The Question of an Equilibration

Gene McCoy, DDS

Presented
At
Tsurumi University
November 28, 2003
Yokohama, Japan

Gordon J. Christensen

"Currently, information about occlusion is more confused and confounded than ever before in my career. Lack of coordinated education at the pre-doctoral level, disagreement on occlusal concepts, and significant financially oriented commercial hype on occlusally oriented devices, have increased the confusion.

Dr. McCoy's article brings attention to many of the basic concepts of occlusion; which, if observed, provide a logical basis for treatment. His conclusions, spread throughout the paper, agree basically with my own and those of Oakeson, Dawson, and many others. I especially liked the statement that only "3%" of the population have total rebuilding of the occlusion, and that the majority of patients have piecemeal restorations. The use of DCS may be confusing to some, but it is explained well. The paper is well written and should be useful to the profession."

Gordon J. Christensen, DDS, MSD, PhD

The Question of an Equilibration

An equilibration of the human dentition is a modification of the occlusal surfaces of teeth in order to improve the way they touch each other in closure and function. In order to determine the need for an equilibration the dentist must compare the patient's present occlusion to a standard of excellence. Herein lies the problem: there is no concept of perfect or ideal occlusion in contemporary dentistry that everyone agrees upon, so comparison is not possible. The ambiguity regarding the subject of occlusion and unresolved questions concerning its liability to oral-facial pain and temporomandibular joint disorders (TMJD) are well documented.[1-7] What is it about the subject of occlusion that defies easy comprehension? How is it that you can read a text or take a course on occlusion and you are unable to walk away with that: "Now I understand the best way to do it," factor? In fact we are often reminded that there are many ways to do it when we hear that not one occlusal scheme will serve all patients.

What is it about occlusion that is not clear?

A major source of the confusion lies in the definition itself.[8] Originally, the definition was simply the closure of teeth[9] (Dorland, 1898). If Occlusion were suspect in a problem, one would naturally examine the manner in which the teeth touched each other in closure/function. Over the years however, the meaning of the word was broadened and occlusion became a synonym for a detailed description of the stomatognathic system.[10] The expanded definition:

> *The relationship between all the components of the masticatory system in normal function, dysfunction, and parafunction, including the morphological and functional features of contacting surfaces of opposing teeth and restorations, occlusal trauma and dysfunction, neuromuscular physiology, the temporomandibular joint and muscle function, swallowing and mastication, psychophysiological status, and the diagnosis prevention, and treatment of functional disorders of the masticatory system. (Jablonski, 1982)*

The change was unfortunate because it clouded the issues. For example, how can we have a serious debate about the role of occlusion in the etiology of TMJD when, if you use Jablonski's definition, dysfunction and the temporomandibular joint (TMJ) are part of that definition?

Occlusion and the stomatognathic system are two distinct entities and should be described separately. It restores order to the ambiguity.

Aside from the definition, what is missing in contemporary texts on occlusion (the stomatognathic system)?

The restorative dentist needs to understand three basic tenets:

1. The most desireable way the stomatognathic system should function.

2. The most ideal morphology and occlusion of the dentition that allows the system to function ideally.

3. How to recognize and correct when the system is not functioning ideally.

What is missing is an understanding of engineering principles which can not only predict when the system is in a failure mode, but also can render the most optimum design of the occlusion (dentition) for success. This paper takes the position that the majority of problems that we are seeing today such as TMJD, oral-facial pain, and damaged dentition are the result of compression of teeth which can easily exceed 250 pounds/inches squared. [11] Therefore, it is to our patient's benefit that we learn as much as possible on the diagnosis and management of this powerful force.

DENTAL COMPRESSION SYNDROME

A New Look at an Old Problem

Historical Background

The flattened teeth in the skulls of our ancestors are dramatic evidence that the untoward condition of clenching and grinding of one's teeth has been in existence since the beginning of time.

There are several references to the gnashing of teeth in the bible, (Psalm 35:16, Psalm 112:10, and Job 16:9)[12] but it is an earlier reference that documents the seriousness of the disorder. Clay tablets from the royal library of the Assyrian King Ashurbanipal reveal that grinding of ones teeth was considered both dangerous and pathogonomonic as far back as the seventh century B. C.[13] A number of these clay tablets, now in the Louvre, were devoted exclusively to the diagnosis and prognosis of certain diseases depending on the comfort of the patient's teeth. In 1886, Black described abnormal wear of teeth associated with nonfunctional activity,[14] but it was Karolyi (1901) who introduced most of the current concepts of this condition.[15] Since that time it has been known by many names: The Karolyi Effect[15] (1901), Neuralgia Traumatica[16] (1906), La Bruxumania[17] (1907), Traumatic Occlusion[18] (1917), Occlusal Habit Neurosis[19] (1928), Traumatogenic Occlusion[20] (1930), Bruxism[21] (1931), Bruxomania[22] (1936), Parafunction[23] (1958), and Dental Compression Syndrome[24] (1993).

Dental Compression Syndrome or DCS was coined to achieve a better patient understanding and to include a wider range of parafunctional activities such as nail biting, tongue thrusting and chewing of oral tissues. DCS deserves recognition for a long successful reign from prehistoric times to the twenty-first century. Newsweek reports in an article, "I Hear America Ginding," that DCS is of epidemic proportions and that Americans spend one billion dollars a year for mouth guards to seek relief.[25]

Etiology

There are many reasons why people are affected with DCS and patients have to be informed to raise their awareness.[26-32]

DCS Triggers:

I. Exercise/Sports
Rowing, water-skiing, lifting weights, wrestling, boxing, riding a motorcycle or any sport where there is a bracing of the body.

II. Psychological
Anxiety, fear, tension, pleasure, aggression, anger, dreaming, stress

III. Medical
Sleep apnea, oral pain, pain in other parts of the body

IV. Drugs
Caffeine, amphetamines, cocaine, ecstasy

V. Bio-engineering factors
DCS can be easily initiated by a violation of bioengineering principles in the stomatognathic system such as prematurities, off-loading of teeth, horizontal distraction of mandible upon closure, and misalignment of TMJ components.

It is important to realize while interviewing the patient that there may be more that one or even several factors contributing to the problem.

Diagnosis

One reason DCS has been so successful over the centuries is that it works well within one's subconscious.[31] Since few patients affected with DCS are cognizant, it is imperative that the visual signs of compression be recognized so that the problem can be addressed. Besides the obvious signs of a flattened dentition and hypertrophied muscles of mastication, there are certain deformations that appear in the oral environment that are barely recognized as to their cause or significance. They affect the dentition, bone, and restorative materials.

Deformations of the Dentition

Classified as non-carious lesions (NCLs),[33-36] these defects typically are site specific in that they appear at the tips of functional cusps and the gingival area of teeth where the susceptibility to stress is high. (Fig. 1,2) A finite element analysis of a tooth model confirms that stress is highest in these areas[37] (Fig. 3).

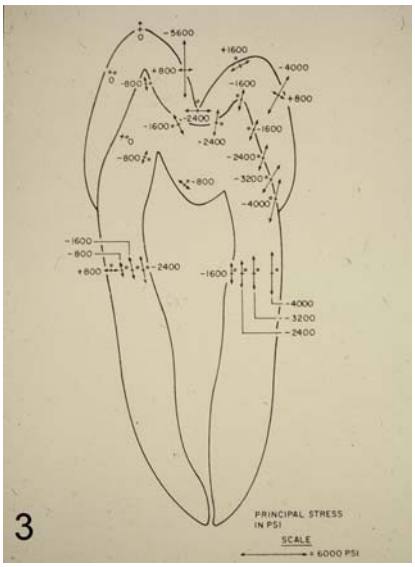


Fig. 1. Compression NCLs – Tips of Functional Cusps.
Fig. 2. Compression NCLs – Gingival Area
Fig. 3. Finite Element Analysis of Tooth Model

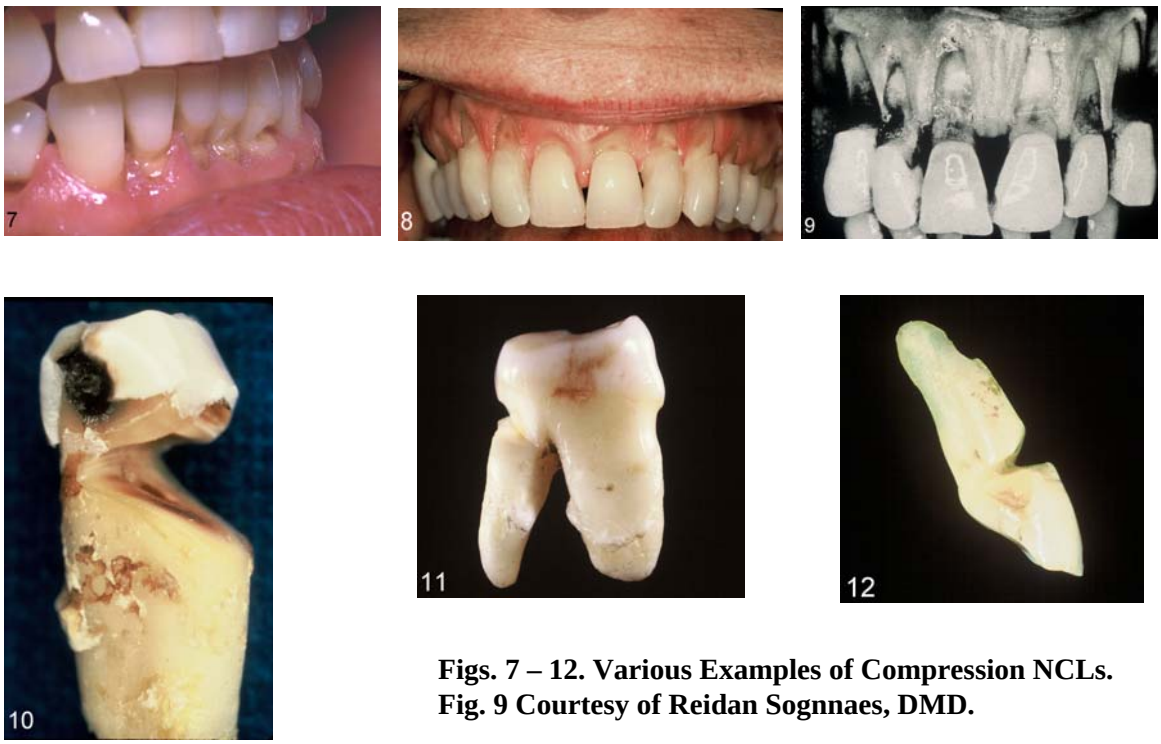
There are two distinct mechanisms responsible for the loss of tooth structure during compression: tensil forces[38] and positive ion egress.[39-44] Engineers tell us that these high stresses may be responsible for the pain experienced by patients who have restorations in this area where tensile forces are powerful enough to pull apart the enamel prisms.[38]

Although NCLs can be caused by a variety of agents such as low pH and mechanical abrasion,[33] compression NCLs distinguish themselves by a glassy sheen. Kornfeld published on the phenomenon in 1932 when he observed that these defects were hard, smooth, and almost glass-like in appearance.[45] It is suggested that the glassy effect is due to the exit of positive ions from these focal points of high stress.[39] The ions are produced by the compression of collagen in the dentition and alveolar bone (piezzo-electric effect).

Fig. 4 – 6. Detail of Compression NCL on Cuspid. Note Defects in Tandem on Lingual

It is to be noted that compression NCLs do not appear on every patient who clenches their teeth for a variety of reasons: variations in the intensity and frequency of DCS, but primarily genetics. They seem to be more prevalent and dramatic in patients with dense alveolar bone compared to patients with periodontally compromised teeth.[46] Compression NCLs have been the subject of controversy among dentists for decades. W.I. Ferrier once wrote (1931) "Their etiology seems to be shrouded in mystery."[47] But it is not such a mystery if we understand the science of biomechanics. Subject to distracting labels such as McCoy's notches[48,49] and abfractions,[33] these defects require a more scientific identification, which is essential to understanding their significance.

What we are actually seeing are multi-shaped examples of hard tissue fatigue. (Figs. 4-12)

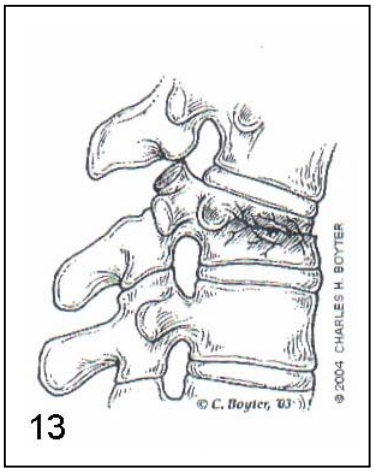


Figs. 7 – 12. Various Examples of Compression NCLs. Fig. 9 Courtesy of Reidan Sognnaes, DMD.

Fatigue applies to changes in the properties of a material due to repeated applications of stresses or strains[50] – in this case, compression failure from DCS. J.E. Gordon, a professor of materials at Reading University, describes fatigue; " one of the most insidious causes of loss of strength in a structure."[51]

If a subject, such as a tennis ball, rebounds to its original shape after repeated applications, it is said to be elastic in nature. However, if a subject exhibits residual defects or sets after repeated applications it is said to be of a plastic nature. Biological structures, such as teeth and bone, are termed viscoelastic.

A similar phenomenon occurs in the spine. (fig.13) In orthopedics, these sites of destructive stress are termed compression or wedge fractures.[52]



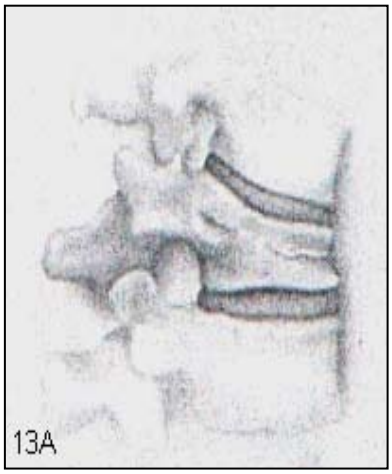


Figure 13, 13A: Vertebral Compression or Wedge Fracture.

Compression failure of an object occurs at its most vulnerable site. Teeth are most susceptible at the gingival area. (Fig. 14)

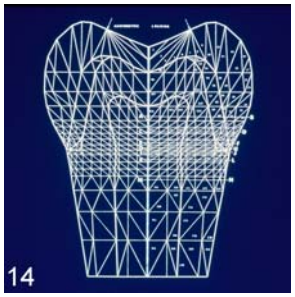


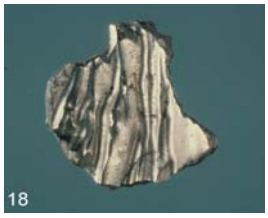
Fig. 14.
Axisymmetric Finite Element model.

If alveolar bone recedes, the failure site will also be lowered. Figs. 15 and 16 demonstrate defects appearing in tandem as the supporting bone atrophies, thus changing the fulcrum point. Also note in fig. 15 that the only occlusal contact is on the incline plane forcing the bicuspid to be flexed toward the lingual when the patient clenches.

Figs. 15, 16: Gingival Fatigue in Tandem

Deformations in Restorative Materials

Fatigue easily manifests itself in prostheses and restorative materials such as amalgam and acrylic. In engineering these wavy patterns are termed 'Lines of Luder'[35,39] or molecular slip bands. The explanation is that molecules in the alloy are rearranging themselves under the influence of compressive strain. One can demonstrate the effect by bending a metal coat hanger back and forth and examining the stress configuration that is produced. Figures 17 &18 demonstrate Luder Lines in amalgam and figures 19 & 20 in acrylic.



Figs. 17, 18. Luder Lines in Amalgam.
Figs. 19, 20. Luder Lines in Acrylic.Courtesy Gregori Kurtzman, DDS

Deformations of the Bone (Exostosis)

Articles on torus palatinus and torus mandibularis have appeared since 1814[53] (Figures 21-24).

Figs. 21 - 24. Examples of Exostosis

Although there is not a consensus on their etiology, many associate their occurrence with TMD and masticatory hyperfunction.[54-56] The author has long suggested that the compression of collagen in the dentition and bone generates negative ions which result in exostosis.[39-41] (Piezzo-electric effect) A situation such as this may well explain the metallic taste that people experience from time to time

Epidemiology

A survey was taken of 100 patients (50 female, 50 male, age range 17 – 76) to determine how many exhibited signs and symptoms of D.C.S. and T.M.D.[41] (Fig. 25)

	Overall %	Female %	Male %
Signs of D.C.S.	95	96	94
Awareness of D.C.S.	61	66	56
T.M.D.	34	36	32
Sensitivity to cold	54	62	46
Muscle enlargement	12	10	14
Flattened teeth	58	56	60
Exostosis	54	48	60
Gingival NCLs	58	54	62
Tip of Cusp NCLs	67	68	66

Fig. 25. Survey: Signs and Symptoms of DCS.

M**anagement of Parafunction**

The presence of deformations in the oral environment should stimulate a dialogue to determine if the patient is currently grinding and/or clenching their teeth or whether this damage occurred during a prior stressful period in his or her life. Often a patient will deny any awareness of DCS but upon returning will say something like, "You know, since you brought it to my attention, I catch myself all the time." Management of DCS begins with awareness and proceeds with a three-step treatment plan that consists of:

I. Education
II. Equilibration
III. Guard Therapy

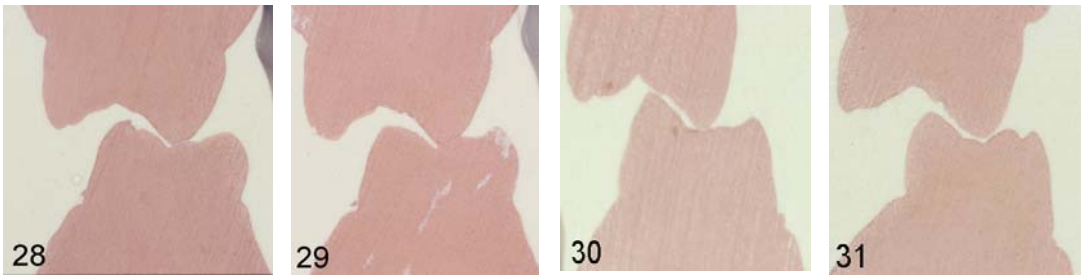
♦ **Step I: Education**

The dental healthcare provider must educate the patient as to everything he or she knows about DCS in the simplest terms. Patients need to understand that teeth should only touch upon swallowing and should know the resting position of the mandible (lips together, teeth apart). The list of etiological agents should be reviewed. Patients should be asked to monitor their jaw position during waking hours and be sensitive to headaches and tension in muscles of mastication upon waking. If it is obvious that the patient is affected with DCS and is indifferent to the problem, their dental records should indicate such and no further treatment should be initiated. However, if the patient is aware of and wants to eliminate or reduce the problem, the next step would be to analyze the occlusion in order to determine if the morphology of certain teeth needs to be modified.

♦ **Step II: Equilibration**

In order to determine the need for an equilibration, the patient's present occlusion must be compared to a standard of excellence, ie, ideal occlusion. Based upon nature's original design the most ideal occlusion is where the occlusal contact is confined to the tip of the functional cusp.

Figs. 26,27. Nature's Biological Cutting Instruments



Figs. 28-31. Sections of Ideal Occlusion

There are two noteworthy observations. One is the minimal contact confined to the tip of the functional cusp and the other is the generous space between the incline planes of the cusps termed the intra-incline space.[41] From these observations it is interesting to note that teeth do not require large areas of contact in order to maintain their position, work efficiently, and be comfortable. But what was nature's intention in providing such clearance between the incline planes? From an engineering point of view, there are several advantages:

Engineering Advantages of Nature's Occlusion

1.

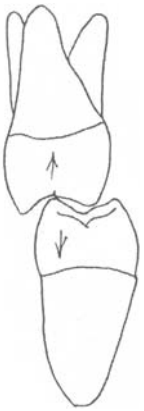


Fig. 32. Vertical Loading

Vertical Loading Fig. 32 The intra-incline space (between the incline-planes) ensures vertical loading. Misch and Bidez describe vertical compression forces as normal and explain that they act perpendicular to and maintain the integrity of the alveolar bone.[57]

2.

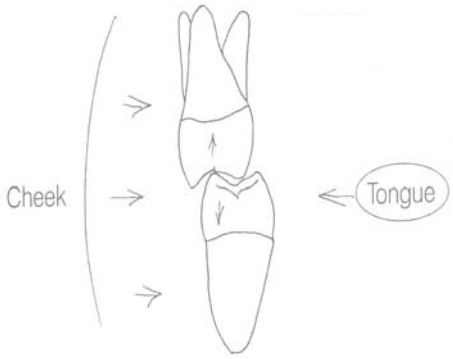


Fig. 33. Neutralization

Neutralization Fig. 33
This is the desired buccal-lingual position of the tooth by reciprocal action of the muscles of the tongue and cheek. When the incline planes do not touch, the tooth is free to assume a neutral position.[58]

3.

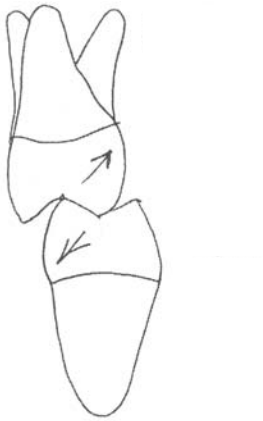


Fig. 34. Off-Loading

Prevention of Off-Loading
Fig. 34, 35, 36

When the incline planes of the cusps are in contact, bending or off-loading of the tooth is likely during mastication and compression resulting in destructive shearing forces, which act parallel to the alveolar bone.[57]

Fig. 35,36.
Indicator wax demonstrating incline plane contacts resulting in off-loading.

4. Condylar Seating

The intra-incline space plays a very important role in condylar seating. Angle once stated (1899), "So it will be seen that the occlusion of the teeth is maintained first by the occlusal inclined planes of the cusps."[59] This is a valid statement, but is it what we want? Our objective is for centric relation (CR) to equal centric occlusion (CO). What if, due to clenching and grinding, the mandible has worked its way forward so that CO is anterior to CR and that position is locked in by the incline planes? If the incline planes of the cusps do not touch, there would be no occlusal resistance when the contracting swallowing muscles retract the mandible up and back upon closure. If there is no resistance, there should be no impediment to achieving CR.

Methods of Equilibration

Indirect Method

1. Reposition condyles
2. Mount models on 3-dimensional articulator
3. Adjust occlusion on models
4. Repeat with natural dentition

Downside

- Time consuming and expensive
- Not as accurate as direct

Direct Method

1. Utilizes patient's own stomatognathic system as a biological articulator
2. Occlusal indicator wax demonstrates contacts in closure
3. Areas of displaced wax are analyzed
4. Contacts on incline planes are eliminated

Advantages

- More accurate
- Less time
- Inexpensive
- Easy to facilitate

An equilibration is a reduction of the working cusp inclines. For easy patient understanding it is suggested that the procedure be described as: " a sharpening of functional cusps." Terms like equilibration and coronoplasty are too formal and require further definition. The patient needs to be informed that the teeth are never shortened and the benefits (increased comfort and diminished DCS) will far outweigh the conservative loss of enamel. The entire procedure should take no longer than fifteen or twenty minutes. The patient should be seen in a week or two for final analysis and polishing. Informed consent must take place. We have been cautioned against imposing occlusal changes based upon the clinician's concept of the ideal.[60] However, it is correct to reshape worn, deformed teeth in order to regain their original configuration with intra-incline space. A review of fifteen articles on occlusal equilibrations published in professional journals from 1966 to 1990 reveals generalized agreement on these points:[61-75]

- Prophylactic adjustments in the absence of pathology are not acceptable.
- Occlusal adjustment is a misunderstood and under-utilized procedure.
- CR should equal CO.
- There should be no interferences in lateral excursions.
- The height of the buccal cusps should never be shortened except to eliminate interference in lateral excursions.
- Traumatic occlusal relationships should be eliminated before restorative procedures.
- Cusps should touch loosely in the opposing fossae.
- Inclined planes should not touch to ensure axial loading.
- Occlusal indicator wax is the most effective way to demonstrate how teeth touch.
- There should be no flat plane occlusion in humans.
- Cuspid guided occlusion is preferred.

A recent publication confirms the relationship between equilibration and gingival fatigue. This seventeen year study evaluated the relationship between gingival fatigue due to DCS and it's relief by sharpening the functional cusps.[76] Over a seventeen year span, 246 teeth were verified as having hypersensitivity from gingival fatigue, which was resolved by equilibration in two visits. The study confirmed that the equilibration specifically was reduction of the working cusp inclines and that it significantly reduced cervical dental hypersensitivity.

♦ Step III: Occlusal Guards

Proper management of the patient who is affected with DCS entails addressing the problem on three separate levels. The sharpening procedure satisfies the engineering requirement and educating the patient can certainly help in stress management during waking hours, but only a guard can insure protection while sleeping.[77-80] But what kind – hard, soft, full arch, anterior?

Unfortunately there are conflicting studies.[81,82] Which is best? Again, we have to evaluate our objectives from an engineering point of view. If our goal is to diminish the force on the TMJ and reduce muscle tension, the best design is a small, thin, hard acrylic appliance that covers the lingual surfaces of the maxillary anterior teeth. It is often referred to as a deprogrammer or mandibular repositioner. A common question regarding this design is, " Do the posterior teeth supererrupt?" No, it is not like the Hawley retainer that is worn a majority of the time. Posterior teeth do not supererrupt overnight – consider the mouth breather.

Regarding hard or soft appliances – a recent study suggests that soft and hard splints are equal in reducing masticatory muscle pain.[83]

Although this may be true, there is an additional factor that the study did not include. In my private practice I had considerable experience with soft guards and found that yes, they were effective in reducing TMJD, but often patients were encouraged to compress against them simply because they were resilient. Generally, studies agree that there is an overall reduction of oral-facial pain (78%) when DCS is treated with any type of guard,[84] but the smaller anterior deprogrammer seems to work best. (Fig. 35, 36)

If the intensity of DCS is such that the three-step treatment therapy is not effective, biofeedback, hypnotism, physical therapy, and drug therapy must be considered.

Figs. 35, 36. Anterior Guard

DCS and Periodontal Disease

DCS can create periodontal disease through a disturbance of the physiology. Firestone and Miller (1947) demonstrated how DCS, generated by psychosomatic factors, can facilitate changes in salivary composition, blood calcium levels, and produce extreme alveoloclasica.[85,86] A recent study confirms the relationship between psychosomatic factors and periodontal disease but curiously does not consider that DCS is the vehicle that is initiated by the stress and delivers the untoward forces to the periodontium.[87]

DCS and the Oral Implant Patient

In the reconstruction of the edentulous patient with endosteal implants, one has to consider that the loss of the patient's natural dentition may have been due to DCS.[88] During the consultation phase, patients should be questioned as to their awareness of DCS. If the patient is semi-edentulous, the patient's remaining dentition will reveal valuable information. The remaining occlusion should be evaluated to determine if a reduction of the working cusp inclines might be beneficial. As with natural teeth, implants require axial loading. If there is an engineering discrepancy between vertical loading of the implant and a natural antagonist, the occlusion of the opposing tooth must be modified to ensure vertical loading of the implant.

Problem Solving for the TMJ

If a patient presents with oral facial pain and/or discomfort in the TMJ, the dentist should consider that DCS might be the source of the problem. Traditionally, clenching and grinding have been the most agreed upon cause of TMD.[89-94] If this is confirmed either by the patient or by information gained by examining the dentition, the three-step management therapy should be initiated to reduce the stress on the TMJ.

If a patient's condyles have migrated down and forward, there are three traditional methods of management: one is to manually reposition the condyles and then equilibrate the dentition. Another is to have the patient wear a splint (mandibular repositioner/deprogrammer) for a period of time and then equilibrate. A third is to use neuromuscular instrumentation. For General Practitioners there is a fourth method that is simple, effective, and produces immediate positive results. If occlusal indicator wax is used to diagnose the occlusal contacts, it is common to see that, due to DCS, the mandible has worked it's way forward and cannot return during swallowing/closure because the incline planes of the cusps are engaged. If this is the case, recreation of the intra-incline space will allow the condyles to assume their natural position.

The focus of what we have been taught is on the position of the mandible/condyles upon closure (CR = CO) rather than the occlusion of the dentition. We have to consider that the teeth themselves may be preventing CR from assuming its proper position. Another consideration: CR can only equal CO when the head is vertical with the body. There are many natural COs that occur when the head deviates from the vertical as when one leans forward or is reclining. We have to be comfortable with all our COs.

Summary

Fifty years ago, McCollum and Stuart described a subtle pathology of function in the human masticatory system that was difficult to understand.[95] That subtle pathology is the damage that results from compression of ones teeth. It is subtle because often the patient is unaware. It is pathologic because it applies untoward stress to the dentition, alveolar bone and the TMJ. It is difficult to understand for many reasons:

- Multiple etiology.
- Few patients complaints.
- Poor understanding of the deformations caused by DCS.
- The role of equilibration during treatment is unclear.
- The dissimilar ways it takes its toll.

For proper management of DCS, the GP should monitor for signs of compression and wear, educate the patient about the problem, and provide treatment. While every patient with a flattened dentition should not have their teeth dramatically altered or reconstructed, there should be consensus in the dental profession that the natural, sharp morphology of teeth is superior to a flattened dentition and should be preserved throughout one's lifetime.

COMMENTARY
8-1-04

Which Concept on Occlusion is Correct?

Gordon Christensen in his annual review: 'New Directions in Dentistry,' stated; "There is extreme controversy about which concept of occlusion is correct and I do not see any relief to that controversy." [96] What exactly does 'concept of occlusion' refer to? The broad interpretation of the word occlusion makes questions like this difficult to answer. Christensen clarifies his question however, when he makes reference to the two different methods of reconstruction, i.e.: neuromuscular instrumentation vs. the gnathological approach of repositioning the condyles/mandible and using a three dimensional articulator. There has been considerable competition between these two groups because of the commercial aspect. At stake – millions of dollars in revenue from courses and instrumentation. Is one method better that the other?

In my opinion, the debate is academic. Both methodologies are based on sound principles of natural physiology and good engineering. Followers of each have considerable training and are dedicated to solving their patient's problems. The arguments are simply justifications for the use of their own particular instrumentation. More important than the method of reconstruction however, is the percentage of patients who actually undergo this form of dental rehabilitation. I would estimate it is less that three percent. The vast majority of patients who visit their dentist on a regular basis have a limited amount of work done each year and it is this segment of the dental population that we should be concerned.

In providing these piece-meal reconstructions, the general practitioner should have a thorough understanding of how the stomatognathic system functions and how the design of teeth influences that function. What guidelines should the GP follow?

Vertical Function vs Horizontal Parafunction

There seems to be confusion between what is considered normal function of the stomatognathic system and parafunction. Again we have to look at the definition of occlusion as the source of that confusion. Okeson explains that even though occlusion is defined in the dictionary as the act of closure, in dentistry, occlusion refers to the relationship of the maxillary and mandibular teeth when they are in functional contact during activity of the mandible. "The question that arises is, what is the best functional relationship or occlusion of the teeth? This question has stimulated much discussion and debate."[97]

Okeson continues; "The problem facing dentistry today is apparent when a patient with the signs and symptoms of occlusal pathosis comes to the dental office for treatment. The dentist must determine which occlusal configuration is most likely to eliminate this pathosis? What occlusion is least likely to create any pathologic effects for most people over the longest time? What is the optimum functional occlusion? Although many concepts exist, the study of occlusion is so complex that these questions have not been satisfactorily answered." [IBID] The quest for optimum functional occlusion has resulted in a number of very different explanations or concepts as to how the system should function: mutually protected occlusion, canine protected occlusion, group function, balanced, theoretically ideal, physiologic, non-physiologic, and therapeutic occlusion. [IBID]

Mohl explains that the variety of concepts is acceptable because; " no one anatomical or functional description can apply to every human masticatory system." [98] The admonition that not one occlusal scheme will serve all patients mirrors Mohl's statement. Unfortunately, there is no persuasive evidence to substantiate these assertions. Granted, the arrangement of teeth and their antagonists may show great diversification among patients overall, but from an engineering point of view, the principles of how they work and support the stomatognathic system should be the same.

For decades we have been trying to provide the best functional relationship of the teeth by focusing on the parafunctional exercise of horizontal excursions with the dentition in occlusion in an attempt to minimize powerful destructive shearing forces. The concept is illogical. The reality is that this destructive activity occurs only when the patient is sleeping and is managed more efficiently by a protective guard. Vertical function is desirable, horizontal parafunction is not. Normal function occurs during swallowing, communication and mastication. The vector for each is vertical, not horizontal.

If we are truly concerned about which occlusion is least likely to create pathologic effects during normal function (mastication) of the dentition, it behooves us to preserve nature's original sharp design. It provides the optimum mechanical fitness and efficiency for the exercise of mastication, which is inseparable from the life, and well being of the stomatognathic system.

REFERENCES

1. Jendersen et al: Tempromandibular disorders/occlusion. J Prosthet Dent July 1988; 80:92-93
2. Lobbezoo F, Lavigne GJ: Do Bruxism and Temporomandibular Disorders Have a Cause and Effect Relationship? J Orofacial Pain 1997;11:15-23
3. Turp JC, Strub JR: Prosthetic Rehabilitation in Patients with Temporomandibular Disorders. J Prosthet Dent 1996;76:418-422
4. Magnusson T, Egermark I, Carlsson GE: A longitudinal Epidemiologic Study of Signs and Symptoms of Temporomandibular Disorders from 15 to 35 years of age. J Orofacial Pain 2000;14:310-319
5. Greene CS, Mohl ND, McNeil C, Clark GT, Truelove: Temporomandibular Disorders and Science: A Response to the Critics. J Prosthet Dent 1998; 80: 214-215
6. Bonilla H et al: Condyle Position as a predictor of Temporomandibular Joint internal derangement J Prosthet Dent 1999; 82:205-208
7. Dawson P: New Definition for Occlusion to Varing Conditions of the Temporomandibular Joint. J Prosthet Dent 1995; 74: 619-626
8. McCoy G: Defining Occlusion. Oral Health 2003; 93:31-40
9. Dorland W: Dorland's Pocket Medical Dictionary. Philadelphia 1898; WB Saunders Co.
10. Jablonski S: Illustrated Dictionary of Dentistry. Philadelphia, 1982, W. B. Saunders Co.
11. Okeson JP: Management of Temporomandibular Disorders and Occlusion. St. Louis 1993; Mosby Year Book. Inc. Pg. 163
12. Attanasio R: An Overview of Bruxism and its Management. Dent Clin North Am 1997; 41:229-241
13. Ring ME: Dentistry, and Illustrated History. New York, 1985, Abradale Press, Pg. 27
14. Black GV: Abrasion of the Teeth. In Litch, WF (Ed.): American System of Dentistry. Philadelphia, Lea Brothers, 1886
15. Karolyi M: Beobachtungenuber Poyorrhea Alveolaris. Oesterr. Ungar. Vrtljschr. Zahnh, 1901; 17:279
16. Karoli M: Zurtherapie der Erkrankungen der Mundschleimhaut Oesterr. Ungar. Vrtljschr. Zahnh. 1906; 22: 226
17. Marie MM, Peitkiewicz M: Fils: LA Bruxomanie. Rev. Stomat 1907; 14:107
18. Stillman PR: The Management of Pyorrhea. Dent Cosmos 59: 405, 1917
19. Tishler B: Occlusal Habit Neurosis. Dent Cosmos 1928; 70: 690

20. Box HK: Traumatic Occlusal and Traumatogenic Occlusion. Oral Health 1930; 20: 642
21. Frohman B: The Application of Psychotherapy to Dental Problems Dent Cosmos 1931; 73: 1117
22. Miller SC: Oral Diagnosis and Treatment Planning. Philadelphia Blakiston Co., Inc., 1936
23. Drum W: Paradentose als Autodestuksktions-vorgang und hin hinweise fur die prophylaxe. Berliner artrol, 1958; 17:300
24. McCoy G: Dental Compression Syndrome, the Quintessence 1993; 13: 92-100
25. Newsweek 12/4/1995; pg 77
26. Attanasio R: An Overview of Bruxism and its Management. Dent Clin North Am 1997; 41: 229-241
27. Ramfjord SP: Bruxism, a Clinical and Electromyographic Study. J Am Dent 1961; 62: 21
28. McLoughlin PJ: Clinical Strategies to Help Patients Reduce Jaw Clenching and Bruxing Behaviors. Intern of Orofacial Myology 1990; 16:1
29. Sayers, P: The Bruxer. Ann Roy Aust Coll Dent Surg 1986; 9: 153
30. Ramfjord SP, Ash MM. Occlusion, ed3. Philadelphia: Saunders. 1983:179
31. Reding GR, Rubright WC, Zinnerman SO: Incidence of Bruxism. J Dent 1966; 45: 1198-1204
32. Glaros A: Incidence of Diunal and Nocturnal Bruxism. J Prosthet Dent 1981; 45: 545-549
33. Grippo JO: Noncarious Cervical Lesions: The Decision to Ignore or Restore. J Esthet Dent 1992; V:55-64
34. McCoy G: The Etiology of Gingival Erosion. J Oral Implantol 1982; 10:361-2
35. McCoy G: On the Longevity of Teeth. J Oral Implantol 1983; 11:248-67
36. Litonjua et al: Noncarious Lesions and Abfractions. JADA 2003; 134:845-50
37. Selna LG, Shillingburg HT, Kerr PA: Finite Element Analysis of Dental Structures: Axisymmetric and Plane Stress Idealizations. J Biomed Mater Res 1975; 9:237-52
38. Yettram AL, Wright KW, Pickard HM: Finite Element Stress Analysis of the Crowns of Normal and Restored Teeth. J Dent Res 1976; 55:1004-11
39. McCoy G: Occlusion and Dental compression Syndrome. The Nippon Dental Review 1997; 659:163-183

40. McCoy G: Examining the Role of Occlusion in the Function and Dysfunction of the Human Mastication System. Korean Journal Dental Focus 1995; 169:10-15
41. McCoy G: Dental Compression Syndrome: A new Look at an Old Disease. J Oral Implantrol 1999; 25:35-49
42. McCoy G: TMJ Disorders and Their Relationship to Occlusion and Dental Compression Syndrome. Dent Today 1997; 16:86
43. McCoy G: Dysfunction of the Human Mastication System. Dent Today 1997; 16: 94-9
44. McCoy G: taking Responsibility for Occlusion. Dent Today 1996; 15:92-3
45. Kornfeld B: Preliminary Report of Clinical Observations of Cervical Erosions a Suggested Analysis of the Cause and the Treatment for its Relief. Dental Items of Interest 1932; 54: 905-9
46. Kuroe T, Itoh, Caputo AA, Nakahara H: Potential for Load-Induced Cervical Stress Concentration as a Function of Periodontal Support. J Esthet Dent 1999; 1:215-22
47. Ferrier WI: Clinical Observations on Erosions and Their Restoration. J Calif State Dent Assoc 1931; Nov.-Dec.
48. Kennedy SE: Biodental Theory Examines Stress. Dent Today 1987; Vol. 6, No. 4
49. Misch CE: Contemporary Implant Dentistry. St. Louis. 1993 Mosby Year Book Inc. pg. 161-2
50. Gordon JE: The New Science of Structures and Materials. Da Capo Press Inc. New York, NY. 1978
51. Gordon JE: Structures or Why Things Don't Fall Down. Da Capo Press Inc. New York, NY. 1978; 333-34
52. Old JL, Calvert M: Vertebral Compression Fractures in the Elderly. AM Fam Physician 2004; 69:111-6
53. Fox J. The Natural History and Diseases of the Teeth. London 1814 from Seah YH: Torus Palatinus and Torus Mandibularis: A Review of the Literature. Aust Dent J 1995; 40(5): 318-21
54. Sirirungrojying S, Song khla DKH: Relationship Between Oral Tori and Temporomandibular Disorders. INT Dent J 1999; 49: 101-4
55. Sonnier KE, Horning GM, Cohen ME: Palatal tubercles, Palatal Tori, and Mandibular Tori: Prevalence and Anatomical Features in a U.S Population. J Periodontal 1999; 70: 329-36
56. Pynn BR, Kurys-Kos NS, Walker DA, Mayhall JT: Tori mandibularis: A Case Report and Review of the Literature. J Can Dent Assoc 1995; 61: 1057-66

57. Misch C, Bidez M: Implant Protected Occlusion: A Biomechanical Rationale. Compend Contin Educ Dent 1994; 15: 1330-1343
58. Wiskott HW, Belser UC: A Rationable or Simplied Occlusal Design in Restorative Dentistry: Historical review and Clinical guidelines. J Prosthet Dent 1995; 73: 164-83
59. Angle EH: Classification of Malocclusion. Dental Cosmos 1899; 41, #3
60. McNeill C: Fundamental Treatment Goals from Science and Practice of Occlusion. Chicago: Quintessence, 1997: 412
61. Silverman MM: Equilibration of the Natural Dentition Following Orthodontic Treatment to Prevent Movement of Teeth and Other Problems. Am J Orthodontics 1968; 54: 831-851
62. Harris J: A Marking Device for Equilibration. J.C.O., 1971; V: 111-113
63. Klein WC: A Simplified Technique of Occlusal Equilibration. J Ont Dent Assoc 1967; 44:30
64. LaMug RF: Occlusal Equibration. AJ Phil Dent Assoc 1975; 26: 10-13
65. Bartlett SO, Elliott RW: Training Devices for Group Instruction on Occlusal Equilibration J Prosthet Dent 1973; 29: 517-523.
66. Murphy NC: Clinical Observations on Occlusal Adjustment. ODJ, 1979;53:41-50
67. Silverman MM: Procedures in Equilibration of Natural Teeth. J Dist Columbia Dent Soc 1977; 17-27
68. Cantor S: Procedures in the Equilibration of the Natural Dentition Prior to Fixed Prosthetic Restoration. Temple Dental Review 1970; 40:22-24
69. Steadman RB: Occlusal Equilibration and TMJ Disorders. VA Dent J 1988; 65: 28-30.
70. Bush FM, Butler JH, Abbott DM: Perspective on Occlusal Adjustment in the Treatment of Temporomandibular Joint Disorders. VA Dent J 1988; 65:30
71. Wenneberg B, Nystrom T, Carlson GE: Occlusal Equilibration and other Stomatognathic Treatment in Patients with Mandibular Dysfunction and Headache. J Prosthet Dent 1988; 59:478-483
72. Wilson DJ: Occlusal Equilibration. J. TN. Dent Assoc., 1973; 53:302-305
73. Schuyler CH: Equilibration of Natural Dentition. J Prosthet Dent 1973; 30:506-509
74. Freese AS: Occlusal Equilibration for the General Practitioner. TIC 1966; 25:4-12
75. Oles RD: Occlusal Adjustment. Journal of Univ of Saskatchewan 1990; 56:527-531
76. Coleman TA, Grippo JO, Kinder Knecht E: Cervical Dentin Hypersensitivity. Part III Quint Int 2003; 34: 427-34

77. Humsi A, Naeje M, Hippe JA, et al: The immediate effects of a stabilization splint on the muscular symmetry in the masseter and anterior temporal muscles of patients with craniomandibular disorder. J Prosthet Dent 1989; 62:339-343
78. Kawazal Y, Kotani H, Hamada T, et al: Effect of occlusal splints on the selectromygraphic activities of masseter muscles during maximum clenching in patients with myofacial pain dysfunction syndrome. J Prosthet Dent 1980; 43:578-580
79. Clark GT: A critical evaluation of orthopedic interocclusal appliance therapy: design, theory and overall effectiveness. J Am Dent Assoc 1984; 108:359-364
80. Shan SC, Yum WH: Influence of an occlusal splint on integrated electromyography of the masseter muscle. J Oral Rehabil 1991; 18:253-256
81. Nevarro F, Barghi N, Mey R: Clinical evaluation of maxillary and hard and resilient occlusal splints. (abstr) J Dent Res 1985;64:313
82. Okeson JP: The effects of hard and soft occlusal splints on nocturnal bruxism. J Am Dent Assoc 1987; 114: 788-791
83. Pettengill CA, Growney MR. Schoof R, Kenworthy CR, : A pilot study comparing the efficiency of hard and soft stabilizing appliances in treating patients with temporomandibular disorders. J Prosthet Dent 1998; 79:165-8
84. Holmgren K, Sheikholeslam A, Ruse C. Sporrvagen 35, S-138 41 Lindgo, Sweden: Effect of a full-arch maxillary occlusal splint on parafunctional activity during sleep in patients with nocturnal bruxism and sign and symptoms of craniomandibular disorders. J Prosthet Dent 1993; 69)3):293-738
85. Miller SC, Firestone JM: Psycomatic Factors in the Etiology of Periodontal Disease Am J Orthodont 1947; 33:675-86
86. Miller SC: Psychosomatic Relations in the Etiology of Periodontal Disease from a Textbook of Periodontia 3rd Ed. Philadelphia: Blakiston, 1950
87. Genco RJ, Ho AW, Grossi SG, Tedesco LA: Relationship of Stress Distress and Inadequate Coping Behaviors to Periodontal Disease. J Periodontal 1999; 70:711-723
88. McCoy G: Recognizing and Managing Parafunction in the Reconstruction and Maintenance of the Oral Implant Patient. Implant Dent 2002; 11:19-26

89. Wright AR, Gatchel RJ, Wildenstein L, Riggs R, Buschang P, Ellis E: Biopsychosocial Differences Between High-Risk and Low-Risk Patient with Acute TMD – Related Pain. JADA 2004; 135:474-82
90. Nagahara K, Murata S, et al: Displacement and stress distribution in the Temporomandibular Joint During Clenching. Angle Orthodont 1999; 69: 372 – 97
91. Lobbezoo F, Lavigne GJ: Do Bruxism and Temporomandibular Disorders Have a Cause and Effect Relationsip? J Orofacial Pain 1997; 11:15-23
92. Glaros AG, Forbes M, Shanker J, Glass EG: Effect of Parafunctional Clenching on Temporomandibular Disorder Pain and Proprioceptive Awareness. J Craniomandib Pract 2000; 18: 198-204
93. Molina OF, Dos Santos J, Nelson SJ, Nowlin T: Profile of TMD and Bruxer Compared to TMD and Non-Bruxer Patients Regarding Chief Complaint, Previous Consultations, Modes of Therapy, and Chroncity. J of Craniomandib Pract 2000; 18: 205 – 218
94. Magnusson T, Egermark I, Carlsson GE: A Longitudinal Epidemiologic Study of Signs and Symptoms of Temporomandibular Disorders from 15 to 35 years of age. J Orofacial Pain 2000; 14: 310 – 19
95. Stuart CE. Articulation of Human Teeth. In: McCollum BB. Stuart CE (eds). A Research Report. South Pasadena, Calif.: Scientific Press, 1955
96. Christensen G: New Directions in Dentistry. Dentistry Today Feb. 2004; 23: 82 – 84
97. Okeson J: Management of Temporomandibular Disorders and Occlusion. 3rd Ed. St. Louis Mosby-Year Book, Inc. 1993 pg 109
98. Mohl ND: Introduction to Occlusion from A Textbook of Occlusion. Mohl, Zarb, Carlsson, and Rugh. Chicago. Quintessence Pub Co Inc 1988. pg 18

Gene McCoy maintains a general restorative practice in San Francisco. He lectures internationally on the relationship between occlusion, DCS, and TMD. Dr. McCoy also conducts hands-on equilibration workshops in his office and for study clubs in the United States and Japan. He is an honored fellow in the American Academy of Implant Dentists and a visiting lecturer at Tsurumi University in Yokohama, Japan.

Dr. Gene McCoy
226 Fox Plaza, California 94102
Tel: 415-621-5471 • Fax: 415-621-5040
Email: genemccoydds@sbcglobal.net
Toothcrunch.com

With special thanks to
Naudia Queen for her assistance in preparing this article.