cela, profitons du travail des pionniers dentaires qui, par processus d'élimination, d'essais et d'erreurs ont accompli tant de choses pour nous. Incorporons les réalités qui ont été révélées de tous les concepts dans nos objectifs diagnostiques et thérapeutiques pour mieux servir nos patients »[4].

J'espère que nous susciterons votre intérêt et vous inspirerons à engager le dialogue par l'intermédiaire de l'éditorial pour que nos membres puissent en profiter. Je vous souhaite autant de plaisir à lire ce numéro que nous avons eu à le préparer.
Au nom des membres de l'éditorial, je vous souhaite une belle saison des Fêtes!

Dr Kim G. Parlett, DDS, MSc.
Co-rédacteur invité – Section occlusion

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Occlusion and TM Dysfunction

The terms occlusion and temporo-mandibular dysfunction (TMD) elicit various emotions when discussed by oral health care practitioners. All clinicians that are responsible for direct patient care recognize the importance of occlusion in dental restoration as well as the existence and need to treat TMD in their patients despite the controversies.

The predicament is how can we ensure that we apply sound scientific principles in our patient care with the plethora of misinformation and dogma that exists? It is our hope that by providing an opportunity for open discussion and scientific review in CJRDP we can revisit excellent research that has been forgotten, as well as offer a forum for establishing a consensus on how we can utilize the best current research in our day-to-day therapies. Avoidance of these topics because of lack of understanding of occlusion and TMD can ultimately serve no purpose. Our goal must be to seek the ideal in patient care.

As clinicians, it is important that we understand what the term evidence-based dentistry (EBD) means. The American Dental Association (http://ebd.ada.org/about.aspx 2010) defines EBD as "an approach to oral healthcare that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences" (http://ebd.ada.org). It is clear that to properly implement EBD in our patient care necessitates an individualized approach that takes into account our patient's desires and values, our education and clinical experience, and an excellent understanding of the available research.

Perhaps the most difficult conundrum that we face is the need to provide EBD that relies on statistically significant results when the nature of occlusal/TMD research is fraught with statistical "hazards" in both research design and measurement. The potential of bias occurs in any investigation due to the difficulty of double or triple blinding. Confounding factors may influence the results in an unknown way. For example, a study of cuspid guidance may determine that it is appropriate in the population studied. However, it is possible that on closer investigation, other factors (e.g., skeletal type, intercondylar distance, horizontal condylar inclination, etc.) may have a positive or negative influence. The determination that cuspid guidance is appropriate may in itself be too simplistic. How much guidance is appropriate? Is there a point where too much of good thing actually creates pathology?

EBD aims for the ideal that oral health care professionals must use the best evidence currently available in their everyday practice. This evidence is available from a variety of sources ranging from case reports to scientific papers. In the hierarchy of evidence, reliability is ranked depending on the type of research completed. Level one reliability of results comes from systematic review of well designed randomized controlled trials (RCT) and is ranked highest. While systematic reviews are considered the most reliable evidence, they are still only as reliable as the evidence assessed. Level two evidence comes from at least one well designed RCT with an appropriate sample size (n). Trials without randomization that are well designed constitute level three. Expert opinion and anecdotal findings through case reports remain at the lower end of the ladder of evidence (Evidence-Based Nursing Practice http://www.ebnp.co.uk 2010). Ideally, experimental design attempts to minimize both type I and type II errors, although this is not always possible. Type I errors (rejection of the null hypothesis when it is actually true) are affected by the level of significance of a study. In most studies, there is usually less than a 5% chance that the null hypothesis will be rejected when it is true (significance level less than or equal to .05). Normally, significance levels vary between 1% (.01) and 5% (.05). If the null hypothesis is rejected, it is rejected in favour of the alternate hypothesis. Type ll errors are the probability of retaining the null hypothesis

when it should be rejected because the alternate hypothesis is true. Strategies such as decreasing the standard deviation of the sampling distributions by decreasing score variability (more experimental control) or by increasing sample size will reveal a minimal meaningful difference. While these steps will increase the power of the study (reducing the possibility that the null hypothesis will be erroneously retained), they are challenging due to the nature of the human stomatognathic system. The system is inherently complex and, in our attempt to simplify it for study purposes, we run a major risk of missing the very nature of the system. It exists as a complex inter-relationship of different parts that are uniquely combined in each individual and, therefore, must be understood by looking at the whole. In order to provide proper evidence for scientific review, research design must pay particular attention to selecting the most homogeneous variables possible to allow clinically useful conclusions to be drawn. It is necessary for all oral health practitioners to recognize that in a structure as complex as the stomatognathic system, it is impossible to define a cause and effect between altering one variable and the resulting effect. Any procedure that alters even one variable in the system will subsequently influence many other structures.

The inherent paradox that unfolds as we study the difficulties in researching occlusion and TMD present practicing clinicians with a challenge. How do we best treat the person that is seeking our expertise? Perhaps the answer lies in understanding that each of our patients is an individual who must be assessed in a very comprehensive way. EBD dictates that we must combine our clinical judgement based on our experience, the patient's values and desires, and the available scientific research. Research, therefore, must concentrate on developing the means of identifying and better assessing all of the factors that are important to our patient's presenting situation. We, as clinicians, must perfect our skill at compiling the myriad of information that we obtain to produce a proper diagnosis and appropriate treatment plan. The ultimate goal must be to improve function. Finally, we should not ignore the past. A review of the history of occlusion and TMD is necessary to ensure that useful information from past research is not lost. In addition, an understanding of where we have been can help shape future research protocols to provide the answers that we must have to treat our patients effectively in an evidence-based manner.

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MESSAGE DU CO-RÉDACTEUR INVITÉ

Occlusion et trouble de l'ATM

Les termes « occlusion » et « trouble de l'articulation temporomandibulaire (ATM) » évoquent certaines émotions lors de discussions avec les cliniciens en santé dentaire. Tous les cliniciens qui sont responsables des soins des patients reconnaissent l'importance de l'occlusion en restauration dentaire ainsi que l'existence et le besoin de traiter le trouble de l'ATM malgré les controverses.

La situation difficile est la suivante : Comment assurer que nous mettons en application d'excellents principes scientifiques pour nos patients compte tenu de l'abondance de renseignements erronés et dogmatiques? Nous espérons qu'en donnant la chance de discuter ouvertement et de revoir les documents scientifiques dans le *JCDRP*, nous pourrons réexaminer l'excellente recherche qui a été oubliée et offrir un forum pour parvenir à un consensus sur la façon d'utiliser la meilleure recherche actuelle dans nos traitements quotidiens. Le soin mis à ne pas aborder ces sujets par manque de compréhension de l'occlusion et du trouble de l'ATM ne sert à rien. Notre but doit être de rechercher l'idéal en ce qui concerne les soins du patient.

En tant que cliniciens, il est important de comprendre ce que signifie le terme dentisterie factuelle ou fondée sur des preuves. *L'American Dental Association* (http://ebd.ada.org/about.aspx 2010) définit la dentisterie factuelle comme suit : « une approche aux soins dentaires qui requiert l'intégration judicieuse d'évaluations systématiques de preuves scientifiques pertinentes du point de vue clinique, en relation avec l'état de santé générale et buccale et les antécédents du patient et en tenant compte de l'expérience clinique du dentiste et des besoins thérapeutiques et des préférences du patient » (http//ebd.ada.org). Il est évident que pour bien mettre en application la dentisterie factuelle il faut une approche individualisée qui tient compte des

désirs et des valeurs de nos patients, de notre formation, de notre expérience clinique et d'une excellente compréhension de la recherche disponible.

Le problème particulièrement épineux auquel nous devons faire face est sans doute la nécessité de mettre à la disposition une dentisterie factuelle qui mise sur des résultats statistiquement significatifs lorsque la nature de la recherche sur l'occlusion ou le trouble de l'ATM recèle de

« risques » statistiques dans le modèle et l'évaluation de recherche. Le potentiel de biais se produit dans toute recherche en raison de la difficulté des études à double et à triple insu. Les variables confusionnelles peuvent influencer les résultats de manière inconnue. Par exemple, une étude sur la guidance canine peut déterminer si cela est approprié dans la population étudiée. Toutefois, il est possible que lors de l'examen plus approfondi, d'autres facteurs (p. ex. type squelettique, distance intercondylienne, inclinaison horizontale du condyle, etc.) peuvent avoir une influence positive ou négative. La détermination que la guidance canine est appropriée peut être en elle-même trop simpliste. Quelle guidance est appropriée? Y a-t-il un point où trop d'une bonne chose crée une pathologie?

La dentisterie factuelle vise l'idéal que les professionnels de la santé dentaire doivent utiliser les meilleures preuves actuelles disponibles dans leur pratique de tous les jours. Ces preuves sont disponibles d'une variété de sources variant de rapports de cas à des publications scientifiques. Dans la hiérarchie des données probantes, la fiabilité est classée selon le type de recherche terminée. La fiabilité des résultats de niveau 1 est établie de l'examen systématique d'études contrôlées, à répartition aléatoire, bien conçues et est classée comme étant le plus haut niveau. Bien que les examens systématiques soient considérés comme étant les preuves les plus fiables, leur fiabilité est fonction de l'évaluation des preuves. Les preuves de niveau 2 proviennent d'au moins une étude contrôlée, à répartition aléatoire, bien conçue dont la taille de l'échantillon (n) est appropriée. Les études sans répartition aléatoire qui sont bien conçues constituent le niveau 3. Les rapports d'experts et les rapports non scientifiques demeurent au bas de l'échelle des preuves (Evidence-Based Nursing Practice http://www.ebnp.co.uk 2010). Idéalement, le concept expérimental tente de minimiser à la fois les erreurs de type I et de type II, ce qui n'est pas toujours possible. Les erreurs de type I (rejet de l'hypothèse nulle lorsque c'est réellement vrai) sont marquées par le niveau de signification d'une étude. Dans la plupart des études, il existe habituellement moins de 5 % de chance que l'hypothèse nulle soit rejetée lorsqu'elle est vraie (niveau de signification inférieure ou égale à 0,05). Normalement, les niveaux de signification varient entre 1 % (0,01) et 5 % (0,05). Si l'hypothèse nulle est rejetée, elle est rejetée en faveur de l'hypothèse alternative. Les erreurs de type II sont les erreurs commises lorsqu'on décide de ne pas rejeter l'hypothèse nulle, alors que cette hypothèse nulle n'est pas vraie. Les stratégies telles que la diminution de l'écart type de la distribution d'échantillonnage en réduisant la variabilité du score (plus de contrôle expérimental) ou en augmentant la taille de l'échantillon donneront une différence significative minimale. Bien que ces étapes augmentent la puissance de l'étude (diminuant la possibilité que l'hypothèse nulle soit retenue par erreur), elles posent de multiples problèmes en raison de la nature du système stomatognatique. Le système est intrinsèquement complexe et, si nous essayons de le simplifier pour les besoins de l'étude, nous courons le risque de passer à côté de la vraie nature du système. Il existe sous forme d'interdépendance complexe de parties différentes qui sont combinées de manière unique chez chaque individu et, par conséquent, doivent être comprises en examinant l'ensemble. Dans le but de fournir des preuves adéquates pour l'examen scientifique, le plan de la recherche doit s'attarder à choisir les variables les plus homogènes afin de pouvoir tirer les conclusions les plus utiles sur le plan clinique. Il est nécessaire pour tous les cliniciens dentaires de reconnaître que dans une structure aussi complexe que le système stomatognatique, il est impossible de définir une cause et un effet entre la modification d'une variable et l'effet du résultat. Toute procédure qui modifie une variable dans le système peut avoir un effet sur plusieurs autres structures.

Le paradoxe inhérent qui se produit au fur et à mesure que nous étudions les difficultés de la recherche sur l'occlusion et le trouble de l'ATM représente un enjeu pour les cliniciens. Comment traitons-nous la personne qui fait appel à notre savoir-faire? Peut-être que la réponse réside dans la compréhension que chaque patient doit être évalué de manière individuelle et très détaillée. La dentisterie factuelle dicte que nous devons allier notre jugement clinique selon notre expérience, les valeurs et désirs des patients et la recherche scientifique disponible. Par conséquent, la recherche doit se concentrer sur le développement de moyens d'identifier et de mieux évaluer tous les facteurs qui sont importants au cas de notre patient. Nous, en tant que cliniciens, devons perfectionner notre aptitude à compiler une myriade de renseignements que nous obtenons pour poser le bon diagnostic et établir le bon plan de traitement. Le but ultime doit être d'améliorer la fonction. Finalement, nous ne devons pas ignorer le passé. Une revue de l'historique de l'occlusion et du trouble de l'ATM est nécessaire pour faire en sorte que l'information utile de la recherche antérieure ne soit pas perdue. De plus, une compréhension de ce qui a été fait antérieurement aidera à déterminer ce que seront les protocoles de recherche futurs afin de trouver les réponses que nous devons connaître pour traiter nos patients efficacement selon une manière fondée sur les preuves.

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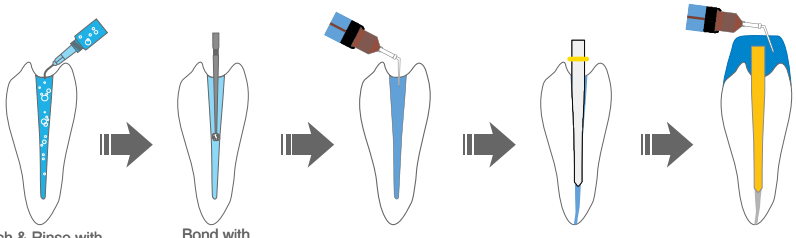

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Cover image of Dr. Harry Rosen and his sculpture "Little Hercules."
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"The Ascent"

Dentist and Sculptor: Dr. Harry Rosen, Founding and Life Member

The academy proudly features Dr. Harry Rosen's realisations as a practitioner, educator, and artist by quoting his own words when relating art to dentistry: "*In dentistry, first you deal with the task at hand by solving your patient's problem. Then it takes a certain amount of creativity and restructuring, working with the elements that you are presented with, and in many instances, seemingly creating something out of nothing.*"

The image above of "*The Ascent*" was recently inaugurated at the Montreal Jewish General Hospital. Depicting a man climbing a stone wall, it was inspired from the poet Robert Browning's phrase: "A man's reach should exceed his grasp or what's heaven for." Another notable sculpture by Dr. Rosen, "Little Hercules," (seen on the cover of this issue of *CJRDP*) was inaugurated at the Montreal Children Hospital last year. Its commemorative plaque reads: "I will be strong/Que la force soit avec moi" and is also truly inspirational. To view the making of these artworks and Dr. Rosen's dentist/artist lifelong achievements and contributions to the dental profession and his community, please visit www.drharryrosen.com.

Dr. Rosen is an active Professor Emeritus at the Faculty of Dentistry, McGill University, and also maintains a Restorative/Prosthodontic practice in Montréal, Québec. He can be reached at: drharryrosen@qc.aibn.com.

Dentiste et sculpteur : Dr Harry Rosen, membre fondateur et membre à vie

L'Académie est fière de présenter les réalisations du Dr Rosen, dentiste, éducateur et artiste, et de citer ses paroles lorsqu'il compare la dentisterie à un art : « En dentisterie, vous avez d'abord la tâche de résoudre le problème du patient. Puis il faut une certaine créativité pour restructurer et travailler avec les éléments en main et, dans certains cas, créer quelque chose à partir de rien. »

L'œuvre intitulé « *The Ascent* » a été inauguré tout récemment à l'Hôpital général juif – Sir Mortimer B. Davis à Montréal. Illustrant un homme escaladant un mur de pierre, il a été inspiré par une phrase du poète Robert Browning : « Il faut vouloir saisir plus qu'on ne peut étreindre, sinon pourquoi le ciel? » Une autre sculpture remarquable par le Dr Rosen, « Petit Hercule » (photo couverture de ce numéro) a été inaugurée à l'Hôpital de Montréal pour enfants l'an passé. Sur la plaque commémorative, on peut y lire ce qui suit : « Que la force soit avec moi ». Vous pouvez consulter le site www.drharryrosen pour en savoir davantage sur les œuvres et les réalisations du Dr Rosen en tant qu'artiste et dentiste, de même que ses contributions à la médecine dentaire et à la collectivité.

Dr Rosen est un Professeur Émérite actif à la Faculté de Médecine dentaire de l'Université McGill, et maintien une pratique de Dentisterie restauratrice et de Prosthodontie à Montréal, Québec. drharryrosen@qc.aibn.com.

2010 Annual Scientific Meeting of the Canadian Academy of Restorative Dentistry and Prosthodontics: October 14-16, Calgary, Alberta

By Dr. Chris von Rosenbach

Ophelia (Alfie) Spyker with the country dance band.

Left to Right, Dr. Rod Toms, Gerry Leewing, Dr. Carolyn Poonwoo, and Dr. Chris von Rosenbach.

Left to Right: Dr. Rick Freeman, Candace Freeman, Cathrine Robertson, and Dr. Dave Robertson.

Brigitte McIntrye and Conference Chair Dr. Ed McIntyre.

The dynamic city of Calgary, Alberta provided the perfect locale for this year's annual scientific meeting. With the Rocky Mountains providing a dramatic backdrop, the Calgary Westin Hotel, just steps from the Bow River, was the perfect venue to host our activities. Convention Chair Ed McIntyre and his committee saw to it that those lucky enough to arrive early had the option of going horseback riding in the foothills or having a fly fishing experience on the Bow River. The very satisfied fishing enthusiasts reported an excellent day trying to snag the wily denizens of that beautiful Western river. CARDP anglers, having gone after sturgeon at the Vancouver meeting and trout in Calgary, can now look forward to chasing down Lake Ontario salmon at the 2011 meeting in Toronto.

For the more serious-minded, the always popular pre-meeting hands-on course featured ceramist and photographer, Naoki Aiba, CDT from Monterey, California. Participants worked through the essentials of dentist-lab

collaboration, facilitated through the medium of digital photography. For those frustrated with shade mismatching, canted mid-lines, and visually unpleasing incisal edge lines, there were plenty of detailed techniques to help overcome these challenges.

The traditional Opening Reception and Buffet, which allows CARDP members and their guests to mingle and renew "auld acquaintance," was held in the foyer just outside the sponsor area. Our thanks here go to Dennis Nimchuk and his committee, for once again attracting strong sponsorship interest to our annual meeting.

In a departure from CARDP's traditional format, the Friday scientific session was a full-day program featuring just one speaker, the internationally renowned Dr. David Garber from Atlanta, Georgia. Dr. Garber's presentation had something for everyone. The morning program concentrated on principles of crown preparation, dealing with veneers, bonding, and aesthetic temporization techniques among other subjects of value to all participants. This was particularly appreciated by the younger dentists and dental students in the audience. These future CARDP members had an inspirational tour of many techniques, founded on solid principles, to enhance their daily practice lives. (One particular pearl: use a laser to simplify removal of veneers.) The afternoon session provided stimulating information for the more experienced dentists in the audience with a focus on implants, solving difficult aesthetic dilemmas, and treatment planning for complex cases. One highlight was the use of pink composite to reline pink porcelain, to allow for a very aesthetic solution to the problem of inadequate soft tissue volume.

The intellectual intensity of the day was then followed in short order by a wild and woolly Western Night at the Wainwright Hotel on the grounds of the famous Calgary Heritage Park. A delicious dinner featuring delectable Alberta beef was followed by line dancing and plenty of good ol' country music, featuring a very "colourful" band (both sartorially as well as musically). The guests from all across Canada left with a wonderful impression of "Wild Rose Country" hospitality.

Under the very capable guidance of Scientific Program Chair Bernard Linke the Saturday program featured four excellent speakers. The lead-off speaker, Dr. Kevin Lung, is an oral and maxillofacial surgeon practicing in Edmonton. Dealing with implant issues that most of us would have nightmares about, his presentation focussed on understanding good implant surgery principles, avoiding and dealing with bad outcomes and complications, and the truly ugly situations which he sometimes has to deal with. A video showing an accident suffered during a non-sanctioned extreme snowmobiling event which resulted in tremendous orofacial damage to a patient, was particularly disturbing. The excellent treatment outcome was a memorable testimony to the restorative powers available with good implant technique!

Dr. Glen H. Johnston, who has presented to the academy before, comes to us from the University of Washington. His subject was adhesive dentistry and dealt with this critical part of every dental practice. He emphasized in particular that the newer generations of single-bottle adhesives often don't perform as well as some of the earlier-generation two-bottle systems. Dr. Johnston recommended a couple of websites which are very useful in comparing dental materials; the ADA professional product review website; the American Air Force Medicine website; and the University of Washington website were listed as excellent resources.

Dr. Robert Miller, another past presenter, returned to lecture on the subject of dental lasers. This modality is becoming much more widely accepted by the dental community and is of particular usefulness with implants. The healing time from many surgical procedures can be cut virtually in half with a laser, as compared to conventional techniques. Dr. Miller examined factors important in the biology of healing and illustrated how the properties of the laser can be used to enhance the tissue healing process.

Mr. Naoki Aiba, CDT, closed out the morning with a condensed version of his hands-on program. The digital camera is an indispensible tool in the delivery of aesthetic dentistry to today's demanding consumer. Mr. Aiba's artistry in porcelain and digital photography were very much enjoyed by the appreciative audience.

A key feature that differentiates the CARDP meeting from other dental meetings, is the half-day session dedicated to table clinics. Douglas Lobb organized a stellar line-up of clinicians. CARDP members (who recognize the value of interactive learning in an intimate setting) were very complimentary of the exceptional quality of the this year's table clinics. In fact, the only complaint was that there was not enough time to take in all of the presentations offered!

As always, the social highlight for attendees and their guests was the President's Gala Dinner Dance, and this year's event was no exception. Outgoing president Vern Shaffner gave eloquent thanks for the help he received during his tenure. Incoming president Kim Parlett thanked Vern for all his hard work and welcomed everyone to next year's meeting, September 22 to 24 at the Royal York Hotel in Toronto. The diehards (you know who you are) danced all night and wrapped up the evening boogying to the beloved "Time Warp" from *The Rocky Horror Picture Show*. What more could anyone ask for?

e-Publishing: Is the Writing Still On the Wall?

Nowadays, all dental journals are expected to present article submissions electronically thereby allowing for cost-effective peer reviews, expedient modifications, and optimal printer layouts. In other words, a scientific publication's paper version is now based wholly on its digital version, bringing into sharp focus the paper version's shortcomings, namely limited author-reader interactivity, the absence of linked references, be they scripted, audio or video, and, not least, a restrictive content and circumscribed distribution associated with hefty printing costs.

We have all experienced, over the years, parting pangs when doing away with our hardcopy professional journals, due to both a lack of storage space and of the time required to manage a paper world. Consequently, our academy has moved to offer a condensed paper format *CJRDP* in favour of a more elaborate e-version for each issue dating back to last spring. A recent survey of past contributors found overwhelming support for this initiative indicating that these authors are receptive to the flexibility and interactivity that e-publishing affords.

A seamless transition to these two new journal concepts is foremost among your editorial board's priorities. We each have our own comfort zone with digital publications so an adaptation period is to be expected. After all, for the past 450 years, humans have gotten quite comfortable reading printed paper in handy, tactile, pliable, and linear configurations. And since we are experiencing the embryonic stages of e-publications, their full capabilities and usages are still very much unknown. We have yet to grasp the potential integrated networking forces of digital communications on the web.[1]

"Bibliophiles are branching out as devices become more book-like" is the lead caption on a recent cover story featuring "A budding interest in e-readers."[2] In this article, what with so many e-books already outselling hardcovers, at nearly half the cost, we are told to expect that by 2013, 50% of all book sales will be in e-presentation. "We are adapting to the notion that we can choose where, when and how we read books" as an estimated 4 million US homes own an e-book reader and sales projections of 29 million devices are anticipated for 2015.

You might therefore be tempted to compare and choose an e-book device from the randomly listed manufacturers, reviews and prices, from this same source[2]:

- Amazon's Kindle 3G and Wi-Fi ($189US); "Most comfortable to hold because of its light weight"
- Barnes & Noble's Nook 3G + Wi-Fi ($199US); "The colour touch screen for navigation is fun and easy to use"
- Sony Reader Pocket Edition ($179–$299US); "Smallest, most elegant-looking device tested; can slip into the pocket of your jeans"
- Libre by Aluratek ($99US); "Biggest wow factor is the price; shortest lag time for page-turns"
- Apple iPad ($499–$629); Super-cool: You can emulate a paper book by displaying left and right pages at the same time"

Thanks to hyperlinks, e-publishing can instantaneously allow you to access an incalculable number of sources and references. You could lose yourself surfing the dental literature within just a few clicks.

Add voice/reading software to these e-books and you could be listening to your recent *e-CJRDP* while driving to the office or on your morning jog.

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1. Greenstein D. Next-Generation University Publishing: A Perspective from California. Journal of Electronic Publishing 2010;13(2). Available at: http://quod.lib.umich.edu/cgi/t/text/text-idx?c=jep;view=text;rgn=main;idno=3336451.0013.205.

2 Minzesheimer B. A budding interest in e-readers, 1-2D, USA Today, October 20, 2010.

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INSTRUCTIONS TO AUTHORS

The paper version of the *Canadian Journal of Restorative Dentistry and Prosthodontics* publishes papers, which are subject to peer review. The *Journal* is primarily electronic with full articles available online; in addition, a print version of the abstracts from each article is also sent to all members of CARDP, subscribers to the print version, dental institutions, and associations. The *Journal* considers articles of original research, reviews, scholarly addresses, literature reviews, case reports, book reviews, historical interest, clinical tips, guidelines, letters to the editor, and so on. Requirements are in accordance with "Uniform requirements for manuscripts submitted to biomedical journals" (http://www.icmje.org). The editorial policies of the journal are in line with those of the Council of Science Editors (http://www.councilscience editors.org/services/draft_approved.cfm). The *Journal* endorses the CONSORT statement (www.consort-statement.org) relating to guidelines for improving the Evidence Based quality reporting of Randomized Clinical Trials (RCTs).

Authors must disclose any commercial interest in the subject of study and the source of any support. A covering letter should state that the work is original and should include the address for correspondence, as well as the phone and fax numbers and e-mail address to ensure rapid processing. Authors should identify their affiliation with a hospital or university department, and indicate if they are students or dentists. After acceptance of the manuscript, the author(s) must sign a copyright transfer agreement.

The electronic version of the *Canadian Journal of Restorative Dentistry and Prosthodontics* will contain all of the high-quality clinical research and review articles and editorial material of the paper version plus additional industry-driven elements such as **product profiles** and announcements. This electronic version of *CJRDP* will be published in conjunction with the paper version of the journal and will be widely distributed to all CARDP members as well as over 5,000 other dental professionals across the country.

The *Journal* reserves the right to edit manuscripts to ensure conformity with the Journal's style. Such editing will not affect the scientific content.

Manuscript Preparation

Manuscripts should be double-spaced and between 1,000 and 4,000 words. The manuscript must be sent by e-mail attachment (Word or Rich Text Format only). An abstract of up to 500 words should be provided, and a statement that the study was approved by the relevant research ethics board should be included, where relevant.

The lead author should also provide a brief bio sketch and high-resolution photo of himself or herself (see details regarding illustrations below).

References

References should be numbered consecutively in the text by superscript numerals. Corresponding references should be listed at the end of the text. Exhaustive lists of references are not encouraged. Unpublished sources such as personal communications should be cited within the text and not included in the reference list.

The sequence for journal references should be as follows: author(s); title of paper; journal name abbreviated as in the Index Medicus; year of publication, volume number, first and last page numbers. When there are more than three authors, shorten to three and add "et al."

Col NF, Eckman MH, Karas RH, et al. Patient specific decisions about hormone replacement therapy in postmenopausal women. JAMA 1997;277:1140-7.

The sequence for chapters of a book should be as follows: author(s) of chapter, chapter title, author(s) of book, book title, edition, place of publication, publisher, year of publication, page numbers.

Galloway AC, Colvin SB, Grossi EA, et al. Acquired heart disease. In: Schwartz SI, Shires GT, Spencer FC, eds. Principles of Surgery, 6th edition. New York: McGraw-Hill; 1994:845-99.

Tables and illustrations

Each table should be typed on a separate page, and should have a legend at the top indicating the information contained.

Illustrations may be sent electronically as a TIFF or JPEG file on a disk or CD. Do not embed images, etc., in text files. *Note: Figure reproduction cannot improve on the quality of the originals.*

Numbers, units, and abbreviations

Measurements are to be metric. In scientific text, physical quantities and units of time should be expressed in numerals, for example, 2 kg, 6 mmol, 5 hours, 4°C.
Use only standard abbreviations, and avoid using abbreviations in the title. Define all abbreviations on their first mention.

Permissions

Written permission must be obtained for material that has been published in copyrighted material; this includes tables, figures, and quoted text that exceeds 150 words. Signed patient release forms are required for photographs of identifiable persons. A copy of all permissions and patient release forms must accompany the manuscript.

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Only electronic submissions will be accepted.

INSTRUCTIONS AUX AUTEURS

Le *journal canadien de dentisterie restauratrice et de prosthodontie* publie des articles revus par des pairs. Le *Journal* est principalement électronique ayant ses articles intégraux en ligne. De plus, une version papier des abstraits de chacun des articles est envoyée à tous les membres de l'ACDRP, aux souscripteurs à la version papier, ainsi qu'aux institutions et associations. Le *Journal* accepte les articles de recherche, les revues, les articles scientifiques, les rapports de cas, les résumés de livre, les anecdotes historiques, les trucs cliniques, les lignes directrices, les lettres à l'éditeur et ainsi de suite. Les conditions essentielles correspondent aux « Exigences uniformes pour les manuscrits soumis à des revues médicales » (http://www.icmje.org). Les politiques en matière d'éditorial pour la revue sont celles adoptées par le Conseil des éditeurs en sciences (http://www.councilscience editors.org/services/draft_approved.cfm). Le *Journal* sanctionne l'énoncé CONSORT (www.consort-statement.org) ayant trait aux normes pour l'amélioration de la qualité des rapports d'études sur les essais cliniques aléatoires.

Les auteurs doivent déclarer tout intérêt commercial dans l'étude et la source de toute commandite. Une lettre d'accompagnement devrait révéler que le travail est original et comprendre une adresse pour toute correspondance, ainsi qu'un numéro de téléphone et de télécopieur et une adresse électronique pour que la demande soit traitée rapidement. Les auteurs doivent mentionner leur affiliation à un établissement hospitalier ou à une faculté de l'université et indiquer s'ils sont étudiants, résidents, chercheurs ou dentistes traitants. Une fois le manuscrit accepté, l'auteur ou les auteurs doivent signer un contrat d'exploitation des droits d'auteur.

Dans la version électronique du *Journal canadien de dentisterie restauratrice et de prosthodontie* y figureront des rapports sur la recherche clinique de haute qualité de même que des rapports de synthèse et les textes de fond de la version papier en plus des **profils de produits** et des annonces concernant l'industrie. Cette version électronique du *JCDRP* sera publiée en même temps que la version papier du Journal et sera distribuée à tous les membres de l'ACDRP ainsi qu'à plus de 5000 autres professionnels dentaires au pays.
Les instructions pour la soumission de profils de produit sont disponibles ici.

Le *Journal* se réserve le droit de réviser les manuscrits pour s'assurer de la conformité avec le style du Journal. Ces révisions n'affecteront pas le contenu scientifique.

Préparation du manuscrit

Les manuscrits doivent être rédigés à double interligne et compter entre 1000 et 4000 mots. Le manuscrit doit être envoyé par courriel sous forme de pièce jointe (Word ou Rich Text Format seulement). On exige un résumé d'un maximum de 500 mots et un énoncé que l'étude a été approuvée par les comités d'éthique à la recherche lorsque cela est pertinent. L'auteur principal devrait préparer une courte biographie et fournir une photographie à haute définition (voir les détails ci-dessous concernant les illustrations).

Références

Les références doivent être numérotées de manière consécutive dans le texte sous forme d'un exposant (indice supérieur). La liste des références correspondantes doit se trouver à la fin du texte. Les longues listes de références ne sont pas encouragées. Les sources non publiées telles que des communications personnelles devraient être citées dans le texte même et non dans la liste des références.

La manière de présenter les références pour une revue est la suivante : auteur(s); titre de l'article; nom de la revue abrégée comme dans Index Medicus; année de publication, numéro du volume, numéros de la première et de la dernière page. Lorsqu'il y plus de trois auteurs, limitez-vous à trois et ajoutez « et al. »
Col NF, Eckman MH, Karas RH, et al. Patient specific decisions about hormone replacement therapy in postmenopausal women. JAMA 1997;277:1140-7.

La séquence pour les chapitres d'un livre doit être la suivante : auteur(s) du chapitre, titre du chapitre, auteur(s) du livre, titre du livre, édition, lieu de publication, éditeur, année de publication, numéros de page.

Galloway AC, Colvin SB, Grossi EA, et al. Acquired heart disease. In: Schwartz SI, Shires GT, Spencer FC, eds. Principles of Surgery, 6e édition. New York: McGraw-Hill; 1994:845-99.

Tableaux et illustrations

Chaque tableau doit être dactylographié sur une page séparée et doit contenir une légende au bas pour expliquer le contenu.

Les illustrations peuvent être envoyées par courrier électronique sous forme de fichier TIFF ou JPEG sur une disquette ou un CD. Veuillez ne pas incorporer d'images, etc., dans le fichier texte. *Remarque : La reproduction des chiffres ne peut pas améliorer la qualité des originaux.*

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Toutes les mesures sont en système métrique. Dans un texte scientifique, les quantités et les unités de temps devraient être exprimées en chiffres, par exemple, 2 kg, 6 mmol, 5 heures, 4 °C.

N'utilisez que les abréviations standard et évitez d'utiliser des abréviations dans le titre. Définissez toutes les abréviations la première fois qu'elles sont mentionnées.
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Myths of Orthodontic Gnathology/ Mythes de la gnathologie orthodontique

By Donald J. Rinchuse and Sanjivan Kandasamy

About the Authors

Donald J. Rinchuse is a clinical professor at the School of Dental Medicine, University of Pittsburgh and in private practice in Greensburg, PA.

Sanjivan Kandasamy is a clinical senior lecturer in orthodontics, Dental School, The University of Western Australia; private practice, Perth, WA, Australia; and adjunct assistant professor in Orthodontics, Centre for Advanced Dental Education, St. Louis, MO.

ABSTRACT

By Dr. Kim Parlett, DDS, MSc

The purpose of this article is to dispel and debunk 10 myths of orthodontic gnathology. The authors have recently written on many topics dealing with orthodontic gnathology, and this article will help to more clearly elucidate and integrate the topics to explain the "big picture." The 10 myths of orthodontic gnathology are as follows:

Myth 1. Occlusion and condyle position are the primary causes of temporomandibular disorder (TMD). Occlusion and condyle position are believed to have only secondary roles in the etiology of TMD and thus treatment of TMD has evolved to a biopsychosocial-medical model.

Myth 2. Orthodontics causes TMD. Orthodontic finishing and certain mechanics have been blamed for the development of TMD but the evidence-based view is that TMD is not caused by orthodontics.

Myth 3. The modern view of TMD treatment is based on gnathologic principles. The current view of TMD treatment is based on the "biopsychosocial model.

Myth 4. Orthodontic gnathology recognizes and evaluates patients' parafunction and chewing cycle kinematics. The authors argue that the use of semi adjustable articulators in themselves do notlead to an evaluation of function.

Myth 5. A "high" restoration provokes TMD, but they are not primary to the development of TMD.

Myth 6. TMD asymptomatic subjects with internal derangement (ID) need treatment. The evidence-basedview is to let "sleeping dogs lie."

Myth 7. Centric relation (CR) is the key to the diagnosis and treatment of TMD. The historical interpretation and semantics of CR is discussed and discredited as well as the reproducibility and significance of bite registration techniques and deprogramming.

Myth 8. Canine protected occlusion (CPO) is the preferred functional occlusion type toward which to direct orthodontic patient treatment. Group function and balanced occlusion appear to be acceptable occlusal schemes. It is highly variable and dependant on the individual circumstances.

Myth 9. Articulators play a critical role in orthodontic diagnoses. Several published articles by the authors have been critical of the use of articulators for orthodontic diagnoses relative to CR and kinematics.

Myth 10. Many valid scientific studies support orthodontic gnathology.

Guest Co-editor's Note

The authors use an extensive list of citations to apply an evidence-based model to their arguments. In so doing they cover many of the issues that are pertinent to not just orthodontics but all dentistry! Without sufficient research, conflicting treatment methodologies and outcomes we struggle with these questions everyday in clinical practice. The authors are critical of orthodontic gnatholgy and gnathology in general in their article. It leaves the reader questioning the importance of many of the basic standards of treatment that we have become accustomed to!

It is our hope that it reprinting this article will stimulate dialogue amongst our readership for future postings.

RÉSUMÉ

Par Dr Kim Parlett, DMD, MSc

Le but de cet article est de réfuter 10 mythes de la gnathologie. Les auteurs ont traité de plusieurs sujets concernant la gnathologie orthodontique, et cet article permettra de mieux cerner la situation dans son ensemble. Les 10 mythes sont les suivants :

1er mythe. L'occlusion et la position du condyle sont les causes principales du trouble de l'articulation temporomandibulaire (ATM). On est d'avis que l'occlusion et la position du condyle jouent un rôle secondaire dans l'étiologie du trouble de l'ATM. Par conséquent, le traitement du trouble de l'ATM a évolué vers un modèle biopsychosocial et médical.

2e mythe. Le traitement en orthodontie est la cause du trouble de l'ATM. On blâme les soins orthodontiques et certaines techniques comme étant la cause du trouble de l'ATM, mais l'opinion fondée sur les preuves vient contredire ce mythe.

3e mythe. La façon moderne de traiter le trouble de l'ATM est fondée sur des principes de gnathologie. La façon courante est fondée sur le modèle biopsychosocial.

4e mythe. La gnathologie orthodontique reconnaît et permet d'évaluer la parafonction et le mouvement mandibulaire lors de la mastication. Les auteurs soutiennent que l'utilisation d'articulateurs semi-ajustables ne mène pas à une évaluation de la fonction.

5e mythe. Une restauration « haute » provoque le trouble de l'ATM, mais n'est pas primaire au développement du trouble de l'ATM.

6e mythe. Les sujets qui ne ressentent pas de symptômes du trouble de l'ATM en présence d'affection interne ont besoin d'être traités. Les preuves factuelles révèlent qu'il « ne faut pas réveiller le chat qui dort ».

7e mythe. La relation centrique (RC) est la clé du diagnostic et du traitement du trouble de l'ATM. L'interprétation historique et la sémantique de la RC est discutée et discréditée ainsi que la reproductibilité et la signification des techniques d'enregistrement de l'occlusion et de déprogrammation.

8e mythe. La protection canine est le type d'occlusion fonctionnelle préférée vers lequel vous voulez diriger le traitement orthodontique. La fonction de groupe et l'occlusion équilibrée semblent être des systèmes occlusaux acceptables. C'est très variable et fonction des particularités individuelles.

9e mythe. Les articulateurs jouent un rôle essentiel dans les diagnostics en orthodontie. Plusieurs articles publiés par des auteurs ont critiqué l'utilisation des articulateurs pour les diagnostics en orthodontie en ce qui concerne la relation centrique et la cinématique.

10e mythe. Plusieurs études scientifiques valides appuient la gnathologie orthodontique.

Note du co-rédacteur invité

Les auteurs utilisent une liste exhaustive de citations pour corroborer leurs arguments selon un modèle fondé sur les preuves. Ce faisant, ils ont abordé non seulement les sujets pertinents à l'orthodontie, mais aussi à tous les domaines de la Médecine dentaire. En l'absence de recherche suffisante, nous sommes aux prises avec des méthodologies thérapeutiques et des résultats contradictoires chaque jour en pratique clinique. Les auteurs examinent d'un œil critique la gnathologie orthodontique et la gnathologie en général dans leur article. Le lecteur doit alors se questionner sur l'importance des normes de base thérapeutiques auxquelles nous sommes habitués.

Nous espérons que la réimpression de cet article encouragera le dialogue et la rédaction d'articles parmi nos lecteurs.

The article below is reprinted with permission from the *American Journal of Orthodontics and Dentofacial Orthopedics* 2009;136(3):322–30.

Dr. Beverly McCollum established the Gnathologic Society in 1926. Gnathology is defined as "the science that treats the biology of the masticatory mechanism as a whole: that is, the morphology, anatomy, histology, physiology, and the therapeutics of the jaws or masticatory system and the teeth as they relate to the health of the whole body, including applicable diagnostic, therapeutic, and rehabilitation procedures."[1]

Many gnathologic research endeavors have added much to our knowledge and understanding of the stomatognathic system, particularly those involving chewing (masticatory) kinematics[2–13] and the early intraoral telemetry studies (to cite only a few).[14–17] Although originally founded on scientific principles, the application of the valid gnathologic research to clinical practice has moved away from these founding tenets. Modern clinical gnathology (vs university-based gnathologic research) has become, for the most part, a pseudo-science based on mechanistic, perfunctory procedures, and instrumentation.

There are many contemporary occlusal institutes that clearly have perverse views on gnathology that are not evidence-based. Dr. Lysle Johnston[18] sarcastically stated that

"gnathology is the science of how articulators chew." In the 1970s, Roth formally introduced the classic principles of clinical gnathology to orthodontics (orthodontic gnathology).[19–21] The notions and considerations of modern orthodontic gnathology are not based on principles of science and do not correspond to contemporary evidence-based thinking. There might not be a unified orthodontic gnathologic view, but it seems that the one established by Roth is by far the most notable.

In general, the objectives of modern clinical and orthodontic gnathology are (1) to establish coincidence of maximum intercuspation (or centric occlusion) with centric relation (CR) in an anterosuperior seated condylar position, (2) to attain canine (mutually) protected occlusion (CPO) and anterior guidance, and (3) to mount pretreatment diagnostic casts on a fully adjustable articulator (with some also recommending pantographic tracings and many recommending deprogramming before taking centric-bite registrations).[19–24]

Gnathologists believe that failure to achieve at least 1 of these objectives will predispose patients to signs and symptoms of temporomandibular disorders (TMDs).[19–21] The purpose of this article is to dispel and debunk 10 myths of orthodontic gnathology. We have recently written on many topics dealing with orthodontic gnathology, and this article will help to more clearly elucidate and integrate the topics to explain the "big picture."[22–29] The 10 myths of orthodontic gnathology are (1) occlusion and condyle position are the primary causes of TMD, (2) orthodontics causes TMD, (3) the modern view of TMD treatment is based on gnathologic principles, (4) orthodontic gnathology recognizes and evaluates patients' parafunction and chewing cycle kinematics, (5) a "high" restoration provokes TMD, (6) TMD asymptomatic subjects with internal derangement (ID) need treatment, (7) CR is the key to the diagnosis and treatment of TMD, (8) CPO is the preferred functional occlusion type toward which to direct orthodontic patient treatment, (9) articulators play a critical role in orthodontic diagnoses, and (10) many valid scientific studies support orthodontic gnathology.

MYTH 1: OCCLUSION AND CONDYLE POSITION (CR POSITION) ARE THE PRIMARY CAUSES OF TMD

Occlusion and condyle position were once thought to be the primary causes of TMD.[19–22,30,31] The temporomandibular joint (TMJ) pain dysfunction syndrome was thought to be a distinct disease caused by 1 etiologic agent (eg, occlusion or stress; later, it was thought to be caused by an eccentric condyle position).[32–34] However, past etiologic agents such as occlusion and condyle position have not been proven to be the primary cause of TMD.[35–49] Furthermore, TMD etiology and diagnosis are complicated because many diseases and dysfunctions can affect the TMJ complex and the neighboring structures of the head and neck.[23–26,50] TMD is now considered a collection of 6 subclasses of diseases and dysfunctions, with many causes for each subclass.[39,40] TMD treatments have changed from a dental-based model (ie, classic dental and jaw causative theories) to a biopsychosocial-medical model that emphasizes orthopedics, neuroscience, chronic pain theory, sleep neurophysiology, genetics, and psychosocial factors.[51–70] Because occlusion and condyle position are currently believed to have secondary roles in the etiology of TMD, these should reduce the significance of the orthodontic gnathologic view; gnathology is very much occlusion and condyle position oriented.[23–26,28,29]

MYTH 2: ORTHODONTICS CAUSES TMD

The orthodontic gnathologic view has argued that orthodontic treatment causes TMD from 2 possible perspectives. First, it causes TMD indirectly because nongnathologic orthodontists do not achieve a gnathologic occlusal finish and thereby produce an iatrogenic functional occlusion (ie, functional balancing interferences) and eccentric condyle (or CR) position that predisposes to TMD. The other possibility is that certain orthodontic appliances or techniques (eg, Class III mechanics, extractions, chin cups, and so on) directly cause TMD.[19–22,28,29] However, the evidence-based view clearly is that orthodontic treatment does not cause TMD.[71-75] This should have been a tremendous wakeup call to the premises of clinical gnathology that are clearly dental-based. Parenthetically, because the data demonstrating that orthodontic treatment does not cause TMD are population-based, it is still possible for an occasional orthodontic patient's TMJ complaint to be caused by treatment.

MYTH 3: THE MODERN VIEW OF TMD TREATMENT IS BASED ON GNATHOLOGIC PRINCIPLES (DENTAL BASED)

Contemporary TMD treatment has moved away from a historic, mechanical, dental-based model, no longer involving occlusal modification or jaw-repositioning protocols.[50,65,66] The current evidence-based view of TMD treatment is now a biopsychosocial model.[51–64] Dworkin[76] stated that "the biopsychosocial model remains the best approach to gaining an understanding for how to integrate the host of biologic, clinical and behavior factors that may account for the onset, maintenance and remission of TMD, as well as for understanding how to make rational choices for treatment." Genetics related to pain and imaging of the pain-involved brain, central brain processing of thinking and emotions, endocrinology, and so on, are the exciting future. Treatments that are effective for all forms of chronic pain are equally effective in mitigating TMD pain.[54,63,65,66] Cognitive behavioral therapies and biofeedback are becoming the recognized initial and early treatment modalities for TMD.[51–53,55,56,63,64] However, there is support for the belief that occlusal splints (stabilizing-type splints are recommended) work best initially, and cognitive behavioral therapies and biofeedback work better later.[56,59–61] Cognitive behavioural therapies involve many treatments emphasizing stress reduction and cognitive awareness: education regarding mind-body relationships with stress management, relaxation training, distraction and pleasant activity scheduling to reduce the impact of pain on activities, cognitive restructuring, self-instructional training, and maintenance skills.[64]

MYTH 4: ORTHODONTIC GNATHOLOGY RECOGNIZES AND EVALUATES PATIENTS' PARAFUNCTION AND CHEWING CYCLE KINEMATICS

Two important aspects of human jaw function are not evaluated by the orthodontic gnathologic approach, particularly in relation to articulator mountings: parafunction and

chewing cycle kinematics. The harshest and perhaps the most destructive occlusal forces are produced from parafunction—bruxing and clenching.[77]

In this regard, it seems that it is not so much the type of occlusion or CR position that a TMD patient has as it is how the patient uses his or her teeth and jaws.[22–24] Patients with optimal and ideal static and functional occlusions (or condyle positions) have TMD, and vice versa. This stresses the importance of properly evaluating a patient's parafunction irrespective of the type of occlusion or condyle position. Incidentally, it was once incorrectly thought some 50 years ago during the "occlusionist" era (and still espoused today) that parafunction was caused by occlusal prematurities or interferences and that bruxing was nature's attempt to resolve the occlusal problems by grinding them away. Current evidence clearly supports the notion that parafunctional habits are basically a central nervous system phenomenon (mediated by the limbic system) and not of occlusal origin.[78–85]

The other aspect of human jaw function that is not evaluated by orthodontic gnathology (particularly by articulator mountings) is chewing cycle kinematics. It is understood that the chewing pattern shape as viewed from the frontal aspect is described as a tear drop.[2,4,43] There are about a half dozen different chewing patterns.[2–4,23,24] This elliptical chewing motion can vary significantly from person to person.[2,4] Simply stated, some patients have a more vertical chewing pattern; in others, it can be more horizontal.[2,4,24] Chewing kinematics can vary based on several factors such as age, dental static occlusion, facial morphology, and so on.[2–4,43,85] For instance, in the developmental stage of the deciduous dentition, chewing pattern shape (judged from the frontal aspect) is very much lateral, with the mandible circling out on opening and circling inward (medially) on closing in a narrow and tight loop.[4] In the developmental stage of the permanent dentition, chewing pattern shape (judged from the frontal aspect) is not nearly as lateral; on opening, the mandible circles inward (medially) and, on closing, circles outward (laterally) in a larger loop than that in the deciduous dentition.[4] The length of the chewing stroke is approximately 16 to 19 mm with about 20 masticatory strokes before swallowing, taking about 12 seconds.[4] The consistency and shape of chewing kinematics vary for patients with deep bite malocclusions.[86] A logical hypothesis might be that those with more vertical chewing pattern shapes adapt best to CPO, whereas those with more horizontal chewing patterns function best with group function or balanced occlusions.[24]

With the above in mind, how does the orthodontic gnathologic approach (and articulator recordings and mountings) account for, and take into consideration, each patient's parafunction and chewing kinematics?

MYTH 5: A "HIGH" RESTORATION PROVOKES TMD

In 1995, Roth[87] wrote: "I would like to have the opportunity of placing a 'high molar restoration with balancing interferences' in the mouths of all who believe that occlusion has nothing to do with TMD." He used this intuitively appealing argument to support the notion that occlusal interferences are the primary cause of TMD. Certainly, it would be illogical to argue that gross occlusal disharmonies would not adversely affect the stomatognathic system and potentially have some negative impact on the TMJs. The modern evidence-based paradigm does not argue that occlusal interferences (this is in sharp contrast to balancing contacts that are generally considered benign and typically do not need occlusal adjustments) are no longer a possible etiologic agent for TMD. The argument is that they now are not primary and have a lesser (secondary) role than once thought. Occlusal equilibration of gross occlusal prematurities is still within the realm of evidence-based care.[22–27,88] The occlusal provocation studies (provoked or produced occlusal interferences in subjects) are equivocal as to the role of high restorations causing TMD.[89–92]

TMD is certainly a potential consequence of a provoked high restoration, but so are headaches, tooth mobility, fremitus, and so on. Furthermore, most occlusal provocation studies are biased because they typically used dental students (or nurses) as subjects who had some notion of the possible outcome of the intervention.

Curiously, some subjects in their control groups (with no high restorations) also had some of the same outcomes (eg, headaches and TMD) as those in the experimental group. Increasing the vertical dimension of occlusion does not generally negatively impact the TMJs unless there is a preexisting ID.[93–96]

MYTH 6: TMD ASYMPTOMATIC SUBJECTS WITH ID NEED TREATMENT

It has been estimated that as many as 30% of TMD asymptomatic subjects have ID.[97-99] The issue becomes whether TMJ ID predispose TMD asymptomatic subjects to TMD later on. And if this is true, the next question is whether these subjects need some form of dental or orthodontic treatment to mitigate future TMD. A relationship (studies were associational and not cause-and-effect) has been established between TMJ ID and craniofacial morphology (although the differences were small).[100–102] TMJ disc abnormality was associated with reduced forward growth of the maxillary and mandibular bodies; for adolescents, there was reduced growth of the mandibular ramus.[100,103] It is not a leap of faith to believe that TMJ disc pathology can affect condylar growth.[100] It has been hypothesized that untreated (or inadequately treated) TMJ ID will most likely lead to pain, degenerative joint disease, compromised mandibular growth, and other negative conditions.[103,104]

There is general agreement that some consideration of this information should be factored into an orthodontist's thought process during treatment planning.[100–102] Nonetheless, the orthodontic gnathology camp (Dr Kazumi Ikeda[105]) argued that these subjects need treatment involving a nighttime occlusal stabilizing splint initially (in the past, the argument was for repositioning splints) followed perhaps by comprehensive orthodontic treatment. Roth[87] always contended that it is not just good enough to maintain a patient's status quo as related to TMJ health, but orthodontists have a higher obligation—to improve their patients' TMJ health status.

It is believed that the best time to treat ID is early, before significant disc, skeletal, and

occlusal changes occur while patients have optimal capacity for tissue repair and growth: ie, when they are young.[103] In addition, it is believed that most initially asymptomatic patients will become symptomatic usually after growth is complete and when the TMJs have progressed to a nonreducing disc displacement and degenerative joint disease; at this stage, treatment would be significantly less effective.[103,104] The contending view, and perhaps the logical and evidence-based view, is to "let sleeping dogs lie" and not to treat these patients because they are TMJ asymptomatic.[106,107] To treat these patients might do more harm than good, since there seems to be no practical and evidence-based treatment options for correcting these TMJ anatomic disc derangements. In addition, no scientific evidence shows that treatment will mitigate future TMD. Furthermore, the relationship of disc displacement to pain, mandibular dysfunction, osteoarthrosis, and growth disturbances is unclear.[106] Not all growing patients with disc displacements grow abnormally, nor do all patients with growth deficiencies have disc displacements.[54,107,108] Interestingly, it was also demonstrated that patients with moderate to severe TMD with associated disc displacement without reduction will improve without treatment over a 2.5-year period.[108] It would seem that, if disc displacement were a significant cause of mandibular growth deficiency, its signs and symptoms would be more common in this population than in the normal population. Finally, the relationship between disc displacement and TMD is complex; the causes are multifactorial (eg, trauma, genetics, stress, and pathology) and therefore cannot be simply explained by disc displacement.[107]

MYTH 7: CR IS THE KEY TO THE DIAGNOSIS AND TREATMENT OF TMD

Roth[87] stated: "If condylar position is not important in orthodontics, how did the term 'Sunday Bite' ever arise?" CR has been defined in so many different ways that it has lost credibility.[109] The concept of CR has historically and arbitrarily migrated from a posterior to a posterosuperior position to recently the most anterosuperior position of the condyles in the glenoid fossa.[23] It would be difficult to prove that any CR position is correct for all patients. There appears to be a range of CR positions. In this respect, one study found that 89% of condyles were not concentric.[110] It seems that mid to anterior sagittal CR positions might be better than a retruded position; however, in some patients, a retruded CR is the healthy norm.[99,111] The American Dental Association in TMD conference reports in 1983 and 1990 stated that "there is insufficient evidence that eccentricity of the condyles in the glenoid fossa will predispose to TMD or any other health consequence."[39,40] Johnston[18] sarcastically wrote about the absurdity of the many false notions of CR: "it could be argued that the progressive modification of Centric Relation (definition) has done more to eliminate centric slides than 20 years of grudging acquiescence to the precepts of gnathology." The gnathologic view dictates that maximum cuspation, or centric occlusion, should be coincident with CR (anterosuperior).[2–4] In the early 1970s, Roth[19–21] argued that the correct CR position was a retruded, posterosuperior position. Early intraoral telemetry studies did not support the concept of a retruded CR.[14–17] Roth's view (and that of gnathology per se) was proven fallacious, and he recanted his previous view of retruded CR and adopted the contemporary view of anterosuperior CR.[19–23] The past notion of retruded (posterosuperior) CR by the orthodontic gnathologists was wrong despite the sad fact that many orthodontists blindly followed this thinking for decades. How much confidence and credibility should we have for orthodontic gnathology with its mired history and false thinking? Furthermore, what happened to orthodontic gnathology patients treated to the old retruded centric position? Did they develop TMD? There are also many problems and issues related to CR records. As Nuelle and Alpern[112] wrote: "Doctor selected TMJ positioning at the dental chair is a blind procedure." Centric records have been shown to be somewhat reliable, but their validity has not been substantiated.[22,23] The orthodontic gnathologic view that claims that the Roth "power centric bite registration" seats patients' condyles in an anteroposterior CR needs to be verified by magnetic resonance imaging data. This becomes especially important because Alexander et al[113] clearly demonstrated in a magnetic resonance imaging study that condyles are not exactly located in the CR positions that clinicians believe them to be.

In addition, how do we know which of the many promulgated CR recordings (and positions) is correct? In this respect, there are at least 6 occlusal philosophies in dentistry (not limited to orthodontics).[28] Five of the 6 views can be considered gnathologically based views: classic gnathology (dating back to Stallard, Stuart, Thomas, and Lucia); bioesthetic dentistry (based on the work of Robert L. Lee); Dawson, Pankey Institute; neuromuscular school (Las Vegas Institute, Jankelson Myotronics view); and the Roth orthodontic gnathologic view. The sixth view is the nongnathologic view, which essentially supports taking a reliable centric occlusion (maximum intercuspation) bite registration as has been traditionally done for the last century. Of course, there can be many variations of this nongnathologic view. The various occlusal schools differ mainly on their view of CR—its position, but more so on how it is recorded. There are various philosophies concerning manipulation techniques to record CR, deprogramming, and whether to use a facebow or an earbow transfer. So, each occlusal philosophy is competing with the others on the proper definition and correct recording technique of CR; this further complicates and muddles the issue of CR, making any 1 view less valid and important.

MYTH 8: CPO IS THE PREFERRED FUNCTIONAL OCCLUSION TYPE TOWARD WHICH TO DIRECT ORTHODONTIC PATIENT TREATMENT

We have discussed the problems with the notion of ascribing to the philosophy and concept of CPO for all orthodontic patients and treatments.[24] A summary of what we wrote in this comprehensive article follows.

CPO, as the optimal type of functional occlusion to establish in orthodontic patients, is equivocal. Woda et al[114] wrote, after a comprehensive review of the literature, "Pure canine protection or pure group function rarely exists and balancing contacts seem to be the general rule in the population of contemporary civilizations." Modern evidence does not support a view that blindly adheres to the concept of CPO for all patients.

One type of functional occlusion should not be considered optimal and preferred for all patients. CPO is merely 1 of a few possible

functional occlusion schemes that might be attained with orthodontic treatment. Subjects with normal static occlusion (or Class I occlusions) tend to have balanced occlusion or else group function, and not CPO.[115,116] Group function and balanced occlusion (with no interferences, only balancing contacts) appear to be acceptable functional occlusion schemes, depending on the patient's unique characteristics. The stability and longevity of CPO is questionable. Reestablishing functional occlusion through orthodontic treatment back to the original type before treatment is problematic, since orthodontic treatment is often started before the permanent canines have fully erupted. It would also appear that consideration of chewing cycle kinematics, craniofacial morphology, static occlusion type, current oral health status, and parafunctional habits might provide important and relevant information about the most suitable functional occlusion type for each patient.[24]

MYTH 9: ARTICULATORS PLAY A CRITICAL ROLE IN ORTHODONTIC DIAGNOSES

We have written several evidence-based reviews that argued against the validity of articulators in orthodontics.[22,28,29] Therefore, this section will merely summarize some pertinent points in these articles. There are many types of articulators: arcon, nonarcon, fully adjustable, semi-adjustable, polycentric hinge, and so on. Alpern and Alpern[117] presented a strong argument that the polycentric hinge articulator might have some advantages over the others. Articulators can be useful for gross fixed and removable prosthodontic and orthognathic surgical procedures to at least maintain a certain vertical dimension while preclinical laboratory procedures are performed on dental casts. A main criticism of articulators in orthodontics is based on the study by Lindauer et al.[118] They found that, during opening and closing, the condyles not only rotate but simultaneously translate (move downward and forward); there is an instantaneous center of rotation. Articulators are based on the faulty notion of a "terminal hinge axis," which goes back to a half-century-old claim of Posselt, that, in the initial 20mmor so of opening and closing, the mandible rotates similarly to a door hinge (and does not simultaneously translate).[118] However, Posselt formulated his view when CR was viewed as a posterosuperior, retruded (and not anterosuperior) CR position, and, during the recording of CR, distally guided pressure was applied to the chin, the most obvious reason for Posselt's finding of a "terminal hinge axis."[22] Furthermore, Mohl35 believed that the sensitivity and specificity of articulator-mounted casts in the diagnosis of TMD are poor. In addition, there is no valid evidence that performing articulator mountings improves patients' stomatognathic health. Interestingly, one of the most reliable and valid reports by the orthodontic gnathologic camp states that the difference between gnathologic and nongnathologic diagnostics is perhaps 1 to 2 mm, and this is only in the vertical plane.[119] Also, articulators cannot accurately simulate jaw movements. Bite registrations are static, and patients are not asked to chew or function. There is no proven validity of bite registrations and where the condyles are located as a consequence of such recordings. Articulator mountings, for the most part, have not been shown to affect orthodontic diagnoses or treatment plans.[120] After all the effort involved in mounting and the attention paid to the minute details of occlusion and condylar position, little consideration is given to the physiologic adaptation of the dentition after posttreatment occlusal settling. In children, the glenoid fossa complex changes with growth; this implies that new mountings would need to be routinely performed throughout treatment. Although argued by orthodontic gnathologists as not true, it takes more time and cost to perform the mountings.[22]

MYTH 10: MANY VALID SCIENTIFIC STUDIES SUPPORT ORTHODONTIC GNATHOLOGY

We have published our criticisms of many orthodontic gnathology studies.[22,25,28,29] We would, therefore, like to briefly address only the recent study of Cordray.[121] First, few studies are perfect and meet all requirements of great research. However, the study by Cordray (and others by orthodontic gnathologists) is more problematic than the typical published study.[29] Cordray seemed to believe that it was possible to evaluate and test the effect of "neuromuscular deprogramming" (with a tongue blade) on centric bite registrations.

However, the study design precluded such an evaluation. Two independent variables (deprogramming and gnathologic bite registration) were confounded and commingled into 1 recording, so that the single, isolated effect of deprogramming alone (vs no deprogramming) could not be accurately determined. To effectively ascertain the true influence of deprogramming (if there was one), a third group would have had to be added—a gnathologic group without deprogramming. In addition, Cordray claimed to support the view that orthodontic gnathology (with articulators) is valid because it can help to better discern and elucidate the correct orthodontic diagnosis (by correctly determining the so-called correct centric bite registration). This conclusion was impossible for a number of reasons: not all the errors were accounted for, the large standard deviation was not explained, there were no blinding and no information on how the nongnathologic centric records were performed, and so on. Furthermore, Cordray did not mention the contradictory findings of Kulbersh et al[122] and Ellis and Benson.[120] More importantly, even if there is a difference in centric recordings when deprogrammed or gnathologically determined, there is the problem in assuming that the newer, deprogrammed record is better (more physiologic) than the original one.[22,23,123]

CONCLUSIONS

It is time to reconsider the validity of the age-old ideas of orthodontic gnathology that are based on rhetoric, blind faith, art, emotionalism, and practice management rather than on science and evidence. Orthodontic gnathologists have proved no health benefit to justify the many perfunctory exercises of the philosophy. The focus of orthodontic gnathology (and the clinical gnathologic view) was on the relationship of occlusion, then condyle position, and now TMJ disc position, dysfunction, and disease on the stomatognathic system (particularly regarding TMD). The view that occlusion and condyle position are the primary causes of TMD, and that diagnoses and treatments should be based on these notions, has been discredited. There is little to no evidence that treating subjects with TMJ ID will prevent or mitigate future TMD. If we are to embrace the concept of "evidence-based" treatment, the specialty will eventually have to carefully evaluate the quality of the evidence and its

message within the context of a contemporary orthodontic practice. The dated ideas and art of orthodontic gnathology may actually be a waste of time for the average orthodontic patient. It is up to us to decide. In the end, the day-to-day application of any "philosophy" must ultimately measure up with literature that is pertinent to orthodontics.

In orthodontics, everything "works" well enough to support a practice. Thus, the fact that something is used "successfully" does not mean that it is correct. Gnathology may make the orthodontist feel better; however, there is little evidence that the same benefits accrue to the patient.

DISCLOSURE

The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.

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Occlusal Function and the Single Crown
Fonction occlusale et couronne

By Mr. Paul Rotsaert RDT

About the Author

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ABSTRACT

The concept of the occlusal compass was originally proposed by Michael H. Polz to help technicians wax-up occlusal forms of crowns. The movements of an antagonistic cusp across the occlusal table of a tooth are described with sequential waxing completed to allow proper clearance in all excursions. This article describes the use of the occlusal compass in the waxing of an upper and a lower 6-year molar. The concepts outlined can be applied to all restorative materials including amalgam, composite, gold, and porcelain.

RÉSUMÉ

Le concept du compas occlusal a été proposé au départ par Michael H. Polz pour aider les techniciens à préparer des modèles en cire de formes occlusales de couronnes. Les mouvements d'une cuspide antagoniste sur la face occlusale d'une dent sont décrits par cirage séquentiel complété pour permettre le jeu dans toutes les directions. Cet article décrit l'emploi du compas occlusal dans la préparation de modèles de cire d'une molaire de six ans de la mandibule supérieure et inférieure. Les concepts décrits peuvent s'appliquer à tous les matériaux de restauration y compris l'amalgame, le composite, l'or et la porcelaine.

When we are taught tooth morphology the emphasis is usually on the features of each individual tooth. The functional aspects are often glossed over or are presented in a manner that causes a great deal of confusion. The concept of the occlusal compass was proposed by Michael H. Polz to help technicians wax-up occlusal forms of crowns. The occlusal compass describes the movements of an antagonistic cusp across the occlusal table of a tooth.

In its basic form the occlusal compass is made up of four movements of the mandible: protrusion, the forward movement of the mandible; laterotrusion, the movement of the mandible away from the midline; mediotrusion, the movement towards the midline; and lateroprotrusion, a combined movement with forward and lateral components.

The three-dimensional pathways are dependent on the geometries of the anterior guidance (lingual surfaces of maxillary anterior teeth) and the posterior determinants (articular eminence, head of the condyle, condylar disc and other associated soft tissues). Figures 1 and 2 show these movements. Note that these movements are paired: a right laterotrusion (teeth) and a left mediotrusion (condyle) are the result of the same movement. In the occlusal design concept the laterotrusive side guidance (canine) will cause the mediotrusive side to disclude. This protection of the mediotrusive side is significant because this is the side where the condyle is translating down the eminence. Any mediotrusive contact can cause significant deflections of the condyle, potentially leading to derangement of the temporomandibular joint.

The advantage of working with full-arch models that are facebow mounted is that the anterior guidance components are present and thus can be used to more accurately approximate the movements of the patient's mandible. Having the guidance components from the right side is critical for simulating the mediotrusive movement on the left side.

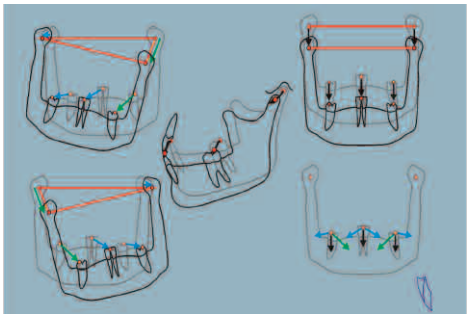


Figure 1. Mediotrusive, laterotrusive, and protrusive movements of the mandible and teeth superimposed.

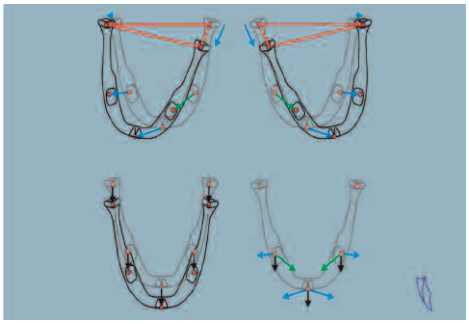


Figure 2. Mediotrusive and protrusive movements of the mandible.

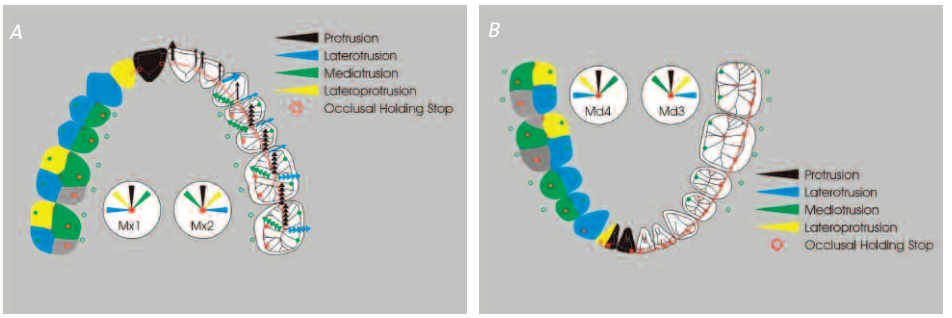


Figure 3. *A* and *B*, Illustration of pathways of the opposing cusp tips on the right side of the diagram: on the left side, the colour coding of the teeth represents the parts of the occlusal surfaces that are significantly influenced by the specific movement.

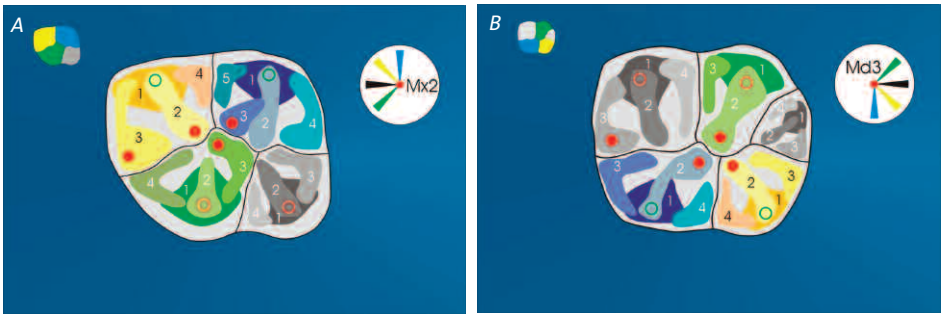


Figure 4. *A* and *B*, View of the occlusal compass to the individual first molars.

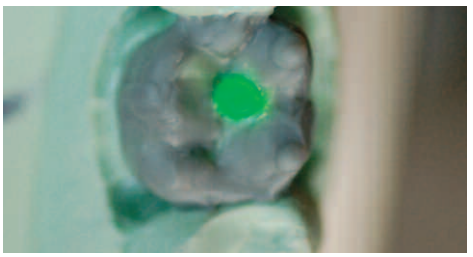


Figure 5. Occlusal view of cusp sketches.

Figure 6. Buccal view maximum inter-cuspal position.

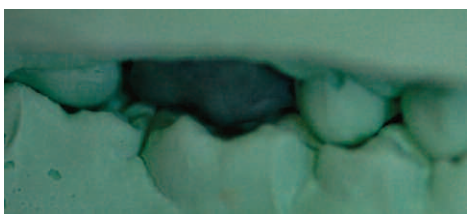


Figure 7. Lingual view maximum inter-cuspal position

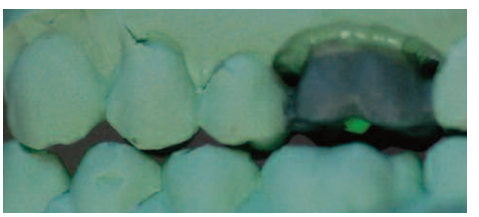


Figure 8. Buccal view laterotrusion.

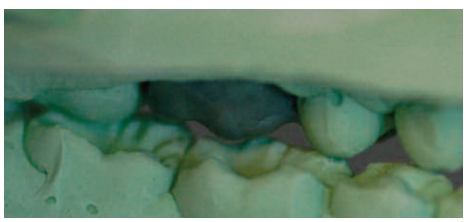
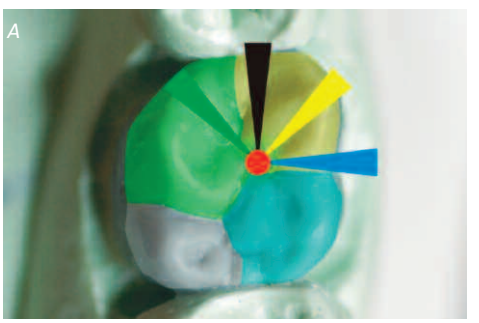


Figure 9. Lingual view mediotrusion.



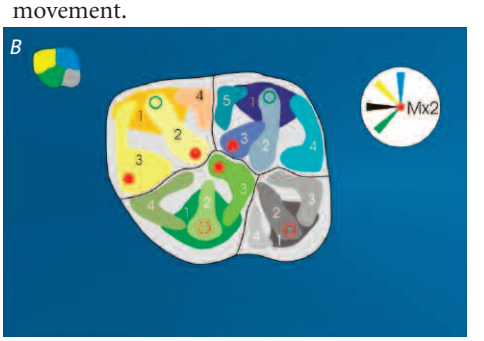


Figure 10. *A* and *B*, Development of the cusp morphology of the upper molar.

Anterior guide tables on articulators can help when the anterior guidance is missing or incomplete. Ideally correct sagittal condylar inclinations can be recorded using condylography.

Figure 3 illustrates the pathways of the opposing cusp tips on the right side of the diagram; on the left side the colour coding of the teeth represents the parts of the occlusal surfaces that are significantly influenced by the specific movement.

Figure 4 takes the view of the occlusal compass to the individual first molars. The patterns illustrate the waxing sequence for the development of the occlusal surfaces. By waxing the occlusal morphology cusp by cusp we are able to focus on the specific pathways that influence the morphology of each cusp.

The stamp cusps that land in the center of the opposing teeth have the greatest influence on the occlusal morphology. In the example of an Angle Class I occlusal scheme it is the middle buccal cusp of the lower molar (the stamp cusp) that drives the occlusal morphology of the upper molar. The key to developing the occlusal morphology is locating the occlusal stop on the occlusal table. In this example a single stop is waxed and based on its position it is connected to one of the triangular ridges. The cusp positions are then sketched in (Figure 5). The two buccal shear cusps of the upper molar are positioned so that the middle buccal cusp of the lower molar moves between them in the laterotrusive movement (Figures 6 and 8). The mesiolingual cusp of the upper molar is positioned in the central fossa area of the lower molar so that the cusp moves between the two lingual shear cusps of the lower molar in laterotrusion (Figure 7). It is very important to verify the mediotrusive excursion (Figure 9) and modify the position so that there are no contacts in this excursive movement.

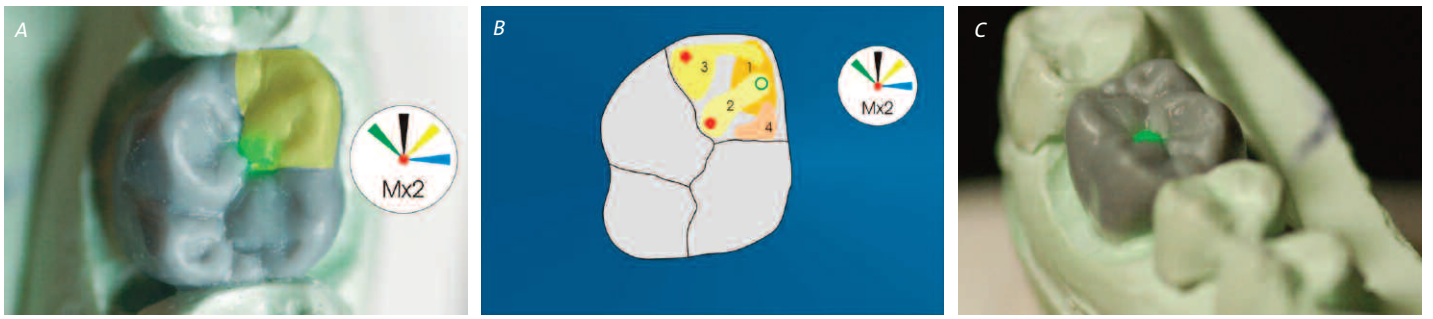


Figure 11. *A–C*, Mesiobuccal cusp of the upper molar.

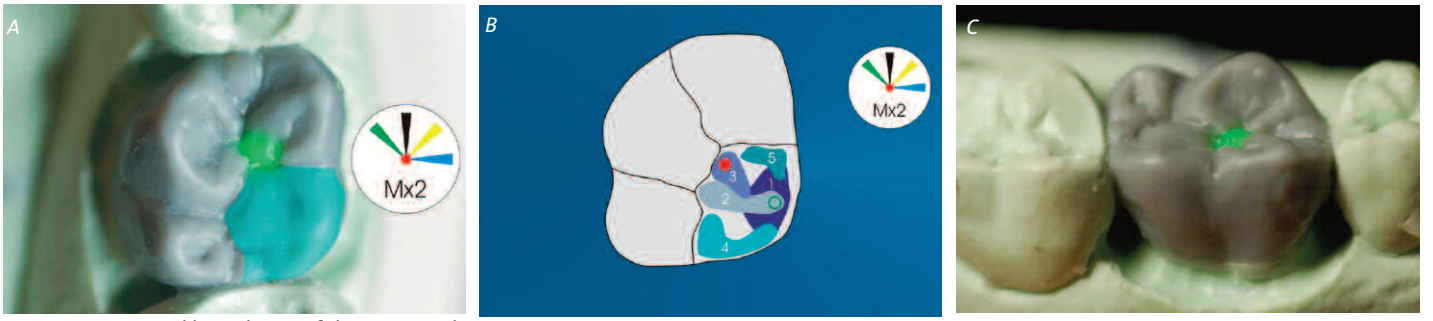


Figure 12. *A–C*, Distal buccal cusp of the upper molar.

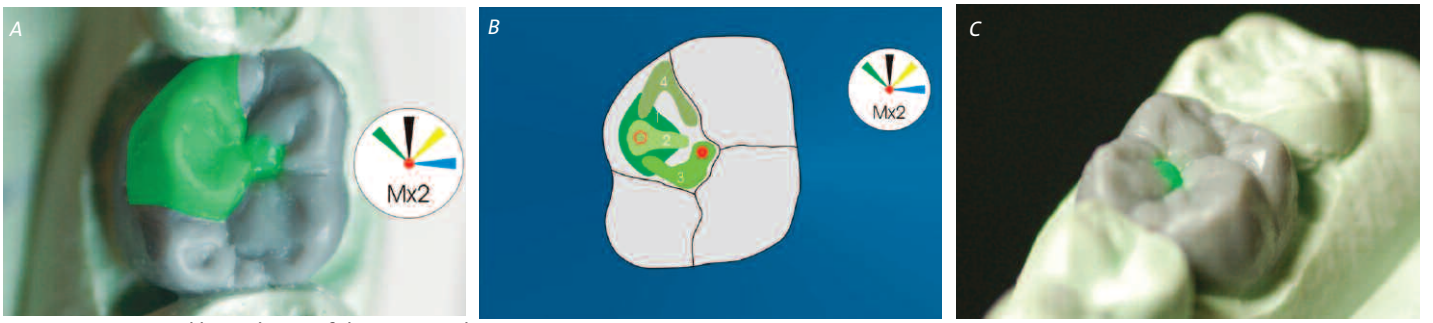


Figure 13. *A–C*, Mesial lingual cusp of the upper molar.

Once the cusp tips have been located, the process of developing the morphology of each cusp can begin (Figure 10).

The mesiobuccal cusp of the upper molar is greatly influenced by the lateroprotrusive movement; thus the yellow colour coding (Figure 11A and B). Care must be taken not to make this cusp too tall, and it is important to ensure that the triangular ridge is somewhat flat. This shape is needed so that the lower cusp can move from the holding stop without contact in the entire range of movement from protrusion to laterotrusion. Once the triangular ridge is completed, the rest of the cusp can be formed including the mesial marginal ridge (Figure 11C).

The distal buccal cusp is more influenced by the laterotrusive movement (blue; Figure 12A and B). The height of this cusp can be higher than the mesial cusp and the form of the triangular ridge can be much higher as well (Figure 12C). This cusp will also tie into the distal aspect of the mesial lingual cusp to form a transverse ridge. The addition of the small lobe mesial from the main body of the triangular ridge creates the larger volume characteristic of this cusp. The mesial and distal aspects of the cusp are filled in to complete the cusp form as well as the distal marginal ridge.

This completes the buccal shear cusps; note the differences in the forms as generated by the influence of the two dominant movements.

The mesial lingual cusp is most influenced by the mediotrusive movement in the occlusal table (Figure 13A and B). The lingual side of this cusp is influenced by the laterotrusive movement where it will pass between the lingual cusps. The mediotrusive movement is from the holding stop moving mesially and lingually. This requires the surfaces in this direction to be clear of obstructions. The distal aspect can be much higher and created with greater volume as there is minimal opposing tooth structure in this area (Figure 13C). The triangular ridge is very shallow and as it develops toward the central fossa it diminishes in size. The small auxiliary ridge radiates from the central fossa and progresses out to the mesiodistal of the occlusal table. This creates a groove that tracks the mediotrusive movement acting as a sluiceway for food during mastication.

The distolingual cusp is almost an afterthought as it may or may not occlude with the opposing tooth. In some patients this cusp is minimal or missing on second and third molars. It is not significantly influenced by a major opposing cusp and is

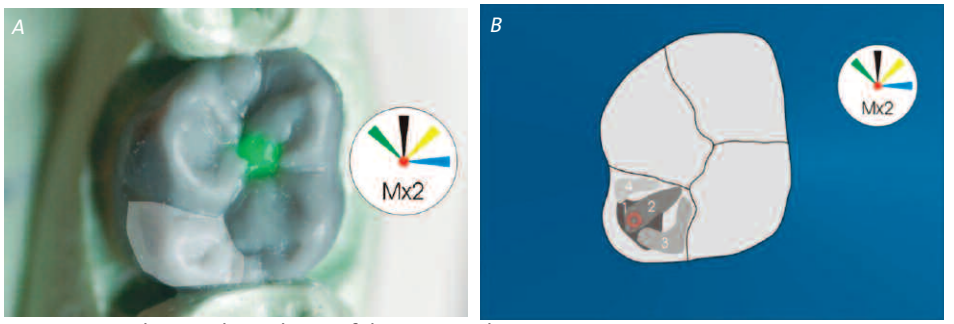


Figure 14. *A* and *B*, Distolingual cusp of the upper molar.

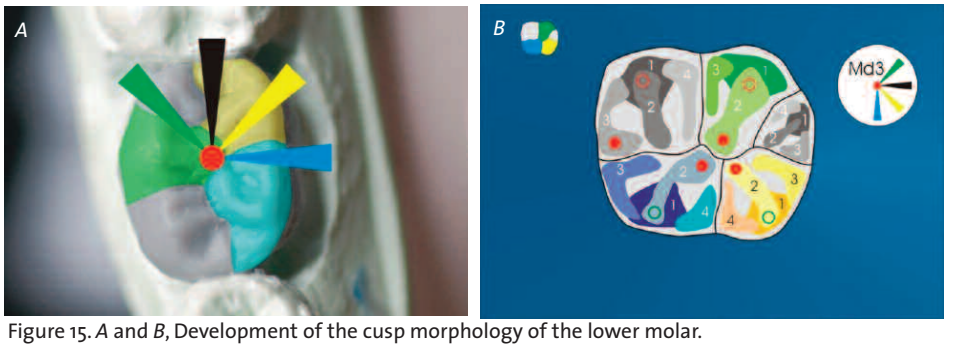


Figure 15. *A* and *B*, Development of the cusp morphology of the lower molar.

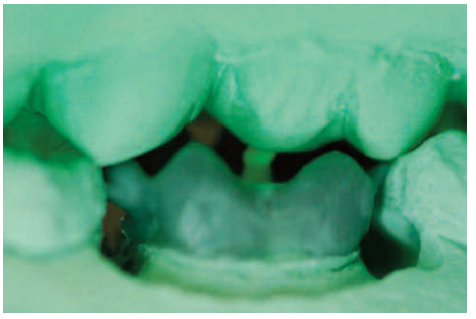


Figure 16. Mesial buccal cusp positioned so that it contacts the mesial marginal ridge of the upper molar.

thus assigned the colour grey (Figure 14). In Angle Class II cases there will be more of an influence from the middle buccal cusp of the lower molar. A small triangular ridge and a distal ridge define the form of this cusp.

This completes the forming of the lingual stamp cusps and the occlusal form of the upper molar. The development of the occlusal morphology using this method should generate a form that is without excursive contacts and blends with the adjacent dentition.

The development of the occlusal morphology of the lower first molar follows a similar sequence (Figure 15).

Again, the first step is to locate the position of the holding stop of the mesiobuccal cusp of the upper molar. The cusps are sketched in taking into account the excursive movements. The heights and position of the two lingual shear cusps are established by the laterotrusive movement of the mesial lingual cusp of the upper molar passing between them. The main stamp cusp (middle buccal cusp) reaches for the central fossa of the upper molar. The laterotrusive and mediotrusive movements are checked for interferences. The mesial buccal cusp is positioned so that it contacts the mesial marginal ridge of the upper molar (Figure 16). There are no significant movements associated with this cusp. It is important to see that none of the basic cusp forms contact any of the opposing teeth in the excursions.

The distolingual cusp is the shear cusp most influenced by the lateroprotrusive movement and will have similar attributes to the mesiobuccal cusp of the upper (Figure 17A and B). This cusp is smaller and flatter when compared to the mesiolingual cusp (Figure 17C). When observing natural dentition, this cusp will often exhibit a greater degree of wear when compared to the mesiolingual cusp.

The mesiolingual cusp is most influenced by the lateral movement; hence colour coded blue (Figure 18A and B). This cusp is larger in size and the triangular ridge is larger and higher in the occlusal table when compared with the distolingual cusp (Figure 18C).

Figure 17. *A–C*, Distolingual cusp of the lower molar.

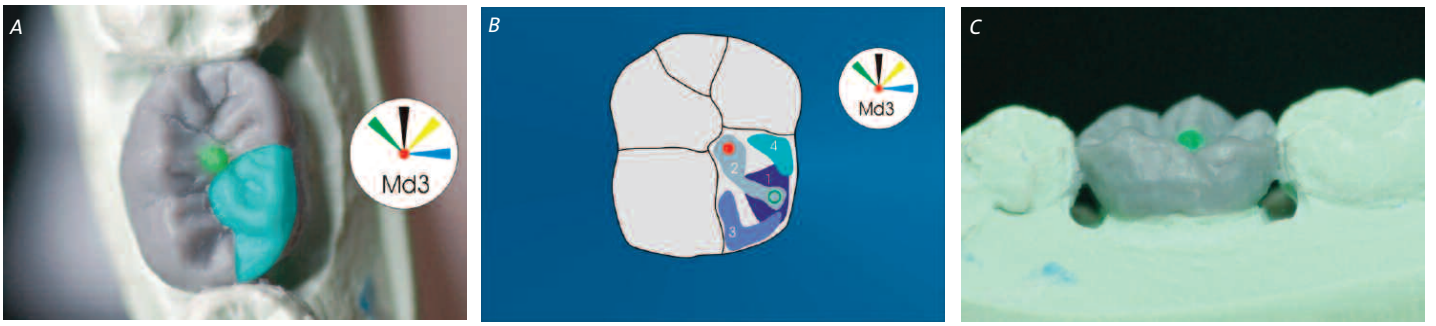


Figure 18. *A–C*, Mesiolingual cusp of the lower molar.

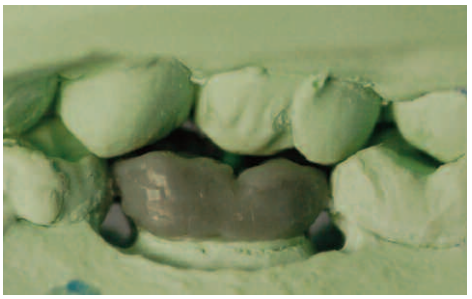


Figure 19. Lingual shear cusps of the lower molar share similarities with the buccal shear cusps of the upper molar.

This completes the lingual shear cusps of the lower molar: note the similarities with the buccal shear cusps of the upper molar (Figure 19).

The middle buccal cusp of the lower first molar is influenced by the mediotrusive movement and is assigned the colour green (Figure 20A and B). Given the large size of this cusp and the mesiolingual cusp of the upper molar care must be taken to allow for sufficient room for the mediotrusive movement. The movement follows the distobuccal disectional groove. The height of contour of the triangular ridge is towards the mesial side of the cusp (Figure 20C). In this occlusal scheme there is a small auxiliary ridge running to the mesial. This produces a relatively simple form for this large cusp.

The mesiobuccal cusp is not significantly influenced by the mediotrusive movement as the only cusp that would affect it is the lingual cusp of the upper second premolar (not a large cusp). This cusp can be developed almost like the buccal cusp of the second lower premolar with the cusp tip occluding on the opposing marginal ridge.

The distobuccal cusp is like the upper distolingual cusp; small and rarely having an occlusal contact. If not for the disectional groove, it could be considered an extension of the middle buccal cusp (Figure 21).

This completes the forming of the buccal stamp cusps and the occlusal form of the

Figure 20. *A–C*, Middle buccal cusp of the lower molar.

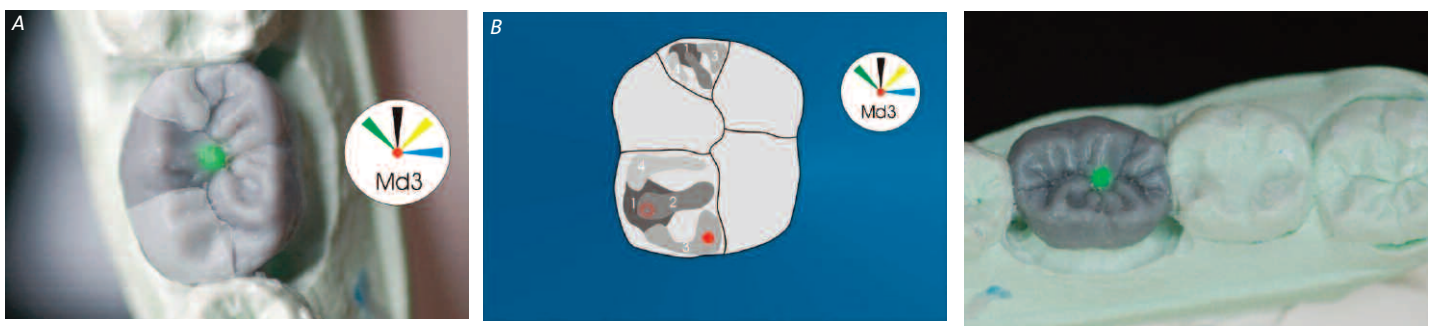


Figure 21. *A* and *B*, Distobuccal cusp of the lower molar.

Figure 22. Lower molars: indirect restoration (crown) on the 36, a direct restoration on the 37, and a natural tooth on the 38.

lower molar. The development of the occlusal morphology using this method should generate a form that is without excursive contacts and blends with the adjacent dentition.

Conclusion

The most restored teeth are the molars, so as a technician it is important to be able to fabricate molar restorations that are functionally correct. The occlusal compass is a powerful tool that we can use to develop the occlusal morphology. Whenever we see an occlusal surface that has a large cusp contacting somewhere within that tooth's occlusal table, the occlusal compass will help guide us in the development of cusp positions and forms. In restoring the posterior anatomy the adage form follows function is of paramount importance. By developing the occlusal forms one cusp at a time with the occlusal compass in mind we are able to recreate natural anatomic forms that will function in harmony with the patient's occlusal determinants. The careful observation of the wear pattern of the teeth adjacent to the tooth being restored gives us an idea of the excursive pathways for each patient. These wear facets are a guide to the angles and direction of the patient's habitual movements that we then us to individualize the occlusal compass.

In the example of the lower molar we have an indirect restoration (crown) on the 36, a direct restoration on the 37. and a natural tooth on the 38. We have used the waxing scheme and the occlusal compass to attempt to replicate the natural morphology found in the 38 in the 36 crown (Figure 22).

The replication of nature in form and function is an ideal worth striving for. The concepts outlined here using wax can be applied to all restorative materials including amalgam, composite, gold, and porcelain.

Conflicts

None declared.

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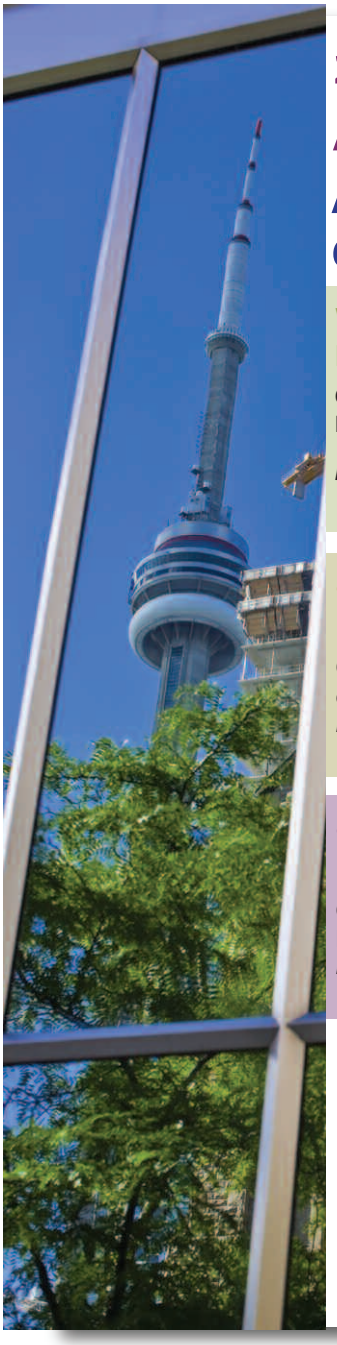

Dental Occlusion Evaluation: 10 Essential Steps
Évaluation de l'occlusion : 10 étapes essentielles

By Dr. Michael Racich

About the Author

Dr. Racich is a 1982 graduate from University of British Columbia with a general practice in downtown Vancouver emphasizing comprehensive restorative dentistry, prosthodontics and TMD/ orofacial pain. Dr. Racich is a member of many professional organizations including the Canadian Academy of Restorative Dentistry and Prosthodontics, the Pacific Coast Society for Prosthodontics, and the International Association for the Study of Pain. He is a Fellow of the Academy of General Dentistry, the International Congress of Oral Implantologists, and the American College of Dentists as well as a Diplomate, American Board of Orofacial Pain. Dr. Racich has published in peer-reviewed scientific journals such as the Journal of Prosthetic Dentistry and the Canadian Dental Journal and lectured nationally and internationally on subjects relating to patient comfort, function and appearance. He currently mentors the didactic/clinical F.O.C.U.S. (Fundamentals Of Creating a Uniform Stomatognathic system) study clubs in British Columbia.

ABSTRACT

A frequently asked question by dental practitioners is: "What are the essentials for assessing a patient's occlusion?" There are many schools of thought when addressing this question but when one distils down the various philosophies there are a few fundamental considerations that emerge. The following brief essay will lay out 10 basic steps for dental occlusal evaluation.

RÉSUMÉ

Une question souvent posée dans la pratique dentaire est la suivante : « Qu'est-ce qui est important de vérifier lors de l'évaluation de l'occlusion d'un patient? ». Il existe plusieurs écoles de pensée à ce sujet mais lorsqu'on examine de près les diverses philosophies, on constate qu'il y a quelques aspects fondamentaux à considérer. Le bref compte rendu suivant vous révèlera les 10 étapes essentielles à l'évaluation de l'occlusion.

A practical approach to dental care involves conceptualizing the final result or, in other words, having a game plan. One way to approach the patient's stomatognathic system is to conceptualize the final occlusal relationship between the maxillary and mandibular arches. A recommended approach is the 10 essential steps for occlusal evaluation (Table 1).

Table 1. 10 Essential Steps for Occlusal Evaluation

1. Chief Concern
2. Facially Generated Treatment Planning
3. "Thinking Wax"
4. "CR"/ Vertical Dimension
5. Sagittal 1st
6. Coronal 2nd
7. Occlusal Plane
8. Tooth Anatomy
9. Materials
10. Maintenance/Orthotics

1. Chief Concern

Patients attend dental practices for many reasons with various expectations including a chief concern. An important consideration for the dental team to appreciate is what could go wrong post treatment with the patient's chief concern and why? Distilled down, the answer falls into three main areas: diet, hygiene, and parafunction.[1] All three of these etiologies are patient preventable only. The dental team therefore act as the facilitators of dental education and patient oral care. That is why excellent communication and rapport are essential before embarking on treatment. A non-compliant patient will doom the dental team's efforts.

A patient that refuses to participate in effective personal and professional oral hygiene care will undoubtedly have future problems or compromises with their oral health such as root caries, periodontal issues, and esthetics (e.g., staining) to mention a few. Diet is another source for failure; specifically, sweets intake. Patients need to be educated on the relationship between sweets and caries and the significance of the frequency and volume of consumption. The patient also needs to appreciate that sweets are more than just chocolate and candies. There are many sources of sugars that the patient might not realize that are damaging such as fruits or sports beverages (sweet/food breakdown product "acid" attacks or acidic substances).[2] Age and the associated decline in salivary flow also require explanation. Strategies to offset lifestyle decisions can then be formulated.

The third and most significant reason for post-treatment failure is parafunction, better described as bruxism.[3] Patients' teeth are never together unless they are chewing or swallowing.[4] Patients teeth might touch for a split second when they chew or they might touch when they swallow. The dental team must educate patients to keep their teeth apart. For patients that brux at night or who just want to protect their dentition while they sleep,

fabrication of a full coverage hard acrylic maxillary or mandibular orthotic is accomplished.

Diet, hygiene, and bruxism. Make all patients aware of these three vices. Failure to properly educate and monitor these three etiologies makes for post-treatment untoward sequelae.

2. Facially Generated Treatment Planning

Having a systematic, thorough approach to diagnostic planning that intimately involves patient input is critical. Facially generated treatment planning helps co-ordinate the dental team and patient objectives as "we meet the person, then the face, the mouth, and finally the teeth."[5–8]

Facially generated treatment planning begins after the dental team has met the patient (objectives, expectations, bias, etc., realized) and then they thoroughly assess the face. The face is assessed both from the lateral (sagittal) viewpoint as well as the frontal (coronal). Basic common sense applies as the dental team gauges the lateral view for Angle classification and for any soft tissue abnormalities (e.g., nose profile). Lateral cephalometric analysis can be useful at this point to locate hard tissue (e.g., the teeth) landmarks as well as soft tissue (e.g., the esthetic plane) landmarks.[9] From the frontal perspective we can assess facial proportion, the so called rule of thirds, for evenness between the upper, middle, and lower face (Figure 1).[10]

Meeting the mouth the dental team assesses tooth display at rest (repose) as well as in full smile.[11] The dental team can next assess whether or not the arch form is too narrow relative to the face and anterior tooth position. The rule of opposites can be applied. The rule of opposites suggests that if something is narrow (the face for example) then subtly widening an associated feature (in this case the arch form) will let the face appear wider and the anterior teeth smaller (Figure 2).

Evaluation of occlusal plane form (generally it should "appear" parallel to the horizon) and overall intra and inter-tooth proportions is also spied. Direct mock-ups with either non-adhesively bonded composite or white periphery tray wax while utilizing a black felt marking pen for block outs yield real-time virtual evaluation which can then be transferred appropriately for in-office or laboratory assessment (Figure 3).

Lastly, the teeth and their structural integrity are scrutinized utilizing basic restorative and operative dental diagnostic criteria. The periodontal status must also not be neglected.

3. "Thinking Wax"

When single tooth dentistry is practiced, the process is visualized by the practitioner. Removal of pre-existing restorations and caries, cavity preparation and tooth foundation design, restorative material choice and placement, finalization of the project are all in the operators mind before the hand-piece is picked up. The more thorough the conceptualization of the final result the finer the outcome and the smoother the sequence of treatment runs; relatively simple procedures such as these happen subconsciously and is effortless. This is not the case with more complex undertakings. A practitioner, especially in the formative years, is being extremely foolish if they believe they can take on complex rehabilitative efforts without having a clear, concise idea of the end result. In their minds eye the practitioner must have the final design concept mastered. One excellent method of facilitating this conceptualization process is "thinking wax."[12] Thinking wax is the process whereby the practitioner goes through the conceptualization exercise with complete wax dentures in mind. The "thinking wax" goal is to therefore answer the question: "What would be done for this patient if complete dentures were being fabricated given the present circumstances?" Depending on the skeletal jaw relationships and facial proportions, soft tissue contours, arch and tooth size considerations, or patient's desires and expectations would it not be nice to be

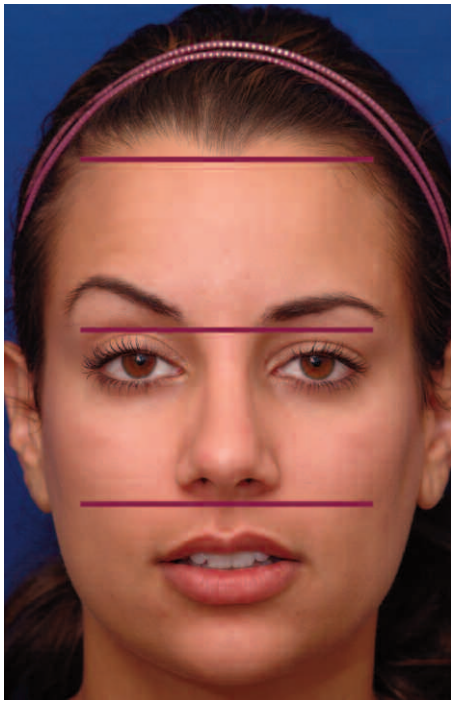

Figure 1. The Rule of Thirds showing well proportioned facial features
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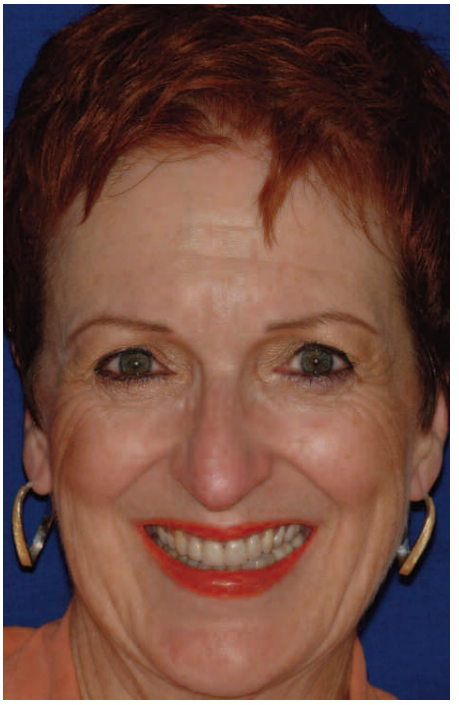

Figure 2. Narrow buccal corridor and longish front teeth offset an oval face.
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Figure 3. Direct mock-ups utilizing wax and black felt pen allow the patient to quickly visualize esthetic or cosmetic changes to their dentition.
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Figures 4 and 5. Mutually protected occlusion. Posterior teeth protect anterior teeth in maximum intercuspation while anterior teeth protect posterior teeth in excursive functioning. Imaged reprinted with permission from Racich MJ. The Basic Rules of Oral Rehabilitation.

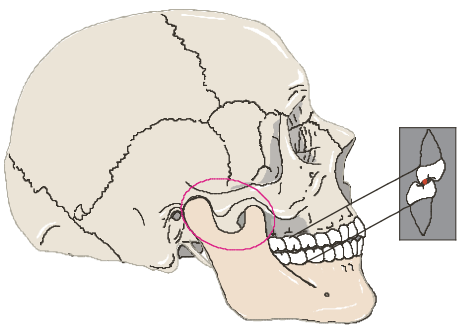

Figure 6. CR and CO. The teeth occlude when the TMJs are in a Consistently Reproducible position where the condyles are in the anterior superior aspect of the glenoid fossa at an acceptable occlusal vertical dimension.
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able to be able to move the teeth and bone to a conceptualized relationship just like which can easily be done with wax denture set-ups? Along with other record taking efforts, such as charting, radiographs, and mounted study casts, diagnostic wax-ups can be produced which can be further utilized to consult with patients or other interdisciplinary team members.

When conceptualizing the final result or "thinking wax" an overall concept such as a mutually protected occlusal scheme should be ascertained (Figures 4 and 5).[3,13]

Ideally all the posterior teeth should contact evenly and down their long axes.[14] The more posterior teeth that are in even contact the more that any clenching forces can be distributed. Anterior teeth should touch minimally if at all when the arches are together.[4] Williamson and others have also shown that if the anterior teeth are in contact during excursions then less force is in the masticatory system (due primarily to elevator muscle relaxation).[15,16] The anterior teeth are also at a better mechanical advantage to withstand lateral forces due the class III lever principles involved.

Thus, ideally during clenching activities the posterior teeth are "protecting" the anterior teeth and during parafunctional activities such as bruxing the anterior teeth are "protecting" the posterior teeth from any excessive lateral forces. Nature has set-up quite an efficient machine by making the posterior teeth not only the chewing work horses but also the intermaxillary relationship stabilizers while allowing the anterior teeth to be the food knives and posterior stabilizer protectors.

4. Centric Relation/Vertical Dimension

Extensive restorative dental/ prosthetic work requires a starting point. Traditionally, this has been centric relation (CR).[3] A look at the Glossary of Prosthodontic Terms, however, shows seven different definitions. CR thus becomes the Confusing Relation. Furthermore, some clinicians advocate other starting positions such as MyoCentric.[17] This only leads us to more Confusion. What then, is the practitioner to do? Who is right? Who is wrong? The truth is that it is not so much what the starting point is but how reproducible and stable the starting position is.[18] CR, therefore, is a Consistently Reproducible position.

The health of the temporomandibular joint (TMJ) must be delineated early in treatment planning. Lack of inflammation and discomfort must be present and can be readily verified by examination and tests such as joint loading, functional resistance, and palpation.[19] Although TMJ noises (e.g., clicking in disc displacement with reduction) can be troublesome for patients, in the absence of pain and dysfunction the practitioner can accept this situation as stable since the TMJ tissues have the capacity for remodelling and repair.[20] Once again, this can be evaluated (joint loading, functional resistance testing, palpation). Treatment with the condylar head in the glenoid fossa with ("adapted centric relation"[21]) or without TMJ noises is not only practical but also physiologic.[4] When the opposing dentitions occlude in CR we have centric occlusion (CO) (which may or may not coincide with maximum intercuspation or habit bite).[3] Most importantly, Consistency and Reproducibility of this position is desirable when extensive treatment has been performed for long-term maintenance facilitation.

Occasionally it is necessary to rehabilitate with the condyles in a relatively forward position in the glenoid fossa. This can occur in such situations as when the retrodiscal tissues cannot withstand loading, the practitioner wants to treat "on the disc", or perhaps the patient is a skeletal class II and wants their final occlusal treatment position to be brought forward (a class II that wants to be a class I).[22] Some practitioners actually favour this relationship, especially those in the MyoCentric camp.[17] The main issue here is not whether this is bad or good or who's right or wrong but instead how consistently reproducible and stable is the relationship of the TMJs, especially when the teeth occlude.[18]

Another consideration when analyzing the starting position or "CR" is to take into account vertical dimension. Occlusal vertical dimension is defined as: "the distance measured between two points when the occluding members are in contact" while the rest vertical dimension is: "the distance between two selected points measured when the mandible is in the physiologic rest position." The vertical dimension of speech is: "that distance measured between two selected points when the occluding members are in their closest proximity during speech."[3] It is important to note that the maximum vertical dimension that is physiologically acceptable is the latter, i.e., speech determines the maximum permissible.[10] Therefore, with the aid of facially generated treatment planning and conceptualizing the final result (thinking wax) guesstimation of the occlusal vertical dimension can be made at a consistently reproducible position (CR) that the practitioner can work with (Figure 6).

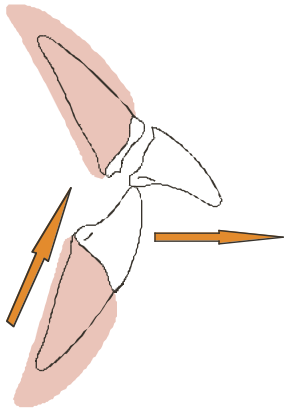

Figure 7. Excessive anterior tooth contact can result in tooth, periodontal, and restorative /prosthodontic trauma.
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5. Sagittal 1st

The Glossary of Prosthodontic Terms defines sagittal as: "situated in the plane of the cranial sagittal suture or parallel to that plane" and the sagittal plane as: "any vertical plane … that divides a body into right and left portions."[3] Knowing where the maxillary and mandibular central incisors are in the sagittal plane allows the practitioner to optimize patient function.[23–25] The envelope of function ("the three-dimensional space contained within the envelope of motion that defines mandibular movement during masticatory function and/ or phonation"[3]) is respected.[26] Undesirable tooth contacts such as anterior fremitus ("… a vibration palpable when the teeth come into contact"[3]) can be eliminated (Figure 7).

6. Coronal 2nd

Coronal 2nd is better known as Smile Design 101 or Smile Design Du Jour. Setting or conceptualizing where the anterior teeth need to be positioned facially really is no more difficult than doing a wax denture try in (thinking wax)![27–29] The interesting article by Waliszewski et al.[30] substantiates these contentions nicely. The authors created three different denture set-ups for six different patients and asked a group of people which they preferred. Did they prefer the natural look, the supernormal look, or the denture look (Figures 8–10)? The results showed that 55% preferred the natural look while 26% preferred the denture look! Surprisingly, only 19% favoured the supernormal look which is so prevalent in today's Western World. Smile Design Du Jour is truly in the eyes of the beholder.

7. Occlusal Plane

The occlusal plane is defined by the Glossary of Prosthodontic Terms as "the average plane established by the incisal and occlusal surfaces of the teeth. Generally, it is not a plane but represents the planar mean of the curvature of these surfaces."[3] The mandibular occlusal plane usually can be visualized when the mandible is at rest as a relatively flat plane with the posterior buccal cusp tips and the incisal edges parallel to the horizon. The occlusal plane anatomically runs from approximately half way up the retromolar pad to slightly below the commisures of the lips. This can be verified with cephalometrics.[31] The maxillary occlusal plane similarly parallels the horizon with the posterior buccal cusp tips co-incident and not canted. If the practitioner so chooses, for a patient with a pleasing smile this can be readily confirmed by placing a maxillary cast on a bench top. The buccal cusps bilaterally should touch the surface evenly (with the incisal third of the maxillary central incisors perpendicular to the horizon).[32] Patients obviously do not want to walk about post-treatment with sloped dentitions when they smile or speak.

8. Tooth Anatomy

When dentistry is practiced that recreates natures design, then esthetic and functional results are achieved. Tooth anatomy restoration is thus an integral part of occlusal rehabilitation or stabilization for mastery of the stomatognathic system.

To refresh the practitioner's memories about tooth anatomy there are many excellent textbooks available.[33,34] Not only do these textbooks provide superb diagrams, the more recent publications have graphic programs that can be loaded onto computers. Tooth images can be rotated, teeth sectioned, and occlusal inter-relationships evaluated. Teeth

Figure 8. Natural look. Image courtesy Dr. Michael Waliszewski.

Figure 9. Supernormal look. Image courtesy Dr. Michael Waliszewski.

Figure 10. Denture look. Image courtesy Dr. Michael Waliszewski.

have many planes, angles, grooves, tips, and

Figures 11 and 12. Cusps, fossas, tooth planes are not only function but highly esthetic.
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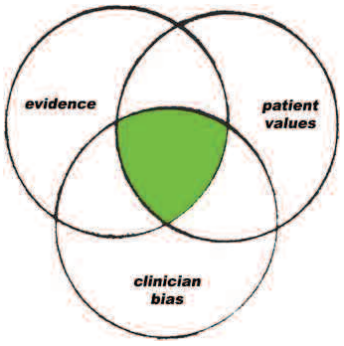

Figure 13. Evidence-based dentistry. The green zone represents the ideal synergistic result when the evidence, clinician bias, and patient values are respected.
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fossa. Sharp cusp tips into well constructed fossa facilitate occlusal equilibration while differing facial planes on a maxillary central incisor diffuse and reflect light to entertain the observer's eyes (Figures 11 and 12).

There are some basic, distilled down rules to follow with tooth anatomy and inter-tooth relationships[35]:

1. Facial and lingual contour
a. height of contour on the facial and lingual of all in the gingival third except on the lingual of mandibular bicuspids and molars where it is the middle third.
b. height of contour extends from the cementoenamel junction (CEJ) on the facial and lingual of all teeth except on the lingual of mandibular bicuspids and molars where it may extend 1 to 1.5 mm above the CEJ.
2. Proximal contact areas
a. are in the occlusal (incisal) third of all teeth except between the maxillary molar contacts where it is at the junction of the occlusal and middle third.
b. viewed from the occlusal/ incisal the proximal contacts always are facial to the central fossa except between Mx molar to molar contacts where it is on the central fossa line.
3. Proximal surface from the contact area facial-lingually and occlusal/ incisal-cervically is flat or slightly convex.
4. Marginal ridges are at the same height regardless of the presence or absence of occlusal contact.
5. Curve of Wilson
a. mandibular premolar buccal cusps are higher than lingual cusps by up to 1–1.5 mm.
b. maxillary molar buccal cusps are shorter than lingual cusps by up to 1–1.5 mm.
6. There are four embrasures:
a. occlusal/ incisal, gingival, lingual, facial
b. with the lingual > facial and the gingival > occlusal/incisal

9. Materials

Dental materials are continuously being introduced into the marketplace and hence to the dental practitioner. The whole issue of change at first appears daunting. However, approached in an evidenced-based manner it's not as difficult as it appears at first glance especially if we treat patients similar to what the dental team would like to be treated like, i.e. not experimental specimens. Evidence-based dentistry involves that rich blend of patient values, practitioner expertise and bias, and what the reported literature has to say about a device, technique or product (Figure 13).[36]

When new techniques or materials are introduced, a go low, go slow approach is practical. Practitioners might wish to try different products but might also want to do so under as controlled an environment as possible such as taking hands-on continuing education programs (where products can be used in real time [i.e., intraorally]) or by selectively incorporating a technique or product in a routine, low risk situation where there is a high probability of success regardless what is employed (e.g., a new dental cement for a well designed cast crown). Also, conferring with peers with regards to their experiences is another useful tool. The practitioner can then distil and evaluate relative to personal experiences and biases and the specific clientele that seeks the dental team's services. Ultimately, as long as the dental materials are appropriately selected for the right dental environment, i.e., the patient's milieu (their occlusal scheme and long-term commitment/ownership), then prognosis can be reasonably stated.

10. Maintenance/ Orthotics

Upfront business practices and cooperative well delineated patient relationships allow long-term work warranties and maintenance.[37,38] Occlusal observations at recare hygiene appointments, for example, can be routinely done.[39] Reinforcement of nocturnal occlusal protection in the form of dental orthotics can also be exercised.[40] There are many uses for dental orthotics with the most practical being simple, straight-forward occlusal protection and hence, occlusion stabilization (Table 2).[41,42]

Table 2. Considerations for Dental Orthotic usage:

1. Vertical dimension changes
2. Occlusion optimization
3. Occlusal protection
4. TMJ unloading
5. Mandibular repositioning
6. Influence growth
7. Altered sensory input
8. Cognitive awareness
9. Placebo
10. Expectations
11. Regression to the mean

Concluding Remarks and Recommendations

1. Patient expectations (knowledge of), education and long-term commitment requisite.
2. Conceptualization of end product is

prudent before treatment initiation.
3. A sequential, consistent treatment approach is advised.
4. Optimization of oral anatomy and physiology routinely should be strived for.
5. An evidence-based approach to restorative and prosthodontic materials is today's standard of care.
6. Ongoing maintenance care is always facilitated.

Conflicts

None declared.

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Anterior Guidance: What Does It Mean To You?

Guidance antérieure : Qu'est-ce que cela signifie pour vous?

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ABSTRACT

Anterior guidance is thought to be well understood by most dentists; however, a distilling process has reduced our current practice to a rather mechanistic approach to therapy which lacks understanding and rationale. The author reviews what we know about anterior guidance and what we may have forgotten and provides evidence for a more individualized treatment concept when altering anterior guidance through our therapies.

Three basis occlusion philosophies have dominated dental teaching and research for the past decade: bilateral balanced occlusion, group function occlusion, and canine or mutually protected occlusion. Each therapeutic approach has its own applications but none is appropriate for every patient. The individuality of each therapy must be understood. Through careful review of the literature we recognize several advantages to designing therapies that favour canine protected occlusions. This type of occlusion has several advantages over the other concepts. First, masticatory muscle activity is reduced with this guidance system as opposed to group or bilateral balance; second, lateral forces directed off the long axis of teeth from parafunction are reduced; and third a mechanical advantage of a class 3 lever is imparted to the stomatognathic system.

Anterior guidance is misleading because it suggests that all anterior teeth have a disclusive function. The anterior teeth are considered a functional unit but the central incisors are not part of any laterotrusive control. They are dominant in proprioception for determining the frontal area of the masticatory cycle and speech. Lateral incisors are highly variable in position and are more dominant during mixed dentition through maturation. The relationship of the cuspid and bicuspid is poorly understood by a static dental classification. It is a dynamic relationship where control of immediate protrusive disocclusion can be affected. The ultimate goal of all occlusal schemes and therapy should be to provide primary stability in maximum intercuspation and disocclusion of all posterior teeth in incursive and excursive function and parafunction. This disocclusion of posterior teeth is highly dependent on the relationship of anterior guidance and posterior condylar guidance. This relationship has been well documented in the literature but it has also been shown that it is highly individualized. Measuring functional condylar movements can help us to set the other parameters of anterior guidance, occlusal plane and cusp inclination to create an efficient chewing apparatus that minimizes destructive forces on our dental restorations.

RÉSUMÉ

La plupart des dentistes pensent bien comprendre la guidance antérieure; toutefois, par un processus d'épuration, notre pratique courante s'est vue transformer en une méthode thérapeutique plutôt mécaniste qui manque de compréhension et de justification. L'auteur passe en revue ce que nous connaissons déjà au sujet de la guidance antérieure et ce que nous avons peut-être oublié et montre un concept thérapeutique plus individualisé lorsqu'il s'agit de modifier la guidance sur les dents antérieures.

Trois philosophies de base sur l'occlusion ont dominé l'enseignement et la recherche en médecinet dentaire depuis les dix dernières années : occlusion bilatéralement équilibrée, occlusion unilatéralement équilibrée (fonction de groupe) et occlusion mutuellement protégée (fonction canine). Chaque méthode thérapeutique possède ses propres applications, mais aucune ne convient à chaque patient. Il faut bien comprendre le caractère individuel de chaque traitement. Après un examen minutieux de la documentation, nous reconnaissons plusieurs avantages de concevoir des traitements qui favorisent la fonction canine. Ce type d'occlusion comporte plusieurs

avantages par rapport aux autres concepts. Premièrement, l'activité des muscles masticatoires est réduite avec la guidance par rapport à l'équilibration occlusale bilatérale ou à la fonction de groupe; deuxièmement, les forces latérales dirigées du grand axe des dents de la parafonction sont réduites; troisièmement, un avantage mécanique d'un levier de classe 3 est concédé au système stomatognatique.

La guidance antérieure peut induire en erreur car elle suggère que toutes les dents antérieures ont une déviation. Les dents antérieures sont considérées une unité fonctionnelle mais les incisives centrales ne font pas partie du contrôle du mouvement latéral de la mandibule. Elles sont dominantes à la proprioception pour déterminer la partie frontale du cycle masticatoire et de l'élocution. La position des incisives latérales est très variable et ces dernières sont plus dominantes au stade de la dentition mixte jusqu'à la dentition permanente. On comprend mal la relation entre la canine et la prémolaire selon une classification dentaire statique. Il s'agit d'une relation dynamique dans le cas où le contrôle de la déviation avec problème protrusif peut être affecté. Le but ultime de tous les systèmes occlusaux et du traitement doit être de permettre la stabilité primaire d'intercuspidation maximale, le rétablissement de l'occlusion de toutes les dents postérieures et la correction des parafonctions.
Le rétablissement de l'occlusion des dents postérieures est fonction de la relation de la guidance antérieure et de la guidance postérieure condylienne. Cette relation a été bien documentée, mais il a été démontré aussi qu'elle est très individualisée. La mesure des mouvements fonctionnels du condyle peut nous aider à définir les autres paramètres de la guidance antérieure, le plan occlusal et l'inclinaison des cuspides pour créer un appareil de mastication efficace qui réduit les forces destructrices sur les restaurations dentaires.

"Anterior guidance" is a term that is instantly recognizable to most dentists. It is a term we heard repeatedly through dental school and one that is referenced, in one way or another, in every lecture since then. It is inherently understood by all dental specialties and is void of the ambiguity and confusion that comes from a term such as "centric relation" which has seven current definitions in the *Glossary of Prosthodontic Terms*. So, what does the term anterior guidance mean to you? It is my hope that this article will in some way help our readers to understand and utilize their own therapeutic, anterior guidance concept.

From my personal observations over the past decade there appears to have been a decline in our profession's interest in the details of occlusal study. With this has come a rather mechanistic approach to anterior guidance which includes duplication of existing lingual contacts and contours using custom incisal guide tables (Figure 1), trial and error methodology with "in the mouth" equilibration of temporary crowns and arbitrary settings for adjustable incisal guide tables that reference standardized norms, and my personal favourite, "let the laboratory technician work it out!"

What happened to the science? Major M. Ash, *Head and Face Medicine* 2007;3:1 wrote that the paradigm shift to evidence based dentistry (EBD) that relates to occlusal therapy (OT), selective occlusal adjustment (OA), and stabilization splint (SS) therapy for TMDs has had an unfavourable impact on the teaching of many of the important aspects of occlusion needed in daily dental practice. The teaching of occlusion has practically been abandoned in our dental schools because of EBD induced contraindications for OA and SS. He argues that it is important to bring a clinical reality back into the dental curriculum by systematically teaching all aspects of occlusal management. This article will review what we do know about anterior guidance offering evidence-based research to support it. There is some evidence to suggest a more scientific approach will allow us to treat our patients to a more individualized, functionally efficient outcome. The important questions we need to review when considering anterior guidance is: What therapeutic concept is right for our patient? Does anterior guidance provide any benefits to the stomatognathic system? What teeth are involved in lateral and protrusive guiding movements? Which surfaces of teeth are involved? How steep should the anterior guidance be? How much anterior guidance is too much? What is our therapeutic concept when we have no anterior guidance, (class 2, div.1, and class 3s)? (Note: Review of the literature suggests that the distribution of skeletal classification for the current North American and European populations is skeletal class 1: 37.2%; skeletal class 2: 57.2%, and skeletal class 3: 11.0%)

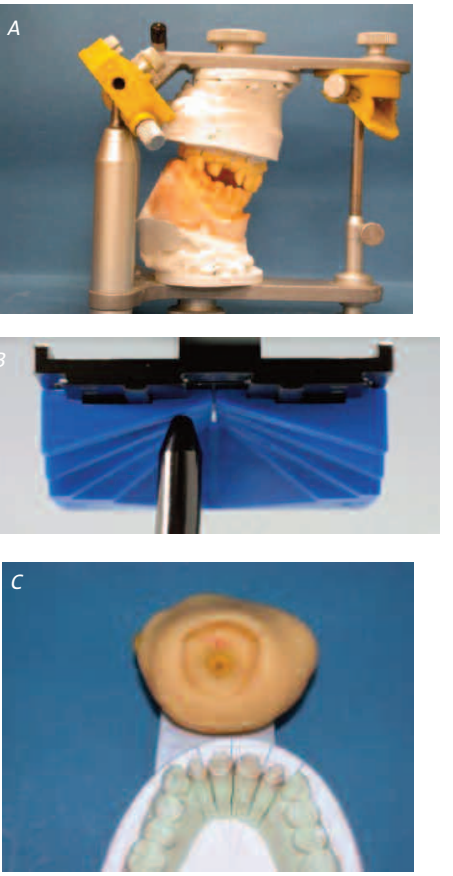

Figure 1*A*. Sam Articulator with adjustable incisal guide table. 1*B*. Gerbach programmed incisal guide table for sequential wax-up teeth #3-6. 1*C*. custom incisal guide table from patients existing anterior guidance contours.

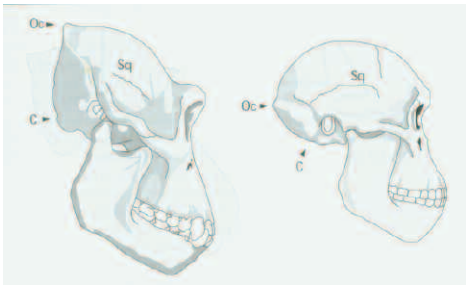

Figure 2. Canine dominant occlusion does not equal canine protected occlusion. With postural uprighting, brain lateralization and speech development, the canine has regressed into the dental arches.

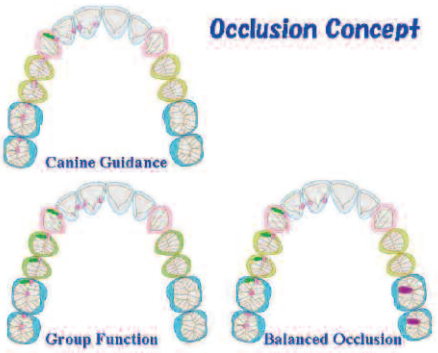

Figure 3. The ultimate goal of any anterior guidance concept should be, to disocclude posterior teeth during lateral or protrusive movements. Canine guidance (CG) describes complete bilateral posterior disocclusion with lateral guidance the sole responsibility of the cuspid. Group function (GF) describes balancing side disocclusion with multiple guidance surfaces on the working side. Balanced occlusion (BO) describes bilateral occlusal contacts during lateral excursions.

First let us clear up the semantics. *Canine dominant occlusion does not equal canine protected occlusion* (Figure 2). Canine protected occlusion is a therapeutic concept! Canine dominance is an evolutionary phenomena consistent from the great apes to modern man. With brain lateralization, development of speech and postural uprighting the canine has regressed into the dental arches. Nevertheless the function of cutting and tearing food has remained primarily the same for more than 3 million years![1–2]

There have been three therapeutic guidance concepts developed since the late 1800s. These theorems were developed by the leaders in dentistry of the time and became the object of great occlusion debate and division through the 1900s. The three concepts were (1) bilateral balanced occlusion, (2) group function occlusion, and (3) canine protected occlusion (also known as mutually protective occlusion) (Figure 3).

All three philosophies were developed as therapeutic concepts to aid the practitioner with his/her treatment goal. This philosophical debate continued to divide organized dentistry into the late '70s. The proponents of each occlusion concept having an uncompromising belief that their particular concept could be applied to all patients whether dentate or fully edentulous!

Today, there is widespread general agreement that anterior guidance is a good thing to provide in our therapies. It means posterior teeth don't touch during incursive or excursive movements (especially during parafunction). The benefits to the masticatory organ include decreased masticatory muscle activity,[3–6] minimized lateral forces, and subsequent decreased incidence of dental disease on posterior teeth,[7] and a mechanical advantage to the system by lowering the forces on the anterior teeth through the physics of a class 3 lever system.[8,9]

It has been clearly stated in the literature that masticatory muscle activity increases as the number of guidance surfaces increases from anterior to posterior.[3–6] Most recently, Tamaki showed the effect of changing the guidance system from canine guidance to variable group function of 2–5 contacts on masticatory muscle activity as illustrated in Figure 4.[10]

Several authors have shown significant effects of occlusal discrepancy on periodontal disease.[7] Goldstein showed significant reduction in mean periodontal scores with canine protected occlusions.[7] Green conducted an extensive literature review and found significant reduction in periodontal disease with occlusal therapy (specifically equilibration). Burgett found a significant increase in attachment width after two years with equilibration before surgery compared to no equilibration. Bernhardt cross sectional study of 4,310 patients demonstrated a statistically significant relationship between non-working contacts, attachment loss, and increased probing depths. Svanberg showed that occlusal trauma accelerates attachment loss in periodontitis. Moozeh found that reduction in mobility was significantly greatest in the group that had non-working interferences completely removed compared to the group that had them left in "harmony." Harrel and Nunn in a comprehensive study compared treated and untreated patients for occlusal discrepancies. Their study shows strong evidence of an association between untreated occlusal discrepancies and the progression of periodontal disease! Several studies by Japanese authors including Ohmori and Tamaki have shown evidence of increased severity of periodontal disease with group function occlusions and bilateral balance occlusions compared to canine

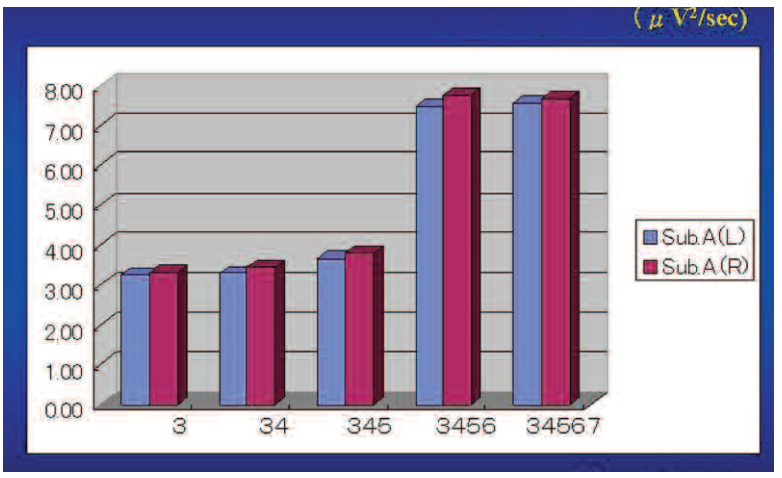

Figure 4. EMG data from study shows lowest levels of muscle activity with canine guidance with similar results for sequential contacts including first and second bicuspids. There is a significant (2×) increase in the EMG activity when the group function includes the 6s and 7s. Adapted from Tamaki et al.[10]

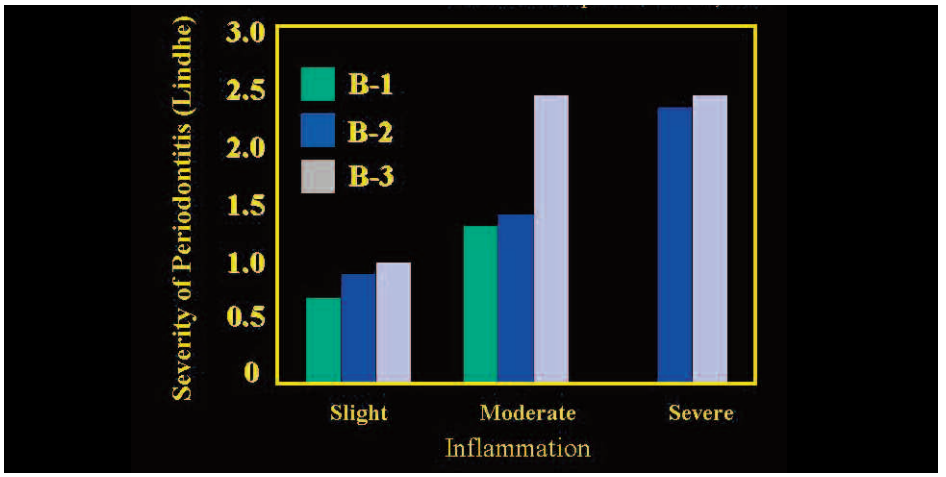

Figure 5. B-1 canine guided, B-2 group Function, B-3 bilateral balance. In the population studied Ohmori classified the study group with slight, moderate, and severe inflammation according to Lindhe and found there was an even distribution of occlusal patterns in the mild inflammation group. There was no significant difference between cuspid guidance and the group function guidance in the moderate inflammation group but a significant increase in periodontal disease with bilateral contact occlusion. With the severe inflammation group there was a significant increase in periodontal disease with occlusal schemes that have multiple lateral contacts. Adapted from Ohmori et al.[17]

guided occlusion (Figure 5).

The third and least discussed advantage of anterior guidance is the mechanical advantage imparted to the stomatognathic system by a class 3 lever.

The further the guidance system is from the temporomandibular joint (TMJ) the lower the level of work/force exerted for a given power/load. This concept is important because it acknowledges that despite the fact that no occlusal system can be without lateral forces, they can be reduced as we move away from the joint.[18] In clinical practice this phenomena is frequently seen as, the anterior teeth with their small conical roots and lack of periodontal support are often the last teeth in the mouth to be lost. The canine is ideally suited for this dominant role in lateral guidance because of its position in the dental arch relative to its distance from the TMJ, its anatomy and its proprioceptive capacity relative to other dental structures (Figure 7).[19]

The term, anterior guidance is misleading because it suggests that all the anterior teeth have a disclusive function. The anterior teeth are considered a functional unit, however, the central incisors are not part of any laterotrusive control. They are actually avoided during mastication. They do, however, play a dominant role in proprioceptive signalling and are a determinant in the frontal area end point of the masticatory cycle and speech.[20,21]

The lateral incisor has a highly variable position in the dental arches relative to its verticality and rotation. It has some laterotrusive control function primarily

Figure 6. A class 1 lever is the most efficient and does the most work with the least applied force. Ideally the jaw lever functions as a class 3 lever. The temporomandibular joint is the fulcrum (F), the masseter muscle, temporalis muscle, and medial pterygoid muscle provide most of the force (P) near the fulcrum, and the work (W) is done by the teeth along the dental arches.

Figure.7 Patient showing severe anterior wear. Anterior guidance that is not in harmony with posterior occlusion, occlusal plane, condylar pathways, creating a class 1 lever. If during a protrusive movement there is a heavy contact of posterior teeth, the molars overpower the TMJ as the fulcrum (F), the power is supplied by the muscles behind theses teeth (P) and a much greater work/load is transmitted to the anterior teeth as a class 1 lever system.

Figure 8. Sequential class 1 wax-up showing protrusive guidance inclines of lower first bicuspid and the distal marginal ridge incline of the upper cuspid (blue wax incline on cuspid).

Figure 9. McHorris, noted that disclusive lingual surface angle is most often the mesial and distal marginal ridges. There can be as much as a 35 differential between the concavity and the marginal ridge.

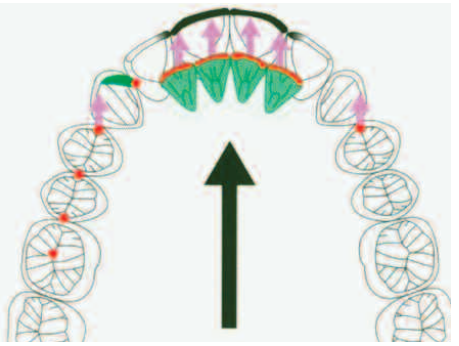

Figure 10. The functional unit illustrated in green.

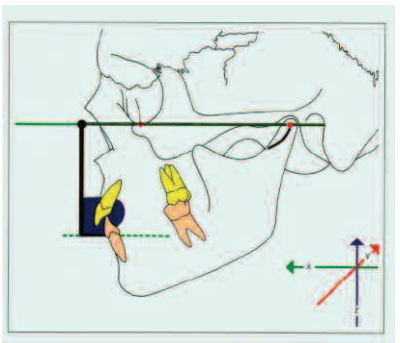

Figure 11 and 12. Slavicek, Sato and McHorris measured the lingual concavity angle relative to the axis orbital plane on three different populations and found similar trends in steepness of angle, sequential decrease in angle from anterior to posterior and length of guidance contact surface. (Adapted from Slavicek R. Okklusionkonzepte, IOK 3-4/1982; Slavicek R. Die Functionellen Determinanten des Kauorganes, 1984)

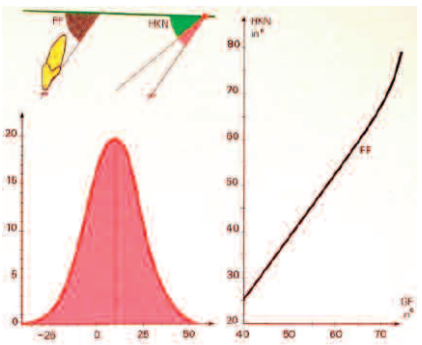

Figure13. Relationship of anterior disocclusion angle and functional condylar guidance led researchers to assert that the anterior guidance angle should be within a range of 0 to 10 degrees of the condylar guidance angle. (Adapted from Slavicek R. Okklusionkonzepte, IOK 3-4/1982; Slavicek R. Die Functionellen Determinanten des Kauorganes, 1984)

during maturation of the developing dentition. It then becomes part of the anterior functional unit along with the canine after maturation. In a class1 dental situation immediate disocclusion of posterior teeth comes from contact of the lower first bicuspid with the distal marginal ridge of the upper cuspid during protrusive movements (Figure 8).

Posterior disocclusion resulting from condylar movement is the other dominant component. The interrelationship between anterior guidance and posterior guidance will be discussed later in the article. Further disocclusion comes from the contact of the lower incisors with the lingual contact of the upper incisors. This typically is not the deepest concavity of these teeth but the prominent marginal ridges (Figure 9).

The functional unit illustrated in green in Figure 10 is not the primary disocclusive unit in protrusion. This unit normally functions as a proprioceptive control for mandibular movement and speech when the posterior occlusion and joint dynamics are in harmony.

Now that we have discussed what anterior guidance is, our next topic is to develop a therapeutic rationale for how much of it we need? Is there a normal value that we can use for our therapies or is it highly variable? What if we have too steep a guidance system? What if it is too shallow? Slacicek, Sato, and McHorris, measured the lingual concavity angle of orthodontic normals, relative to the axis orbital plane.[8,9,20] Research by Slavicek, Sato, and McHorris, of non orthodontic normals showed a consistent disocclusion angle for the lingual concavity of each tooth, even among different populations.

Why can't we use these norms to apply to our therapy? Like most of the research that has been done on occlusion and its association with TMD, the answer is complicated!

This research further looked at condylar functional movement tracings and showed a high correlation between the disocclusion angle and condylar guidance angle for the canine (Figure 13).[20,8] However, when we try to apply this data into the general dental population, the individual variability makes it impossible to establish clinically useful norms that yield consistent results. Therefore "clinical application must be assessed on an individual basis."[22]

Remember, the ultimate goal is disocclusion of posterior teeth. Anterior control is only one of the variables. As therapists we need to understand the role of each variable in order to provide optimal treatment for our patients. It is beyond the scope of this article to address all of these parameters; however, we must consider the effect of (1) anterior disclusive angle (CI); (2) posterior condylar guidance angle (HCI); (3) cusped teeth versus flatter teeth; and (4) occlusal plane inclination (OPI).

These four variables will determine the amount of disocclusion for every patient. As

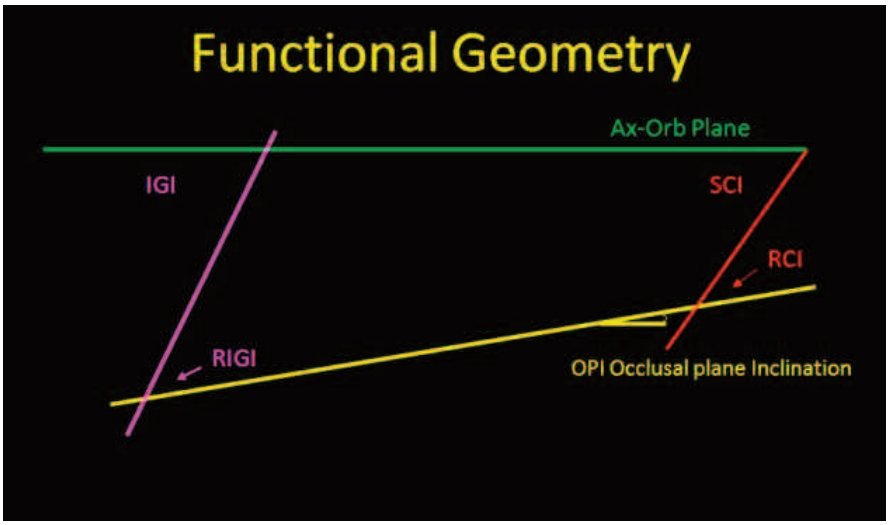

Figure 14. Axis orbital plane (AOP) is used as the reference plane as it corresponds to most commonly used articulator systems. Horizontal condylar inclination (SCI) is patient specific and derived from condylar tracking device. Anterior guidance angle (IGI) is variable component and can be used/changed by therapy. Occlusal plane inclination (OPI) is defined as a plane from tip of lower central incisor to tip of distobuccal cusp of lower six year molar. The intersection of the IGI and SCI with the occlusal plane create relative incisal guidance angle (RIGI) and relative condylar inclinations (RCI), respectively.

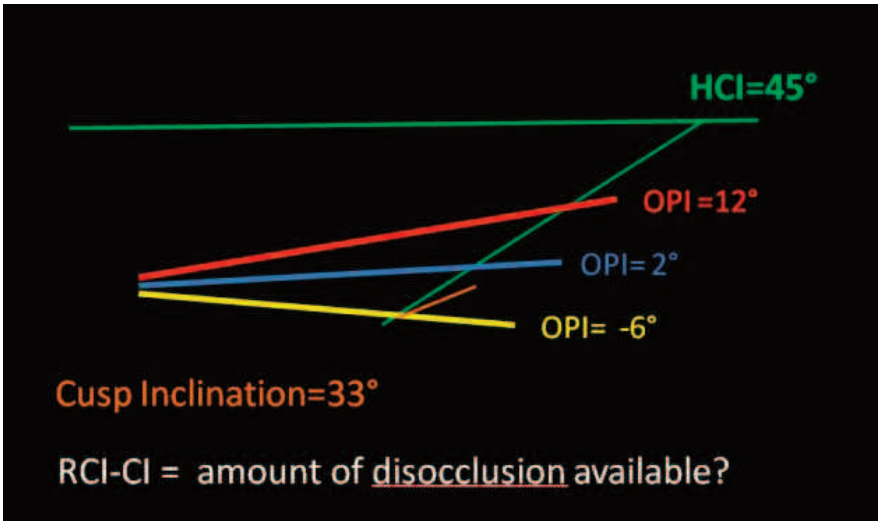

Figure 15. This figure illustrates how functional geometry concepts can be used to predict and design therapies that will provide the appropriate amount of posterior disocclusion. Assuming a 33° cusp inclination (CI) and a known horizontal condylar inclination (HCI) of 45° it is clear how altering only one parameter can have a significant impact on the amount of posterior disocclusion! For example: HCI-OPI=RCI, RCI-CI= amount of disocclusion. 45° 12°=33°, RCI-CI=0 no disocclusion available(contacts inevitable)! 45° 2°=43°, RCI-CI=10° adequate disocclusion available (good function). 45° (6)°=51°, RCI-CI=18° too much disocclusion! (inefficient chewing).

therapists we are able to change or modify the dental structures to accommodate the functional condylar anatomy to disocclude posterior teeth for optimal efficiency. Too little disocclusion during functional movements may cause interferences during parafunctional loading. Too much disocclusion creates excess separation of posterior teeth during functional movements and will be inefficient for chewing. Slavicek felt that considering parafunctional loading and mandibular deformation the ideal amount of disocclusion for maximum efficiency would be in the range of 6–8 degrees.[20]

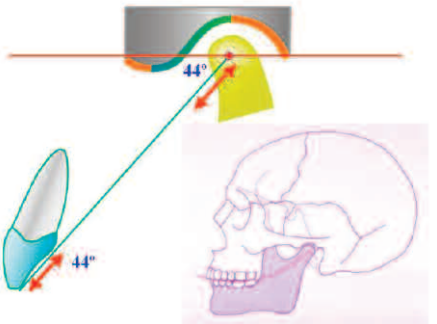

Figure 16. The anterior teeth could be considered the guardians of the posterior teeth during any eccentric bruxing attempts. If they are properly coupled all bruxing forces become the responsibility of the anterior teeth, and all friction to include possible wear, becomes their burden. This amount of friction can be controlled however to insure their integrity by providing a disclusive angle that is identical to the condylar disclusive angle (1:1 ratio). Anterior disclusion significantly reduces the electrical activity of the powerful masseter and pterygoid musculature. Anterior teeth disclusion allows the mandible to work within a class 3 lever principle (Adapted from McHorris[23]).

Dr. Martin Mai, (Vienna Austria personal communication) developed this concept further and coined the phrase "Functional Geometry" where he illustrated the impact that changing these variables will have on the amount of disocclusion or interference created by our therapeutic design concept (Figures 14 and 15).

The last question is "What if anterior guidance is too steep?" Anyone who has ever placed anterior crowns recognizes the clinical significance of interfering with this delicate balance of adaption and harmonization. This is not a case of "if a little anterior guidance is good, more will be better!" Several researchers have shown that for harmony, Anterior guidance should be equal to or greater than posterior condylar guidance.[23] The literature reports a range of 0–10 degrees.

What if we err on the side of "more disocclusion is better?" What if we increase or steepen our therapeutic anterior guidance beyond 10 degrees? Several researchers have shown that artificially steepening canine guidance will alter muscle activity. One of the most novel research protocols on this topic is an experimental design by Tamaki where he

artificially induced increasing canine guidance through cast gold lingual onlays provisionally cemented on dental students. He altered their guidance system, starting with a canine guidance that was equal to condylar guidance and then steepening the guidance in 5-degree increments. He then looked at the effect this had on condylar movement pathways and on muscle activity.[10]

At 10 degrees and greater the condylar movement pathway showed a definite retrusive, surtrusive movement on the working condyle. Clinically this would not be apparent but one can hypothesize that this type of movement has the potential to be very destructive to the retrodiscal component of the disc-condyle assembly. This phenomena was also mentioned by Coffee, Mahan and Gibbs in 1989.[24]

They felt that this effect of tooth guidance on condylar movement was an unexpected finding and warranted further research to see if there was a correlation with TMD! Parlett found a high correlation between these retrusive and surtrusive condylar movements on the working side condyle and the incidence of internal dearangement.[25]

In 1981, Kirveskari wrote, "that negligible functional tooth wear has brought about changes to the form-function harmony of the stomatognathic system exemplified by the persistence of cusps and vertical overbite of anterior teeth. It appears that the presence of cusps can be easily tolerated provided that their form is accommodated to the joint function. However, anterior guidance is usually necessary for this requirement to be met."[26]

Treatment strategies should be based not on the original heavy masticatory function but on the present day condition where parafunction is the new enemy of our dental restorations. Anterior guidance in harmony with the cusps of teeth and the TMJ will help to decrease masticatory muscle activity, minimize lateral forces on posterior teeth, and create a mechanical advantage to the system of the lowering of forces on the anterior teeth by insuring a class 3 lever system. Harmonizing all of these components will allow you to create a therapeutic concept individualized for each patient that optimizes function, muscle efficiency and maximum protection from the pathologic levels of force consistent with parafunction.

Conflicts

None declared.

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Brief History of Occlusion in the 19th and 20th Centuries
Une brève histoire de l'occlusion aux 19e et 20e siècles

By Dr. Ian W. Tester DDS, MSc

About the Author

Dr. Ian Tester graduated from the University of Toronto with a DDS degree in 1982 and a master's of science in dental sciences degree from Donau University in Krem's Austria in 2004 with the major emphasis on the treatment of the complicated patient utilizing orthodontics, prosthetic dentistry, physical therapy and medical intervention. Dr. Tester practices general dentistry in St. Catharines, Ontario with a focus on multidisciplinary treatment of the complex dental patient. Dr. Tester lectures in the US. and Canada on the topics of TMD, function and dysfunction, esthetic and restorative dentistry, occlusion, and prosthetics.

ABSTRACT

The preponderance of literature reviews and lack of new basic research in North America emphasizes the need to reflect on the history of the science of occlusion so that we can design appropriate evidence-based studies. The ultimate goal must be a consensus that is backed by sound scientific research. A review of the evolution of the term occlusion throughout the late 19th and 20th century reveals a history marked by much dogma and controversy. Careful study also reveals some excellent research that should provide a framework for future studies as well as a good deal of useful information that can be applied in our therapies today. This paper offers a brief overview of the history of occlusion and temporomandibular dysfunction research.

RÉSUMÉ

La prépondérance des analyses documentaires et l'absence de nouvelle recherche fondamentale en Amérique du Nord font ressortir le besoin de tenir compte de l'historique de la science de l'occlusion afin de pouvoir concevoir des études factuelles adéquates. Le but ultime est d'obtenir un consensus qui est appuyé par une recherche scientifique solide. Un examen de l'évolution du terme occlusion vers la fin du 19e siècle et au 20e siècle révèle une histoire marquée de dogmatisme et de controverse. Un examen minutieux révèle également une recherche excellente qui devrait fournir la structure pour les prochaines études ainsi que beaucoup d'informations utiles qui peuvent être appliquées aux traitements actuels. Cet article donne une brève vue d'ensemble de l'historique de l'occlusion et de la recherche sur la dysfonction de l'articulation temporomandibulaire.

Albert Einstein (1879–1955) wrote that "truth is what stands the test of experience." The study of occlusion and its importance to health and restorative success cannot be overemphasized. The polarization of clinicians into the broad categories of "occlusionists" and "non-occlusionists" has done little to foster current research into diagnostic and therapeutic modalities related to occlusion. The preponderance of literature reviews and lack of new basic research in North America emphasizes the need to reflect on the history of the science of occlusion so that we can design appropriate evidence-based studies. The ultimate goal must be a consensus that is backed by sound scientific research. A review of the evolution of the term occlusion throughout the late 19th and 20th century reveals a history marked by much dogma and controversy. Careful study also reveals some excellent research that should provide a framework for future studies and a good deal of useful information that can be applied in our therapies today. The years 1870 to 1970 saw much of the groundwork laid for our current understanding of occlusion. In addition, much of the perceived controversy revolving around the science of occlusion dates back to myths perpetuated from this period.

The complexity of the stomatognathic system and challenges faced in studying such an intricate structure are made even more difficult by the terminology that is used. The current understanding of the word "occlusion" is historically inaccurate and the term is more appropriately defined as "articulation of the teeth and temporomandibular joints." A study of the history of occlusion requires a broadening of the scope to include a review of the history of gnathology. Gnathology as defined in *The Journal of Prosthetic Dentistry* Glossary of Prosthodontic Terms is "the science that treats the biology of the masticatory mechanism as a whole: that is, the morphology, anatomy, histology, physiology, pathology, and the therapeutics of the jaws or masticatory system and the teeth as they relate to the health of the whole body, including applicable diagnostic, therapeutic, and rehabilitation procedures."[1] The term gnathology was originally suggested by Harvey Stallard in 1924 and is a combination of the Greek terms "gnathos" meaning jaw and "ology" meaning the study of early history.[2]

Early understanding of the function of the

temporomandibular joint dates back to the first edition of *Gray's Anatomy* which was written and published by Henry Gray in England in 1858. Gray recognized that the temporomandibular joint was capable of both hinge as well as sliding action. He termed this a "ginglymo-arthrodial joint." Earlier, Balkwell (1824) of England noted the sliding action of the joint; however, this research was largely ignored in North America until the time of Bonwill (1858) who believed the transverse movements were in a straight line forward. He was a proponent of balanced occlusion and believed that a four inch distance existed between the condyles and the distance from each condyle to the lower incisor was also four inches. This triangular theory led to the development of the Bonwill articulator. Other notable 19th century contributions were made by Snow (development of the facebow for transfer of the hinge axis), Sigmund (1870) and Ferdinand Graf von Spee of Kiel, Germany who described the correlation between the curved arrangement of the occlusal planes of teeth and the curves of condylar paths (1890).[2–18] Finally, W.E. Walker (1897) modified Bonwill's earlier articulator to reflect the fact that the condylar path was not parallel to the occlusal plane. The Walker-Bonwill articulator which later evolved into the Walker physiological articulator was used in combination with anatomical teeth that Walker based on his evaluation of the natural dentition. This created a more accurate transference from articulator to the mouth with respect to function. In addition, Walker developed the facial clinometer which allowed measurement of the direction of the condylar paths and occlusal plane relative to the facial plane. It is clear that the principles of jaw movement were well defined by the end of 19th century.[2–7]

1900–1950

Alfred Gysi of Zurich, Switzerland (1865–1957) was responsible for many important developments including recordings of the hinge axis and the development of anatomical teeth that were based on a 33 degree condylar inclination (Trubyte teeth). Gysi also discussed grinding these teeth to create a mortar and pestle effect (later described as lingualized occlusion through the work of Brenner and Payne – 1940). Gysi graduated from the University of Geneva in 1886 and opened his own practice in 1891 in Zurich. In addition to significant contributions to the fields of photography, botany, and histology he conducted important research in the fields of Prosthodontics and occlusion after the turn of the century.[4]

Figure 1. Alfred Gysi.

Figure 2. McCollum gnathoscope.

Norman Bennett originally described the Bennett Movement (side shift of the rotating condyle) in 1908 using instrumentation called a gnathograph. Monson developed the spherical theory of occlusion which was based on a combination of Bonwill's four inch triangle; Von Spee's compensating curve and Balkwell/Christensen's condylar movements in three dimensions. Hanau (1923) disagreed with Monson and developed the Hanau articulator to produce bilateral balanced occlusion with articulator movements designed to reflect mandibular movements. Meyer (1933) proposed using a functionally generated path to produce a functional occlusion.[3,8]

Pankey and Mann (Pankey-Mann system) combined the Monson four inch sphere and Meyer's functionally generated path to produce bilateral balanced occlusion. Later, Schuyler's influence allowed the development of the Pankey, Mann, Schuyler system (PMS) which was a combination of incisal guidance, long centric and posterior separation of teeth in excursions.[2]

B.B. McCollum formed the Gnathological Society in 1926 and proceeded to guide this organization in refining research into mandibular movement. Initially he modified a Snow facebow which he rigidly attached to the mandibular teeth with compound. Using small pencils he demonstrated the presence of a distinct rotational hinge axis. After confirming the existence of the hinge axis McCollum lead the Gnathological Society of California to investigate the work begun by Balkwell, Walker, Gysi, and others using instrumentation similar to Gysi's and Walker's that was rigidly fixed to the mandible and more precise. In addition they developed a functional clutch that could be fixed to the mandible without interference with intercuspation during the studies. Dr. McCollum was a proponent of balanced occlusion which had been popularized through previous complete denture studies. His laboratory technician, Everitt Payne developed the incremental wax buildup techniques used today to create the balanced occlusion. Dr. Charles Stuart, another member of the gnathological society teamed up with Dr. McCollum to produce the first semi-adjustable articulator deemed the McCollum Gnathoscope in 1930 and the McCollum gnathograph in 1934. This instrument recorded mandibular movement on extra oral plates.[5]

Harvey Stallard is credited with defining and postulating the "structural and functional unit" which was the term used to define the anterior teeth working to produce a mutually protected occlusion (disocclusion of the posterior teeth). As a member of the Gnathologic Society this created two distinct belief systems within the group. Stallard and Stuart were proponents of anterior guidance (Mutually protected occlusion or cuspid protection) while McCollum and Payne were in favour of balanced occlusion.

The years prior to 1950 were ultimately a period that could be termed "The Dawn of

Gnathology." Many concepts were introduced that emphasized excellence and precision with respect to reconstruction. It is important to note that much of the literature focused on an "inside-out" movement of the mandible. A paradigm shift occurred in the 1950s when research began to look at "outside-in" mandibular movement that was more representative of function. The concentration on the posterior determinants of occlusion (temporomandibular joint condylar inclination and Bennett movement) was also lessened with anterior guidance taking a prominent place in the literature.

1950–Today

In the second half of the 20th century, Gerber and the Swiss school popularized lingual occlusion. This was one of four dogmatic occlusal theories being promoted. Group function (Byron and later Pankey, Mann), cuspid guidance (Stuart and Stallard) and balanced occlusion (McCollum, Payne) were all purported to be the best occlusal scheme.

The 1950s and 1960s provided a wealth of information about mandibular movement and stomatognathic function. Posselt (1952) in his classic gnatho-thesiometer studies was able to identify the habitual and extreme positions of mandibular movement.[10–12] Posselt's research recognized the envelope of function which Ahlgren (1966) verified. Moller[19] (1966) used electromyography to study the actions of the muscles in mastication further adding to the literature base that emphasized function.

McCollum and Stuart published their classic "Research Report" in 1955 which summarized the philosophy of capturing mandibular movements, accurate transfer of casts and the use of an Arcon type articulator.[2,6] Stuart fabricated the Stuart articulator with gnathological settings that allowed use of accurate transfer of models and articular movements. Subsequently, Guichet designed the Denar pantograph for determining condylographic movements and articulator settings and many practitioners adopted the Denar articulator system for routine prosthetic dentistry.[3,20]

Woefel (1957) provided electromyographic evidence supporting the mandibular hinge axis theory. Using needle electromyography he identified a lack of external ptyregoid activity during initial hinge opening followed by contraction during protrusive movements.[13] Brotman further developed hinge axis theory.[14] The stage was set for the 1960s as research attempted to expand on the theories developed to date. Centric relation and its definition dominated much of the research.

Granger[21] (1960) reiterated the necessity of proper hinge axis location and transference while Cohen[22] (1960) noted that centric relation occurred at the only point in mandibular position where the mandible underwent pure rotation. Cohen also described three different slopes of the glenoid fossa. He felt that the shallowest fossa was the most tolerant to aberrant closure patterns which caused the condyle to seat improperly. The steeper eminence led to the most lateral strain on the teeth and pathology in the joint. Hinge axis location was deemed necessary to determine if centric occlusion was in harmony with centric relation. In addition, vertical dimension changes on the articulator did not affect the centric relation position if the hinge axis was correctly recorded. The axis of rotation of the ginglymoid part of the joint was described as being 5 mm below the center of each condyle by Naylor[23] (1962). Boucher[24] (1962) discussed growth and development of the articular eminence. The fossa is shallow at birth and gradually deepens thereafter. The eminence starts to form at age 7 to 9 years. This development accelerates during the 10th and 11th years. By the 13th year the articular eminence has usually attained adult proportions. Slight flattening occurs after the age of 40.

D'Amico[25] (1961) reviewed the function of natural teeth reporting to the Academy of Restorative Dentistry in Chicago. He concluded that the study of the evolution of natural teeth of the primate family did not support von Spee's observations or the theory of balanced occlusion. His attrition studies on pre-white California Indians noted that the heavy attrition recorded was diet related and not an evolutionary response. He further illustrated the role that the cuspids played in avoidance of deleterious lateral forces. Periodontal failure due to occlusal forces was reduced by the elimination of traumatic antagonist tooth forces.

Schuyler[26] (1963) in a classic article on anterior guidance noted its importance as equalling or surpassing the temporomandibular joints (TMJs) in influence on the functional occlusion of the dentition. The incisal guidance does not have the flexibility of the TMJs for adaptation. Schuyler noted that the condylar pathways had little influence on the incisal guidance; conversely, the incisal guidance did have an influence on the development of the glenoid fossa. He stressed that an improper anterior guidance could produce an abnormal movement pattern of the condyles. Mounted diagnostic casts were used to establish the pre-existing incisal guidance. In combination with the functionally generated path technique and proper anterior guidance a "freedom in centric" ensured a non-locked posterior occlusion.

Lucia[27] (1964) defined centric relation as the intersection of the centers of vertical arcing and lateral motion in each condyle when they are in the most posterior terminal position in relation to the maxilla. The need to remove the proprioceptive influence of the teeth that leads to muscle programming was described by Guichet.[20] Okeson termed this programming "muscle engrams." Lucia felt that removal of muscle engrams dictated by tooth contact would allow a perfect hinge axis closure in centric relation. Glickman (1966) defined CR as the most retruded position of the mandible to which the mandible could be carried by the patient's own musculature. Graber (1966) defined it as an unstrained neutral position of the mandible neither deviating to the left or right nor protruded or retruded. Goldman, Cohen (1968) believed centric relation to be the most posterior relationship of the mandible to the maxilla from which lateral excursions could be made.[21] In 1969 Jankelson reported on the stimulation by Myomonitor of cranial nerves V and VII as a method of producing a "physiologic rest" position of the muscles which became the basis of neuromuscular occlusion.[15] Subsequent research by Remein and Ash refuted this position as it was non-reproducible and created an anterior-inferior condylar position from CR.[16]

Long[28] (1973) described the use of a leaf gauge to seat the condyles through the use of the elevator muscles. This gauge consisted of multiple leaves 0.5 inches wide and 0.01 inches thick. The effect of anterior deprogramming and the production of a class three lever braces the condyle against the articular disk on the posterior slope of the eminence. Williamson's[29] technique began with 10 leaves being placed between the upper and lower incisors. Leaves were removed until the teeth initially contacted. One leaf was added sequentially until the patient felt no posterior contact when biting for 5 minutes. This time period was based on Jarabak's work that aberrant neuromuscular electromyography recordings returned 5 minutes after splint removal.[30] The last leaf was removed and the bite registration was taken ostensibly in a centric relation position.

Celenza[8] (1973) described centric relation as the most important spatial relationship of the mandible to the maxilla. He defined this position as the most retruded position of the mandible and stated that it must be repeatable and consistent. Guided and unguided gothic arch techniques and guided biting point methods were used. No statistical differences were noted between all three techniques. Lundeen[31–34] described centric relation as the most superior posterior position of the condyles.

Weinberg (1975) used transcranial radiography to study condylar position with respect to TMD. He recognized the multi-causality of the condition and believed that lateral transcranials radiographs that were anatomically aligned would identify condylar misalignment created by deflective occlusal contacts. Concentric 2-dimensional position was the goal.[2,35] Williamson[35] (1978) noted that tomographs provided superior diagnostic information to transcranials which he used to substantiate Dawson's[37] hypothesis that centric relation was a superior position of the condyles braced against the posterior slope of the articular eminence. In a paper published in 1983 Gilboe[38] described the posterior limitation of condylar movement as dictated by the intra-articular tissue and the eminence, not by the concept of condyle-fossa spatial relationship. He defined centric relation as "the most superior position of the mandibular condyles with the central bearing area of the disk in contact with the articular surface of the condyle and the articular eminence." Gilboe described the bimanual manipulation technique of Dawson as creating a posterior directed force on the mandible with a simultaneous superoanterior force created by the elevator muscles positioning the condyle against the eminence and disk. He felt that anterior deprogrammers created a similar force vector however Guichet's chin point guidance technique pushed the condyles too posterior away from the eminence. The capsular ligament was noted to be responsible for maintaining the central bearing area of the disk against the condyle. The temporomandibular ligament limits posterior movement of the condyle pivoting it against the eminence when maximally stretched.

Lundeen, Shyrock and Gibbs[39] (1979) studied mandibular border movements using plastic blocks engraved by air-turbine drills. They concluded that patients with excessive Bennett movement (3.5mm +) and little or no anterior guidance were the most challenging to restore as the elimination of eccentric cusp interference was extremely difficult. A fully adjustable articulator was recommended with condylar recordings including Bennett movement. Patients with minimal Bennett movement (.75 mm or less) had molar cusp heights that were steeper and reflected the anterior guidance and non-working condylar pathway (posterior determinant). These patients could be restored adequately on a semi-adjustable articulator. The study of 163 subjects note that 80% had a Bennett movement of 1.5 mm or less with the average being .75 mm.

Williamson and Lundquist[17] (1979) concluded that if posterior teeth were separated by a leaf gauge the temporal muscles remained active while the massetter muscles showed minimal electromyographic activity. In excursive movements when the posterior teeth were kept from touching (i.e., anterior guidance) a marked reduction of massetter and anterior temporalis on the mediotrusive side and reduction of massetter activity on the laterotrusive side was noted. If the anterior guidance was eliminated muscle activity in excursions was not reduced. It was also stated that the absence of lateral forces on the posterior teeth was desirable which again supported anterior guidance.

McHorris[40,41] discussed occlusal schemes and the functional role of teeth emphasizing anterior determinants that are coordinated with appropriate occlusal plane angles as well as posterior determinants. He described cusp fossa and cusp embrasure occlusions and noted that steep eminences allow steeper anterior teeth slideways while shallow eminences require shallow front tooth slideways.

Mahan and Gibbs (1984) identified the actions of the external ptyregoid superior and inferior heads during opening and closing movements. The superior head was found to contract on closure stabilizing the articular disc while the inferior head was active during translation laterally and protrusively.[2,42]

Woods[43] (1988) further described centric relation as a border position that may be related to the horizontal hinge axis. This position was described as a repeatable, anatomical and physiologically stable relationship of the condyle maximally braced against the thinnest part of the disk against the eminence. The centric relation position was commonly not coincident with the intercuspal position of the teeth. Woods emphasized that centric relation is a reference position used by the dentist to accurately transfer pantographic tracings and the patient's models to an articulator. Roth[44,45] combined deprogramming with a bimanual manipulation technique using Delar wax (Delar Corp.). By chilling three thicknesses of wax placed on the anterior teeth after centric registration the patient was instructed to bite hard into soft wax placed on the posterior teeth. In this way the elevator muscles provided a superior anterior force which proved to be an accurate and repeatable method of taking a centric relation record in a normal patient group. Carr46 failed to find any physiologic basis for the use of a leaf gauge to deprogram muscles using electromyography after 15 minutes of leaf gauging.

Jensen[26] (1990) described the effect of jaw size

on occlusion terming it the "5th factor." With class II and class III malocclusions the anterior determinants of occlusion were reduced or eliminated from the guidance scheme. Using a hypothetical mandibular model he illustrated the various strains that could occur in tooth to tooth contact as the arches widened and narrowed. In addition, the increasing importance of posterior determinants in the absence of anterior guidance as well as the need to create a proper group function guidance mechanism using the bicuspids and first molar were discussed. The increasing potential for production of a class III lever system was reported.

Kinderknecht et al.[47] (1992) used an Axiotron to study terminal hinge axis location and deprogramming. Their conclusion was that in healthy subjects the amount of positional change in the TTHA after 12 hours of deprogramming with a custom anterior deprogrammer made out of stent material and orthodontic resin was not statistically significant. In addition, they concluded that the Axiotron was a valid tool for in vivo study of the terminal transverse hinge axis. Numerous other authors have reported on the validity of using electronic condylography to describe condylar position.[11,23,48–51] In a normal healthy individual the repeatability of the maximum intercuspation position can be verified.

Dawson[52] (1995) recognized that some structurally deformed TMJs function adequately and are comfortable in cranial loading despite the fact that they could not meet the requirements of a true centric relation position. He termed their position as adapted centric posture (ACP). Slavicek[53] has used the terms reference position (RP) and deranged reference position (DRP) in place of CR and ACP. RP is defined as the retral border position of the mandible with the joint structures unstressed. DRP is the reference position of a joint that has a deranged disc.

Wiskott and Belser[54] (1995) reviewed the history of various occlusal schemes and proposed a simplified scheme for occlusal design in restorative dentistry. Observations of natural dentitions revealed (1) occlusal contacts (OC) were fewer and less ideally placed relative to ideal schemes; (2) functional and parafunctional forces were not directed along the long axes of teeth only; (3) the terminal hinge axis is neither absolutely stable nor absolutely reproducible; (4) unstrained lateral movements have a smaller envelope of motion than strained movements; and (5) position of teeth depends on forces of low intensity and long duration and tooth stability is mostly independent of occlusal relationships. A simplified pattern of OC should follow these guidelines and allow adequate function, esthetic demands and be applicable to small and large restorations ensuring stability. The primary characteristics outlined by the authors were (1) anterior guidance; (2) at least one buccal cusp of a mandibular tooth occludes with the central fossa of a maxillary tooth neutralizing eruptive force; (3) proximal contacts are necessary to stabilize the teeth mesiodistally; (4) OC must be designed to allow room for variability in TMJ movement; and (5) cusp to fossa contact should be a definite bearing surface as opposed to a point to reduce the force per surface area and reduce wear. They further concluded that immediate side shift (ISS) would create concave internal slopes of cusps in parafunction and thus cusp anatomy should reflect this freedom to avoid interferences. The authors suggested that occlusal surfaces should reflect a "worst case" scenario as more room for posterior tooth movement in excursions could create no harm.

This brief review of the period 1950–2000 recognizes that much of the research was devoted to function as well as identifying and recording the hinge axis, and defining centric relation (CR). A brief review of the evolution of CR definitions reveals two major beliefs. The tolerant gnathologists (Ramjford, Wirth, Lauritzon, and Slavicek) recognized that much of the argument of different CR definitions was over a less than a .6 mm difference of condyle position. Gerber and others argued for a more dogmatic definition requiring tripodism of contacts and a point specific CR position. (Personal Communication – Dr. R. Slavicek July 2010). All gnathologists agreed that a defined reference point was necessary to practice clinical dentistry.

No review of history would be complete without emphasizing the contributions of Dr. Harry Lundeen and Dr. Charles Gibbs who completed comprehensive research on function and dysfunction throughout the 60s, 70s, and 80s beginning at Case Western University and continued after moving to the University of Florida. They preached diagnostics as a priority with canine guidance and 1:2 occlusion ideal.[14] In addition, Dr. Robert Lee developed his concept of biological occlusion (bioesthetics) during the 1960s and 1970s. He was a pioneer in jaw tracking and axiopantography and also recommended a 1:2 occlusal scheme with cuspid guidance. This concept fit well with the "tolerant" gnathology as described by Slavicek.

Dental Implants and Occlusion.

The unique interface with which implants are integrated to bone has led to much conjecture on the best occlusal treatment to ensure success. Taylor et al.[55] completed an extensive literature review and concluded that non-axial loading had no effect on the integrity of the osseointegrated surface although these forces could have a deleterious effect on screws and joints. The cylindrical shape, surface coating and thread components of implants make it impossible to load an implant with just compressive forces. Tension and shear forces will be transferred to bone at the same time. Progressive loading of implants has been promoted as a method of progressively increasing bone mass about implants through graduated application of stress. The authors concluded that there was no evidence to support graduated loading and indeed the concept was clinically extremely difficult to achieve due to the variety of functional and parafunctional forces involved. Similarly, occlusal overload of implants in animal models does not produce a direct cause-effect with respect to failure of the integration. Finally the authors noted the presence of so called "osseoperception" that allows proper functioning of implants without an associated periodontal ligament. This form of proprioception comes from the combined efforts of other stomatognathic proprioceptors.

A second review of occlusal considerations in

implant therapy completed by Kim et al.[56] emphasized that occlusal overload causes mechanical complications with screws, prosthesis fractures, and implant fractures; however, the effect on integration was not conclusive. They reported that some authors believed that peri-implant bone loss was primarily associated with biologic complications such as peri-implantitis. The basic principles of implant occlusion may include (1) bilateral stability in centric occlusion; (2) evenly distributed occlusal contacts and force; (3) no interferences between retruded position and centric occlusion; (4) wide freedom in centric occlusion; (5) anterior guidance where possible; and (6) smooth, even lateral excursive movements without working/non-working interferences. The authors discussed various occlusal schemes suitable for occlusion on full arch fixed prostheses, overdentures, posterior fixed prostheses, and single implant restorations and concluded that the objectives of implant occlusion were to minimize overload to the implant prosthesis and interface and to provide long term stability. This is best accomplished by minimizing force magnification, improving force direction and increasing support area.

Conclusion

So where are we today? The dogma of the past will inevitably be replaced by excellent evidence-based research that can assist clinicians in making proper diagnostic and treatment decisions. An understanding of the path that research has taken should lead to better experimental designs in the future. Consensus must be established so that clinical guidelines can be written. A brief review of the history of "occlusion" is a good starting point.

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Simplified Muscle Reconditioning Splint Construction: Rationale, Fabrication, and Case Report

Réalisation simplifiée de plaques occlusales pour le reconditionnement de la musculature : principe, fabrication et rapport de cas

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ABSTRACT

The management of temporomandibular disorders (TMD) appears to hold an uncommon fascination for clinicians of many disciplines. Any therapeutic approach must be used carefully, for a normalization of the function rather than a pseudo structural ideal.TMD is reversible if caught in time and treated with bite plane therapy in phase I (reversible treatment) and with appropriate phase II therapy (additive or subtractive occlusal therapy, restorative dentistry, orthodontics) to restore balance from/to the CR position. Occlusal splints, which have the advantage of being noninvasive, constitute one of the most therapeutic responses used in the treatment of TMD.

Presented here is an in-office procedure for simplified fabrication of a muscle reconditioning splint/stabilization splint to decrease delay in starting treatment and the time needed for adjustment of the device in the mouth.

RÉSUMÉ

Le traitement des troubles de l'articulation temporomandibulaire (ATM) semble fasciner les cliniciens de plusieurs disciplines. Tout traitement doit être utilisé avec soin, pour une normalisation de la fonction plutôt que pour un idéal pseudo-structurel. Les troubles de l'ATM sont réversibles s'ils sont identifiés à temps et traités par une plaque occlusale à la phase I (traitement réversible) et par un traitement approprié à la phase II (traitement occlusal d'addition ou de soustraction, dentisterie restauratrice, orthodontie) pour rétablir l'équilibre (relation centrée). Les plaques occlusales qui ont l'avantage d'être non invasives constituent l'une des réponses thérapeutiques utilisées pour le traitement des troubles de l'ATM.

The management of temporomandibular disorders (TMD) is often confusing because the etiopathogenic phenomena complex is multi-factorial. The masticatory apparatus is not a simple mechanical system but a complex biological entity, multi-functional, in direct touch with its environment and strongly influenced by the individual psychosocial aspects. Any therapeutic approach must be used carefully, for a normalization of the function rather than a pseudo structural ideal. Occlusal splints, which have the advantage of being noninvasive, constitute one of the most therapeutic responses used in the treatment of TMD.[1,2]

This article reports a clinical situation in which a combination of physical and odontologic resources followed by oral rehabilitation were used to treat limited mandibular movements and painful symptoms of the muscles of the face.

Clinical Report

A 35-year-old female reported to The Oxford Dental College and Hospital with a history of pain and difficulty in opening the mouth wide. The patient complained of generalized muscle soreness in the right side of the face. She had symptoms of pain in the face and ears, headaches, and limited functional mandibular movements. Clinical examination verified the presence of acute muscular pain and tenderness in the right masseter, sterno-cleidomastoid and temporalis muscle, limited opening, and difficulty in protruding the mandible. Intraorally 16, 26, and 46 were missing, causing drifting and supraeruption of the adjacent teeth and interferences in the mesial and palatal inclines of the mesiobuccal cusp of 27, and the distal and buccal inclines of distobuccal cusp of 36 resulting in lateral shifting of the mandible from the musculosketally stable position (CR) of the condyles (Figure 1). The history revealed that the symptoms were related to stressful episodes at home related to personal problems.

Figure 1. Preoperative intraoral view.

Here factors related to the development of TMD include the loss of posterior occlusal support, (Angle's class I) occlusal relation, muscular hyperactivity, emotional stress, and possibly oral habits.

Treatment Plan

The patient was made aware of the relationship between her emotional stress, parafunctional activity and the symptoms she was experiencing. Given the clinical findings, this patient was referred to physical therapy before beginning the odontological procedures. Physical therapy included counselling, patient education (habit reversal techniques and proper use of the jaw), thermo therapy, auto-massage, and stretching exercises. Behavioural therapy is generally considered as a first conservative approach for the treatment of TMD patients. The rationale for choosing behavioural therapy arises from the idea that parafunctional activity and psychosocial factors play a role in the pathogenesis of musculoskeletal pain. The objectives of education are to reassure the patient, to explain the nature, the aetiology and the prognosis of the problem, to reduce repetitive strain of the masticatory system (e.g., daytime bruxism), to encourage relaxation and to control the amount of the masticatory activity. Exercise therapy is the cornerstone of rehabilitation of regional musculoskeletal disorders. The program suggested for TMD patients with muscle pain and/or limited mouth opening includes relaxation exercises with diaphragmatic breathing, auto-massage of the masticatory muscles, application of moist heat pads on the painful muscles, stretching, and co-ordination exercises including proprioceptive training and posture.

After the initial physical therapy, specific odontologic procedures began by obtaining maxillary and mandibular casts, which were mounted on a semi-adjustable articulator and a stabilisation splint was fabricated for night wear. She was also informed that her occlusal condition was not stable and might be contributing to her complaints. After all symptoms had resolved, the significance of rehabilitating the dentition was discussed.

Rationale of Using a Muscle Reconditioning Splint

A Muscle Reconditioning Splint (MRS) is also called the muscle relaxation or stabilization appliance because it is primarily used to reduce muscle pain and to treat muscle hyperactivity. Studies have shown that wearing it can decrease the parafunctional activity that often accompanies periods of stress. Thus, when a patient has a TMD that relates to muscle hyperactivity such as bruxism, a stabilization appliance is considered. This appliance can help minimise forces to damaged tissues, thus permitting more efficient healing. The treatment goal of the stabilization appliance is to eliminate any orthopedic instability between the occlusal position and the joint position, thus removing the instability as the etiologic factor in the TMD.[3,4]

Allowing the Condyle to Seat in Centric Relation

No report on splints would be complete without an understanding of the role of centric relation (CR) on the healthy stomatognathic system. Centric relation is the optimal arrangement of joint, disk, and muscle. Splint therapy must use CR as the ultimate treatment position. For the condyle to completely seat under the disk in this anterosuperior position, the lateral pterygoid must completely relax because of its attachment to the disk through the superior belly. If this muscle stays contracted after hyperactivity, the disk will be pulled anteromedially (along the direction of the muscle origin) and will not seat completely over the condyle. When the disk is loaded in a

power bite or through parafunctional activities, the disk, attached muscle, condylar head, condylar ligaments, and retrodiscal tissues can sustain excess force loads and be damaged if the condyle/disk assembly is not properly related to the fossa. Chronic and acute overloading of the condyle/disk assembly when it is out of its normal physiologic position contributes greatly to the catch-all term temporomandibular disorder.[5]

Locating the Musculoskeletally Stable Position/Centric Relation

For muscle relaxation splint to be optimally effective, the condyles must be located in their most musculoskeletally stable position, which is centric relation. Two techniques have become widely used. The first used the bilateral manual manipulation technique with the discs properly interposed between the condyles and the mandibular fossae. In the other technique a stop is placed on the anterior region of the appliance that allows separation of the posterior teeth immediately prior to centric relation record fabrication. This results in the patient "forgetting" established protective reflexes that are reinforced each time the teeth come together, making mandibular hinge movements easier to reproduce.[6–8]

Anterior Deprogramming Device Fabrication

Various techniques to separate the posterior teeth include positioning cotton rolls between the incisors, use of a plastic leaf gauge, or a small anterior deprogramming device made of autopolymerizing acrylic resin (DPI-RR Cold Cure Acrylic Material). The resulting anterior stop acts as a fulcrum, allowing the directional force provided by the elevator muscles to seat the condyles in a superior position within the fossae.[8] The technique is as follows:

1. Clear acrylic resin (DPI-RR Cold Cure Acrylic Material) was mixed and adapted to the maxillary central incisors, ensuring coverage of the lingual surfaces while folding it over the incisal edges, slightly extend the material onto the facial surface of the teeth (Figure 2). Shape the lingual portion to minimize the amount of contact with the mandibular incisors.

2. While it is still soft guide the patient into closure until incisal contact occurs on the device and the posterior teeth are about 2 mm apart and slight mandibular incisor indentations occur. Cool with an air-water spray for approximately 10 seconds until the material sets hard and confirm that there is no posterior occlusal contact.

3. Trim excess material until there is no interference during closure .Once the material has hardened, using it as a template, a suitable bite registration material (3M ESPE Imprint Bite Registration Material Dental Products, D-82229 Seefeld Germany) can be placed between the posterior teeth (Figure 3).

Figure 2. Posterior occlusal contact has been eliminated while mandibular incisor contact occurs on anterior deprogramming device.

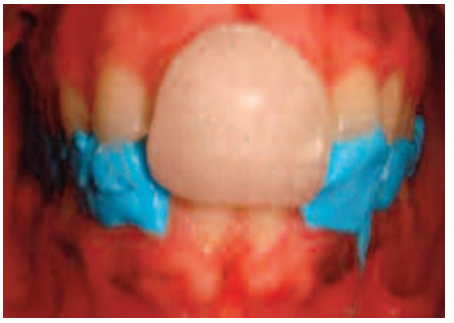

Figure 3. Centric relation record made with registration material interposed between posterior quadrants while mandibular incisor contact occurs on anterior deprogramming device.

How Should an Occlusal Splint be Designed?

Maxillary or Mandibular?

Presumably it is possible to obtain the same results regardless of the situation of the occlusal splint but the choice of the individual situation of the occlusal splint depends on a few basic principles. It is essential to always focus on the biggest toothless arch to increase the stabilizing effect by the creation of additional occlusal contact points.[1] All teeth are in contact in CR on a maxillary appliance. A mandibular appliance often will have cuspid-to-cuspid contact in CR, with the maxillary anterior teeth not touching. The maxillary appliance is an attractive choice for night wear, as all of the teeth are in contact with equal intensity.[5] The maxillary appliance is usually more stable and covers more tissue, which makes it more retentive and less likely to break. It is also more versatile allowing opposing contacts to be achieved in all skeletal and molar relationships. Other reasons for the choice of one arch over the other include arch irregularities, the patient's profession, and the potential for gagging.

Should the Occlusal Splint Be Hard or Soft?

Since 1942, Mathews recommended the use of soft occlusal splints, which are still currently used.[9] However, behind their simplicity of utilization, soft splints show numerous disadvantages. Okeson showed in1987[10] that the soft occlusal splint could encourage muscle hyperactivity. Also soft occlusal splints deteriorate more quickly by the simple fact of their nature and it seems impossible to equilibrate a soft occlusal splint which generates an uncontrolled inter-maxillary relation. The hard occlusal splint thus appears more effective in the reduction of the muscular hyperactivity than the soft occlusal splint.[1,11]

Should the Occlusal Splint Be Complete or Partial?

The partial occlusal splint can cause irreversible dental migration (extrusion, intrusion, and laterotrusion) resulting from the absence of stabilization with the antagonist arch. For the small pieces, during sleep the risk of inhalation is not zero. The full-arch occlusal splints are therefore recommended.[1]

The Occlusal Splint Should Be Smooth or Indented?

All splints are classified as either permissive[1,5,10] or nonpermissive. A permissive splint allows the teeth to move on the splint unimpeded, which in turn allows the condylar head and disk to function anatomically. The

smooth occlusal splints are represented by anteriorbite splint[1] and the smooth full-arch occlusal splint by the muscle reconditioning splint or stabilization splints. A nonpermissive splint[1,5,12] has a ramp or "indentations" that position the mandible inferiorly and anteriorly and secure it there. An example of a nonpermissive splint is anterior repositioning appliance.

Historically, treatment of the patient with TMD has been divided into phase I and phase 2 therapy. Phase 1 therapy seeks to alleviate pain and improve function and often involves reversible therapy. This therapy most commonly includes physiotherapy, pharmacotherapy (antidepressants), and psychological therapy (cognitive behavioural therapy) and palliative home care. Phase 2 therapy involves treatment such as occlusal therapy (occlusal appliances), surgical intervention, orthodontic modification, or prosthodontic rehabilitation, and it is often irreversible.[13] The muscle reconditioning splint has been indicated in the second place in all cases of persistent TMD despite preliminary treatment but also in the presence of acute musculoskeletal pain, significant malocclusions established and/or major parafunctions . It is used for its effect on the muscular reconditioning and also to reinforce the personal responsibility of the patient.[1,3,10,14]

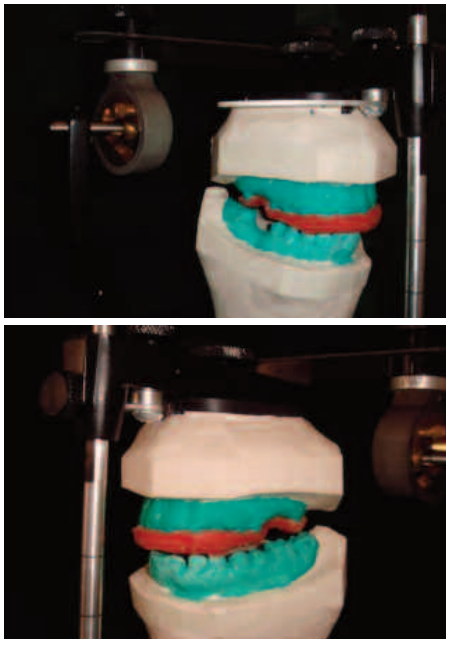

Figure 4. Canines provide a smooth and gentle disocclusion of the posterior teeth.

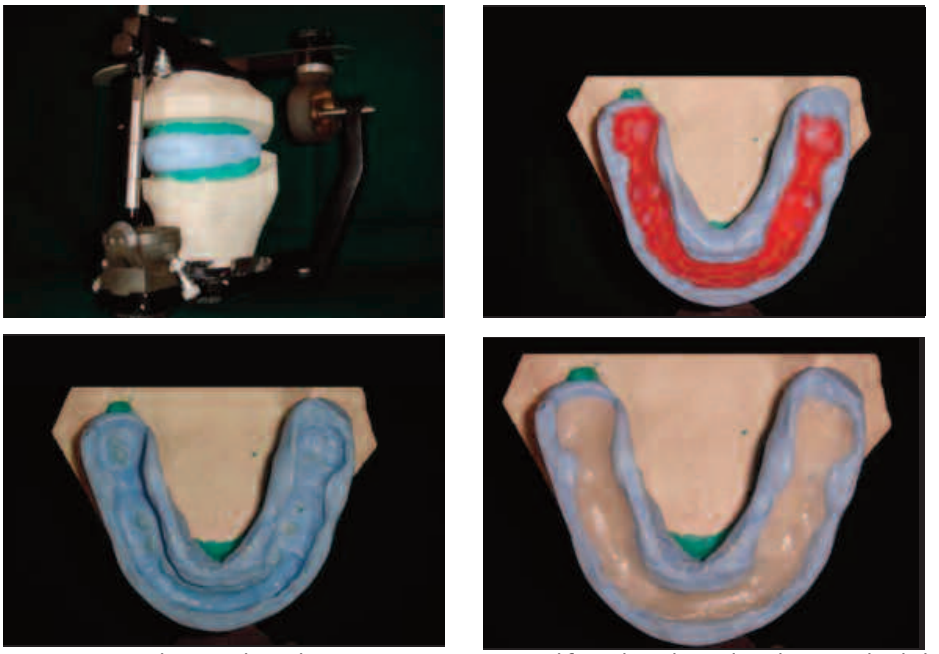

Figure 5. Putty index is made on this wax, next wax is removed from the index and acrylic resin is loaded into it.

Therefore it was decided to fabricate a full-arch, hard, permissive maxillary muscle reconditioning splint presented here is an in-office procedure for a device to decrease delay in starting treatment and the time needed for adjustment of the device in the mouth.

A face bow transfer is done, next interocclusal records are made and the maxillary and mandibular casts are mounted on a semiadjustable articulator in centric relation (see Figure 2 and 3). Undercuts in the maxillary arch are blocked out, and the appliance is developed in wax.

Wax (DPI Modelling Wax) is well adapted over the teeth on the maxillary cast. While the wax is still warm, close articulator to its original position established. The thickness of the wax will dictate the thickness of the bruxing device.(Figure 4).

The wax must be adjusted in articular reference position (centric relation [CR]), with equal intensity stops on all the antagonistic teeth. The CR represents a position of reference of mandibular centring in transverse direction ensuring a musculoskeletally stable position for each condyle.

Next it must have an anterior guide permitting the immediate posterior disocclusion without generating any posterior interference Canines must provide a smooth and gentle disocclusion of the posterior teeth. Any contacts on the posterior teeth are caused by eccentric interferences and ought to be removed. Eccentric contacts of the mandibular central and lateral incisors also must be eliminated so that the predominant marks are those of the mandibular canines. During protrusive movement, guidance by the maxillary canines, not the mandibular central and lateral incisors, is the goal.[3] Wax is added and or removed wax to achieve this[15] (see Figure 4).

Next an occlusal index is made on this wax with polyvinyl siloxane silicone impression material (Aquasil Putty and XLV, Dentsply, USA) and the articulator is closed so that the indentations by the mandibular teeth act as an orientation guide (Figure 5).

After applying separating medium to the cast and index, the wax is removed from the putty index and a mix of clear acrylic resin is loaded into the putty index until it is approximately level full (Figure 6).

Figure 6. Stabilization splint realized at the maxillary arch.

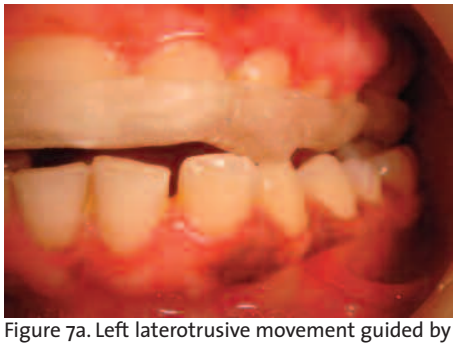

Figure 7a. Left laterotrusive movement guided by the left maxillary canine.

Figure 7b. Right laterotrusive movement guided by the right maxillary canine.

The articulator is closed so that maxillary cast is seated in the clear acrylic resin (DPI -RR Cold Cure Acrylic Material). The two members of the articulator are locked carefully and the resin is allowed to set. After which it is trimmed and polished and checked in the patients mouth (Figure 7 and Figure 8).

Instructions and Adjustments

The patient is instructed to use the appliance at night. She is monitored at regular intervals. As muscles relax and symptoms resolve, a superoanterior position of the condyle may be assumed. This change must be accompanied by adjustments of the appliance to optimum functional occlusion. Wearing must not exceed a few months because, with her parafunctional habits, the patient gets used to the occlusal splint and a negative dependence can be created. So that the patient is aware that her TMD is correlated with stressful situations such as her children's examinations or sporting events, episodic daytime wearing may be advisable during these periods or during activities.

Discussion

If a patient rapidly becomes comfortable with a splint, it may be an indication that the disorder is muscular. If symptoms worsen with permissive splint wear, this may indicate an internal derangement (disk) problem or an error in the initial diagnosis. In and of itself, this information has limitations. However, with a thorough TMD and occlusal examination, such information can be an invaluable piece of the diagnostic puzzle.[5]

The stabilization splint or the muscle reconditioning splint does not cure the patient, but could improve during sleep, the unconscious behaviour. It protects the structures and perhaps re-educates muscles and joints.[1] But especially, when it is necessary, it reinforces the personal implication of the patient, which is, in fact, the essential treatment. The wearing should be preceded for about 1 or 2 months of treatment with behavioural rehabilitation (emotional stress therapy) only to induce the patient awareness.[16] Behavioural therapy is generally considered as a first conservative approach for the treatment of TMD patients. A psychotherapist can help the patient deal with these extreme stressful conditions but ultimately patients do best when clinicians take the time to fully inform them about their condition. This contributes to reduce the fear, the depression and the anxiety that are characteristic of chronic pain patients. This means that enforcing patient responsibilities and thereby addressing psychosocial factors (like coping and locus of control) can be a powerful tool for successful rehabilitation.[16]

The patient has to be reassured by explaining the problem, the supposed etiology and the good prognosis of this benign disorder. Patients require good information to assist them in making choices, overcoming unhelpful beliefs, and modifying behaviour. The relationship between chronic pain and psychosocial distress should also be stressed. The rationale for choosing behavioural therapy arises from the idea that parafunctional activity and psychosocial factors play an important role in the pathogenesis of musculoskeletal pain.[16–19] Normal jaw muscle function has to be explained, stressing to avoid overloading of the masticatory system, which could be the major cause of the complaints. The patients have to pay close attention to the jaw muscle activity, to avoid bad oral habits and excessive mandibular movements. In acute conditions, they have to avoid hard food and/or cut hard and tough food in small pieces, chew with back teeth on both sides, and avoid chewing gum. Later in the rehabilitation program training of restrictive activities of daily living is part of the procedure in order to return to normal, or desired, levels of activity and participation, and to prevent the development of chronic complaints. Behaviour modification strategies such as habit reversal are commonly used. Although many habits are abandoned when the patients become aware of them, changing persistent habits requires a structured program. Patients should be aware that habits do not change spontaneously and that they are responsible for the change.[16]

Advantages regarding tooth replacement were discussed and the patient elected to accept the treatment. Permanent alteration of the occlusal condition is indicated for two reasons. The first and most common being to improve the functional relationship between maxillary and mandibular teeth and the second may be as a treatment goal to eliminate TMD. Here the patient had missing teeth which caused orthopedic instability. Therefore the occlusal interferences were eliminated first. If occlusal prematurities exist in the preoperative situation and typical simple-to-complex restorative procedures are accomplished without removal of occlusal prematurities, the new restorations may increase occlusal disharmonies and subsequent occlusal problems. An analogy is a dirt road with deep ruts in it. Driving out of the ruts is difficult or sometimes impossible.[20-22] Similarly, if occlusal prematurities are present in the preoperative state, the new restorations must adapt to the incorrect occlusion, and any

Figure 8. Completed prosthesis.

subsequent attempts at occlusal equilibration are more difficult.[20] Wearing of the stabilization splint and subsequent improvement of the condition was significant evidence to support that the occlusal condition was the causative factor related to TMD. Restoration of posterior teeth has been suggested to decrease or eliminate the pain associated with TMDs. The patient was rehabilitated with metal ceramic restorations and has been symptom free following the occlusal therapy (Figure 8). The treatment effect has been attributed to stabilization of the occlusion, redistribution of occlusal forces, and reduction of joint loading.[21]

Conclusion

To conclude, the occlusal splint fabrication is, today, an act proposed mainly as a second-phase of treatment after a first initial treatment phase: psychotherapy, behavioural education, physiotherapy, and home exercises.[1] The clinician is faced with the need to provide therapy that has some reasonable degree of objective and/or subjective impact on the effects of a disorder. The therapy should do no harm; be acceptable in terms of patient's criteria for success; be in keeping with the need to balance costs, benefits, and risks; and be consistent with the standard of care determined by the dental profession. From the standpoint of clinical reality, the effects of occlusal equilibration on function and parafunction is one of the major treatments for occlusally oriented diseases. The occlusal splint is, mainly, a means of reinforcing the auto-management of the patient; it offers him the opportunity to control dysfunctions by himself. But the practitioner must imperatively explain the use of the occlusal splint installation, because it is essential that the patient understands the principle and its implications on the treatment.

Disclosure

No conflicts declared.

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Simplified Impression Procedure for A Patient with Microstomia
Une empreinte simplifiée pour un patient avec microstomie

By Dr. Praveen G, MDS; Dr. Swatantra Agarwal, MDS; Samarth Agarwal, MDS; Saurabh Gupta, MDSc; Atul Bhardwaj, post-graduate student.





About the Authors

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ABSTRACT

Microstomia may result from surgical treatment of orofacial neoplasms, cleft lip, maxillofacial trauma, burns, Plummer-Vinson syndrome, scleroderma, radiotherapy, or certain systemic and developmental diseases. Making the impression represents the initial difficulty in prosthetic rehabilitation of such patients because of the abnormally small oral orifice. Sectional impression trays for both the primary and final impression of maxillary edentulous arches where microstomia exists have been introduced by other authors. This article presents a simplified impression procedure for obtaining an accurate impression by modification of sectional plastic stock trays to obtain a single full arch impression.

RÉSUMÉ

La microstomie peut être le résultat d'une chirurgie de néoplasmes de la sphère orofaciale, de becs-de-lièvre, de traumatisme maxillo-facial, de brûlures, du syndrome de Plummer Vinson, d'une sclérodermie, de radiothérapie ou de certaines maladies systémiques et d'anomalies du développement. L'orifice buccal anormalement petit de ces patients rend la prise d'empreinte difficile. Les porte-empreinte par sections pour la première empreinte et l'empreinte finale des arches édentées du maxillaire en présence de microstomie ont été introduits par d'autres auteurs. Cet article présente une prise d'empreinte simplifiée pour obtenir une empreinte exacte en modifiant les porte-empreinte par sections en plastique pour une empreinte de l'arche au complet.

An abnormally small oral orifice is defined as microstomia.[1] It may result from surgical treatment of orofacial neoplasm, cleft lip, maxillofacial trauma, burns, Plummer-Vinson syndrome, scleroderma, radiotherapy, or certain systemic and developmental diseases.[2,3] Conservative management of microstomia has been described in literature and includes the use of microstomia orthoses to expand the oral opening.[4,5] Prosthodontic treatment, however, is more complex due to reduced oral opening. Making the impression represents the initial difficulty in prosthetic rehabilitation.

Luebke described a sectional impression procedure for dentulous patients by using two plastic sectional impression trays assembled with Lego building blocks and auto polymerizing resin.[6] Whitsitt and Battle introduced a procedure for obtaining the primary impression of edentulous arches using putty silicone as flexible tray then washing with light-body silicone to obtain more detail.[7] Heasman et al. modified a procedure for making final impressions of edentulous arch by using two sectional acrylic resin impression trays joined together with two fins.[4] Moghadam advocated a practical procedure to obtain maxillary primary casts of edentulous patients. Two identical perforated stock trays are cut symmetrically, leaving their own handles attached. The trays are cut minimally in width to allow their insertion into oral cavity with ease.[7] McCord et al. described a simplified technique for joining the final

impression by using a sectional tray in which one section locks into other section in keyed recess.[8] Baker et al. used sectional locking custom trays for making an accurate impression.[9] Al-Hadi describes a three-section tray for a preliminary impression and a final impression[10] followed again by a two-section tray to make more accurate final impression.

This article describes a simplified impression procedure for obtaining an accurate impression by modification of sectional plastic stock trays to obtain a single full arch impression for dentulous microstomic patients.

Technique

Two perforated sectional stock trays, right and left side are selected (Figure 1). The right side tray is checked for buccal and lingual extensions, then the tray is trimmed and adjusted (Figure 2). This tray will record the impression of the dentulous area on the entire right side along with the anterior teeth on the contralateral side. A trough is made on the external surface of the handle on this tray. The left-side tray is checked for buccal and lingual extensions. The labial and lingual flanges in the tray are trimmed, but only in the anterior region without trimming the occlusal surface (Figure 2). The impression made in this tray will overlap the right-side tray only in the anterior region and will record the posterior dentulous area of the entire left side. Nick and notch is made on the tissue surface of the handle on this tray. The handle of this tray is then lubricated with petroleum jelly.

A green tracing stick is softened over a flame and placed in the trough made on the handle of the right-side tray. Before the green tracing stick hardens, both the trays are placed intra-orally, oriented together, and stabilized until the green tracing material hardens (Figure 3). Green tracing material in the trough of the right tray will record the nick and notch made on the tissue surface of the handle on the left tray (Figure 4). This record helps to orient the trays during and after the impression, enabling the registration of a full arch single impression.

Alginate is mixed according to the manufacturer's instruction and loaded on the right-side tray, placed in the mouth and stabilized till the material sets. This tray is kept in mouth undisturbed till the entire arch impression is completed (Figure 5). The impression made in this tray will record the dentulous area of the entire right side along with the anterior teeth on the other side.

Alginate is again mixed and loaded on the left side tray, placed in the mouth and oriented accurately with the help of nick and notch that is recorded by the trough and stabilized till the alginate sets (Figure 6). The impression made in this tray will overlap the right side tray only in the anterior region and will record the posterior dentulous area of the entire left side.

After the impression material sets, the left tray is removed first and then the right tray is removed (Figure 7). Both of the impressions are washed to remove any salivary debris, are disinfected, and are then oriented accurately with the nick and notch extra-orally to obtain a single full-arch impression (Figure 8).

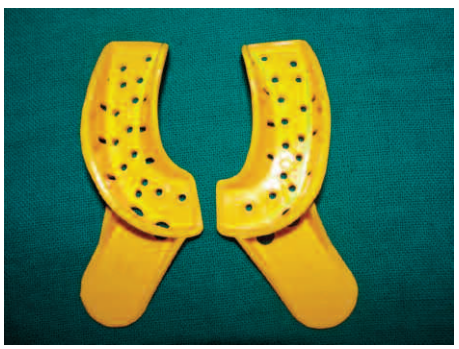

Figure 1. Selected right and left sectional stock trays.

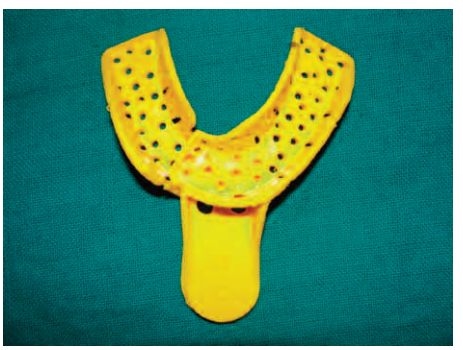

Figure 2. Modified flanges of right and left sectional stock trays.

Figure 3. Tray positioned intra-orally and stabilized for recording nick and notch.

Figure 4. Nick and notch made on the handle recorded by trough with a green tracing stick.

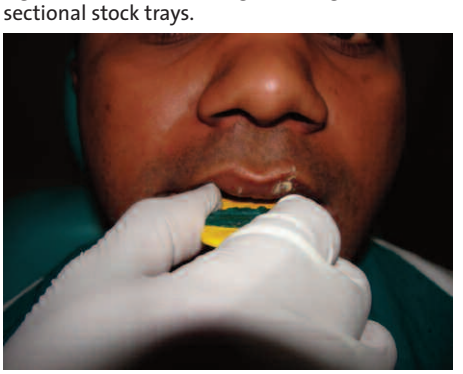

Figure 5. Right-side tray loaded with alginate and placed intra-orally.

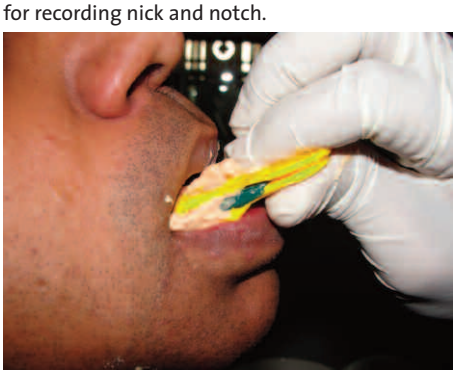

Figure 6. Left-side tray loaded with alginate placed intra-orally, oriented accurately to right tray by nick and notch and stabilized until alginate sets.

Figure 7. Disassembled impression of right and left side removed.

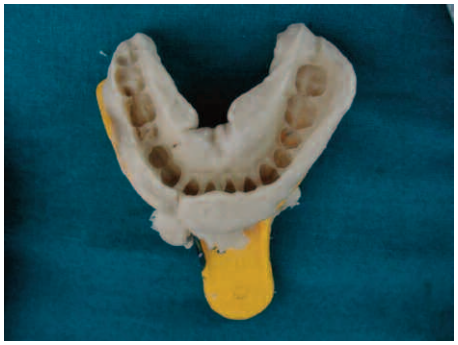

Figure 8. Left- and right-side impressions assembled extra-orally to obtain a single full-arch impression.

Discussion

The rehabilitation of a patient suffering from microstomia is challenging to a prosthodontist because of the patient's clinical condition. This condition often complicates and compromises the prosthodontic treatment plan. For such patients, a prosthodontist encounters certain problems during treatment such as: difficulty in insertion of full-size stock trays, trauma to peri-oral tissue due to lack of flexibility of oral tissue, and improper tissue manipulation due to fibrous bands.

A modification of conventional impression procedure is therefore required for recording an accurate impression. The approach to impression making have been numerous and the literature describes a number of sectional impression techniques using split custom made impression tray for both primary and secondary impression. Various pins, bolts, and Lego pieces have been used for the locking mechanism of sectional impression trays fabricated for patients with limited oral opening.[3,6,11]

The technique described here is simplified and cost-effective as compared to Leubkes method by utilizing Lego plastic building block for joining the two halves. The material used in this technique is easily available.

Less time is required for modification of sectional plastic stock trays as compared to Bakers technique in which additional time and labour was required for custom fabrication of a sectional tray. Also, with this technique, tray manipulation and impression making is simpler, as compared to the Al-Hadi technique in which three sections of trays were made for preliminary impression and final impression. With this proposed technique, the buccal mucosa is not traumatized and the patient is comfortable while utilizing less chair-side time.

Conclusion

Impressions can be made for patients with reduced mouth opening with a sectional impression tray that can be assembled and disassembled in the mouth and then reassembled outside the mouth. This article describes an impression technique for patients with limited mouth opening, using sectional impression trays to obtain full arch impression.

Conflicts

None declared.

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iPad in Business

"With its high resolution and ease of use, iPad has the ability to make a major impact on oral health care."

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iPad advances digital dentistry.

When new patients enter Dr. Jonathan Ferencz's thriving prosthodontics practice in midtown Manhattan, they're greeted with a smile – and an iPad.

For Dr. Ferencz, the latest technology has always driven quality patient care. As an early iPad adopter, Dr. Ferencz knew the device could launch a new era in digital dentistry.

iPad has become central to all aspects of the practice. In addition to simplifying patient forms and record-keeping, iPad enables Dr. Ferencz to show his clients photos of treatment options. And his technicians refer to digital images on iPad to create perfect-looking dental prosthetics.

Painless Patient Records

iPad simplifies the record-keeping process for both patients and staff. Rather than designing, filling out, scanning, and then shredding paper forms, Dr. Ferencz and his staff have created a fast, efficient system using iPad.

Patients complete their intake forms directly on iPad using the Adobe Ideas app, and can even sign the form using a stylus on the iPad screen. From there, a member of his staff emails the forms into the practice's database. There's no paper and nothing to file. "It's efficient," Dr. Ferencz says. "With iPad, we save so much time – and space."

Putting iPad into patients' hands also helps emphasize Dr. Ferencz's commitment to the latest and best dental practices. "It conveys a subliminal message that this office is up-to-date technologically," he says. "So they know that we're up-to-date in our dentistry as well."

Visual Conversations

When patients enter the treatment room, iPad takes on another role: communication tool.

Prosthodontics deals with aesthetic and reconstructive dentistry, such as crowns and veneers. Dr. Ferencz's challenge is to get patients to see what he sees, and to show them what he can do. With iPad, he can effortlessly display photographs and radiographs to patients during consultations. And using the Adobe Ideas app, he can annotate the images onscreen while pointing out areas of interest.

"iPad is ideally suited to this kind of visual conversation," he says. "The patient and I can flip through the radiographs and clinical photos together, and I can illustrate my points as we go."

Because the patient has a visual idea of the procedure and a sense of what the outcome will look like, the result is a direct improvement in care. "With iPad, I can greatly enhance patient acceptance of my proposed treatment," Dr. Ferencz says.

iPad in the Lab

Dr. Ferencz's iPad use doesn't end in the treatment room. Immediately after a discussion with a patient using iPad, Dr. Ferencz might bring the device to his in-house lab to demonstrate an issue to one of his technicians.

"On a dental restoration, the most effective way to make a correction is to show the photograph to my technician and say, 'Here's how I'd like you to reshape it,'" he says. "That way, we're having a conversation about a clinical photograph, not a drawing or a diagram."

A Business of Trust

iPad is also a powerful, persuasive way to share images during doctor-patient conversations about treatment options. "On our first day with iPad, I used it three times to show patients radiographs and photographs of clinical conditions," Dr. Ferencz explains. "And in each case the patient booked the procedure immediately."

When he asked the patients whether the presentation on iPad had an impact on their decisions, one of them said, "I trust Dr. Ferencz, and I would have done what he said, but the way the images appeared was just amazing. I had to schedule the procedure immediately."

And this is just the beginning. "I think we've just begun to scratch the surface with iPad applications," he says. "It really is totally revolutionary."

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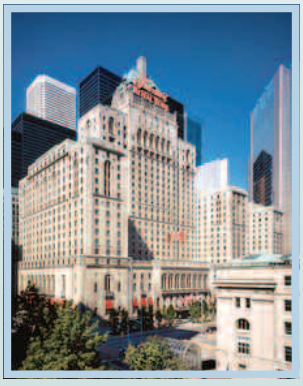

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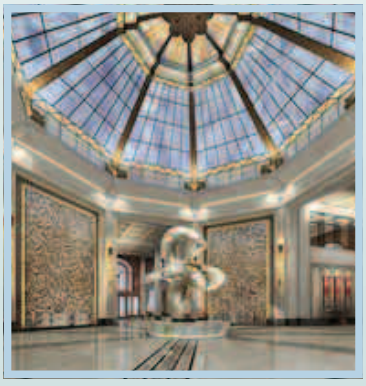

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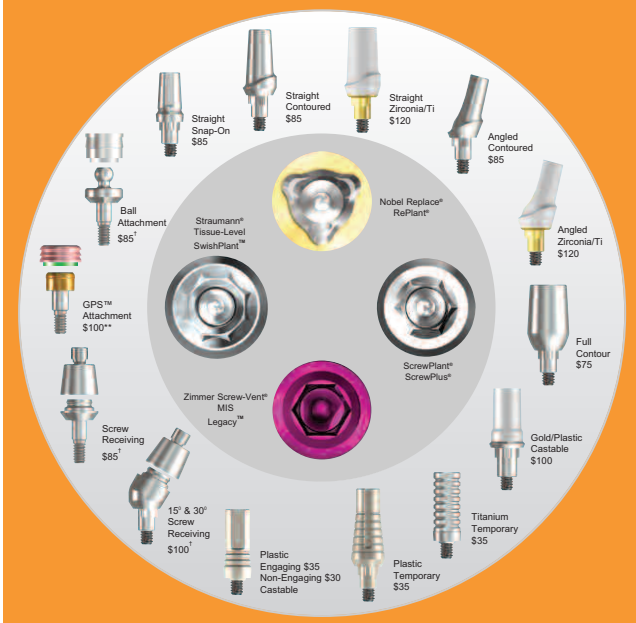

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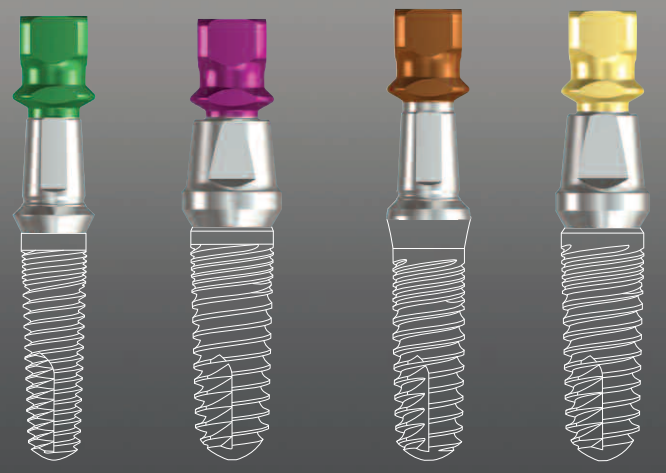

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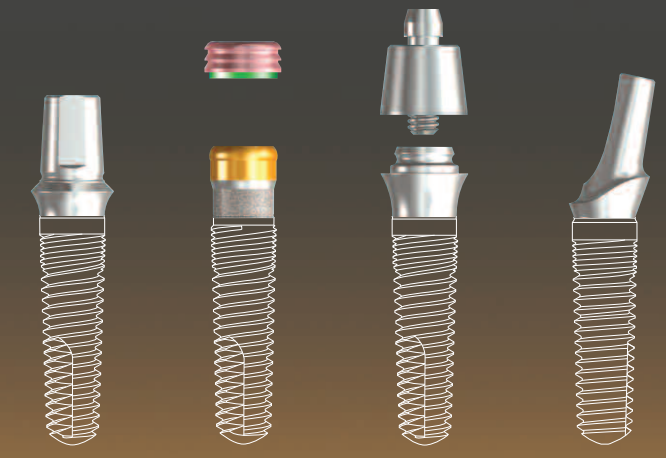

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