A COMPARISON OF TRADITIONAL OCCLUSAL EQUILIBRATION AND IMMEDIATE COMPLETE ANTERIOR GUIDANCE DEVELOPMENT

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ABSTRACT: Traditional occlusal equilibration has been advocated by numerous authors as a treatment modality for chronic myofascial pain dysfunction syndrome. However, treatment predictability and reliable clinical success has not been reported by all authors. Some report no correlation between occlusal contacts and chronic myofascial pain dysfunction syndrome. Recent publications and manuscripts have described a new occlusal adjustment technique which is aimed at reducing lengthy pretreatment disclusion time in mandibular excursions. This reduction in disclusion time physiologically and rapidly reduces contractile muscle activity in the masseter and temporalis muscles, which leads to the resolution of numerous chronic myofascial pain dysfunction syndrome (MPDS) symptoms. This new occlusal adjustment process is known as Immediate Complete Anterior Guidance Development (ICAGD). The purpose of this article is to describe the important differences in focus, sequence, and theory between traditional occlusal equilibration and ICAGD.

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The implementation of tooth adjustment procedures has been advocated by numerous authors as an effective treatment modality to treat chronic myofascial pain dysfunction syndrome (MPDS).[1-7] Yet other authors have found no reliable success with occlusal therapy. Some report no correlation to occlusal contacts and muscle function.[8,9] Recent publications and articles[10-13] have outlined a new approach to occlusal therapy that is aimed at reducing the time required for posterior teeth to disclude from each other. Disclusion time reduction by the Kerstein[10] method of occlusal adjustment, known as "Immediate Complete Anterior Guidance Development" (ICAGD), has been shown to significantly lessen contractile muscle activity in the masseter and temporalis muscles. This results clinically in dramatic reductions in chronic MPDS symptoms in approximately one to three month's time from initiation of treatment.[10-13] This new process, first described by Kerstein in 1990, differs in sequence, focus, and theory from traditional occlusal equilibration.[10-13]

Traditional Occlusal Equilibration

Traditional occlusal equilibration was first described by Schuyler[6] in 1935. Numerous papers on the subject have been written, but they all share one common focus: the importance of a stable centric relation occlusion without premature contacts in the retruded contact position.[6,7,14-18] Studies of EMG recordings[3,5,19] indicate that

muscle function is more harmonious with less intensity when the condyles are in the centric relation position at the same time the teeth are in maximum intercuspation.

Okeson[20] describes the optimum occlusal condition as one where the mandible closes with the condyles in their most superior anterior (centric relation) position, resting against the posterior slopes of the articular eminences with the disks properly interposed. At the same time, there is even simultaneous contact of all possible teeth directing forces through the long axes of those teeth. This definition assumes that occlusal function begins from a static closure position (centric relation) and function then occurs subsequent to this positioning of the mandible in centric relation. The concept of a centric relation occlusion in dentate patients centers around the perceived importance of centric relation contact prematurities as an initiating factor of muscular dysfunction.[3,21,22]

To obtain a perceived correct occlusal arrangement, it has been suggested that the mandible be guided into centric relation[6,7,14-18] so that the condyle disk assembly can be seated in the most superior position without any forced displacement. Bimanual manipulation is commonly used to locate the terminal hinge axis for the first phase of occlusal equilibration. According to Ramfjord,[23] the first and most essential step in establishing an ideal occlusion is to obtain a proper centric relation position. The value of this correct position is that it indicates an optimal medial centering of the mandible.

Another goal of traditional occlusal equilibration is to remove any vertical component to a centric relation-maximum intercuspal position slide, so that any discrepancy between the two positions is horizontal only.[7,14-17] If possible, all slides should be removed so that centric relation occlusion and maximum intercuspal position occlusion are coincident.

In most instances, closure of the mandible in centric relation leads to the location of a single tooth contact on cuspal inclines. This is perceived by the neuromuscular system as a potentially damaging tooth, which activates protective reflexes in seeking a more stable position. The result is a slide from that centric relation contact down the cuspal incline into centric occlusion position. This centric slide has been verified in approximately 80% of all dentate patients.[24]

The centric relation slide has been classified as anterosuperior, with either a right or left component to the slide, depending on which tooth inclines are in contact when the mandible moves from centric relation to centric occlusion. As these inclines are successively eliminated from contact, the overall centric contact position begins to approach the patient's original vertical dimension of occlusion, which is maintained by the centric occlusion position.[25] An acceptable centric relation position has been developed when all posterior teeth are in contact during a guided closure, and no slide occurs when force is applied to the occlusion.[26]

Sequence of Equilibration

Neff[18] outlined a sequence of adjustments to be followed when performing occlusal equilibration. The sequence is as follows:

1. Preliminary recontouring
2. The elimination of all centric relation occlusal interferences
3. The elimination of all excursive interferences such as protrusive and lateral
4. Re-examination of centric relation occlusion
5. Smoothing of all corrected surfaces except the centric stops.

Here it is evident that centric relation occlusion is the primary procedural focus as well as the primary adjustments to be accomplished.

Both Okeson[27] and Dawson[7] include step #2 of Neff's sequence in their sequence, and centric relation and centric occlusion are made to be coincident in their occlusal therapeutic philosophies. Dawson also believes that to eliminate the signs and symptoms of bruxism it is critical to eliminate all centric relation interferences so that no slight prematurity can initiate muscle hypercontraction.[7]

It has been advocated that corrective procedures to relieve occlusal disharmony in the centric relation position should be completed before doing any corrective grinding to relieve occlusal disharmony in the eccentric positions.[6,7,14-18] Complete interdigitation of all available supporting cusp tips (maxillary lingual, mandibular buccal), marginal ridges and central fossae is advocated so as to stabilize the centric relation closure position. The development of a multiple contacting arrangement in centric relation is the initial goal of traditional occlusal equilibration and comprises the first phase of treatment. When this phase is completed, then lateral excursions are adjusted to remove interfering excursive contacts.

Posterior eccentric tooth contacts are of concern and are recommended to be removed if present. This is because of the increased force levels they place on the teeth due to their positional proximity to the TMJ, which is the fulcrum of jaw function.[28]

Working posterior tooth contacts generating lateral group function, including the first molar to disclude the balancing side during function, has been advocated as an acceptable occlusal scheme.[7,18,28] Beyron's[29] studies demonstrated that group function on the working side with functional disclusion on the balancing side may be

the optimum arrangement of occlusion. Working first molar guidance contact is not perceived to have known effects to increase muscle activity and, therefore, has been advocated by numerous authors as an acceptable guidance component in a working side excursion.[6,7,14,15,23]

Balancing interferences should be eliminated due to their destructive force levels on the involved teeth, as well as their known neuromuscular effects to increase muscle activity.[30] Protrusive interferences also create damaging horizontal force levels on the involved teeth[19,31] and should be eliminated when developing an optimum occlusal scheme.

The concern over potentially injurious lateral functional forces applied to the teeth during excursions indicates that the teeth themselves are considered to be at risk of fracture from the forces of occlusion. Muscular dysfunction from hypercontraction secondary to posterior lateral excursive contact is not described to be of significant concern except for balancing interferences. Rather, it is believed that centric relation interferences and CR-CO slides cause muscular hypertrophy and dysfunction.[5-7,14-18,23]

Dawson advocates guiding the mandible during excursive equilibration to ensure that all interferences are recorded and eliminated through the complete range of motion.[7] Firm manipulation is deemed important so as to find all potential lateral contact and move the mandible all the way out to its border position. In a study involving 103 patients, unguided jaw movements revealed that only 29% of the patients had balancing interferences; however, when patients were guided, 87% had balancing interferences present.[32] The elimination of lateral interference contacts is comprised of working, balancing, and protrusive interference removal.

It has been suggested that the elimination of all lateral occlusal interferences should be accomplished by Schulyer's time-honored rule: BULL (Buccal-Upper, Lingual-Lower) for balancing interferences; LUBL (Lingual Upper-Buccal Lower) for working interferences; and DUML (Distal Upper-Mesial Lower) for protrusive interferences.[6] This method of adjustment leaves centric contacts undisturbed and provides for elimination of interferences.[7]

Posterior disclusion is the recommended occlusion of choice with some form of anterior guidance or cuspid disclusion separating the posterior teeth during excursions. The canines have been reported to have (a) the most dense compact bone around their roots,[33] and (b) the longest and most sizable root formation for optimum crown/root ratio.[34] Therefore, they are capable of receiving horizontal stresses that occur when the mandible moves laterally. It has also been reported that the canines activate very few muscles as compared to posterior teeth when in contact during lateral excursions.[30]

Generally, it is accepted that anterior group function on the working side is adequate to replace cuspid rise disclusion when it is not possible, due to anatomic tooth alignment limitations, to establish complete canine control over the excursion.[33]

Both Dawson[7] and Okeson[35] advocate immediate posterior disclusion, but do not in any way define a way to measure immediacy. Also, the inclusion of first molars in lateral guidance would clearly negate immediate posterior disclusion. This is an important concept for the reader to understand because immediate posterior disclusion cannot be achieved without (a) prior assessment of disclusion time, (b) total elimination of posterior guiding surfaces, and (c) group function occlusion anterior to the premolar/molar region.[10]

Use of Appliances

It is generally accepted that splint therapy should precede occlusal equilibration procedures.[7,14-18,25] It has been advocated that selective grinding is indicated only when sufficient evidence exists that permanent alteration of an occlusal condition will reduce the symptoms of a temporomandibular joint disorder. This must be evaluated through reversible occlusal splint therapy.[36]

Summary of Occlusal Equilibration

Traditional occlusal equilibration emphasizes the establishment of a stable centric relation occlusion which positions the condyle and disks in proper orientation to each other, with secondary emphasis on lateral and protrusive disclusion. The initial adjustment steps include guided centric relation closure adjustments to establish multiple tooth contacts on all available classical, stereotypical cusp tips, central fossae, and marginal ridges in the centric relation position. The secondary adjustments are excursive adjustments that are guided by the operator from centric relation to the border positions. Cuspid guidance, or group function of the working side, is advocated as an acceptable guiding control over the excursions.

Lastly, the theoretical basis for this procedure is that centric relation contacts are the most important occlusal component, for they stabilize the mandible in a position that seats the condyle-disk assembly in an unstrained position, thereby minimizing pressure on the temporomandibular joint.[7,20,23] **Table 1** provides a comparison of traditional occlusal equilibration and Immediate Complete Anterior Guidance Development (ICAGD) as to differences in focus, sequence, and theory.[10,13]

Table 1
Summary of Differences Between Traditional Occlusal Equilibration and Immediate Complete Anterior Guidance Development (ICAGD)

	Occlusal Equilibration	ICAGD
1. Goal	Guided CR closures	Immediate posterior disclusion
2. Initial adjustment step	Centric relation (guided closure)	Excursive movements (unguided)
3. Closure position	CR-CO coincident (guided closure)	CO anterior to CR and pretreatment MIP (unguided)
4. Changes in quantity of molar contact	Increased	Decreased
5. Importance of lateral interferences	Potentially damaging forces placed on teeth	Prolonged compression time of periodontal ligaments
6. Pretreatment appliance use recommended	Yes	No

Immediate Complete Anterior Guidance Development (ICAGD)

Immediate Complete Anterior Guidance Development (ICAGD) refers to the occlusal adjustment process that focuses primarily on establishing immediate posterior disclusion (< 0.5 sec) in the right and left excursions, and secondarily in the protrusive excursion.[10]

This technique was first described as Complete Anterior Guidance Development (CAGD) by Kerstein and Farrell[11] in 1990, without T-Scan* computer-assisted analyses.[37-39] The same repetitive pattern of balancing and working contacts was seen in 53 chronic MPDS[11] sufferers. Because of the development of CAGD, 51 of 53 patients underwent drastic reductions in all forms of chronic MPDS symptoms. This group reported positive and definitive physical changes in approximately one month's time following initial CAGD.

The T-Scan force movie[40] software analysis of this same pattern of interfering contacts, seen in an EMG study of another seven female MPDS sufferers during excursive movements, translated into a lengthy period of working and nonworking molar contacts and nonworking bicuspid contacts preceding true anterior tooth control over the excursion. The quantity of time in seconds in which the posterior teeth control the excursive movement before anterior guiding contact was termed, "disclusion time."[10]

"Disclusion time" is defined as the duration of time that working and nonworking molars and nonworking premolars are in contact during an excursive movement commencing from the habitual closure position through to the contact of anterior guiding surfaces. Disclusion time measures the time required for posterior teeth to separate from each other during an excursion. During the time frame of posterior interfering contact preceding true anterior guidance, numerous opposing posterior occlusal surfaces are riding over one another. Disclusion time measures the sum time of all changing combinations of interfering posterior teeth that are in contact during an excursion which is commenced from the habitual, nonretruded closure position through to the sole contact of anterior guiding surfaces. Measurements for disclusion time during excursive movements is as follows:

1. For the Class I occlusion, disclusion time should be measured from the habitual closure position until only canine, or only canine and incisor guidance contact, is seen during a given force movie. This would exclude working premolars as proper guiding surfaces for the Class I subject.
2. For the Class II occlusion, disclusion time measurement should be carried through until furthest anterior working premolar is the sole guiding contact seen in a given force movie.
3. For the Class III occlusion, disclusion time measurement should be carried through to the sole contact of anterior guiding surfaces, excluding the working premolar (similar to the Class I occlusion).

The rationale to exclude the working premolar, where further anterior tooth contact acting as guidance is possible, is based in work by Williamson and Lundquist.[31] Their work showed that premolar and molar contact in lateral excursive movements activates more muscles than do the anterior teeth.

Disclusion Time Calculations

Changes in disclusion time during a force movie can be expressed by the following Formula 1:

$$\triangle DT(sec) = \sum[(M_W + M_B + P_W + P_B)n]$$

where

M_W = working molar interferences (sec)
M_B = balancing molar interferences (sec)
P_W = working premolar interferences (sec)
P_B = balancing premolar interferences (sec)
n = number of possible segments of a given force movie measured during the excursion

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Formula 1 allows one to break up the excursive movement into small time segments to view the changing combinations of interfering teeth. For example, the pretreatment photographs in **Figure 1** are represented by the right working force movie in **Figure 2**. The five frames of this force movie contain numerous changing combinations of interfering teeth.

1. Habitual closure position pretreatment is at = .600 sec
   force movie frame 41
2. From the habitual closure the excursion begins at .600 sec → .940 sec = .340 sec
   force movie frame 58
   In this segment, $M_W + M_B + P_W + P_B$ are all in contact.
3. From .940 sec → 1.200 sec = .260 sec
   force movie frame 71
   In this segment, P_B approaches 0 but $M_W + M_B + P_W$ are all in contact.
4. From 1.200 → 1.400 = .200 sec
   force movie frame 81
   In this segment, M_W approaches 0, P_W approaches 0. P_B remains at 0. Only M_B is in contact.
5. From 1.400 → 1.480 = .080 sec
   force movie frame 85
   In this segment, anterior guidance begins; M_B approaches 0; M_W, P_B, P_W remain at 0. The total pretreatment disclusion time = .340 + .260 + .200 + .080 = .880 sec and the number of force movie frames measuring the excursion = 85-41 = 44.

After proper occlusal therapy to reduce disclusion time, there are no lines of Accufilm† ink present on the posterior teeth (**Figure 3**). The disclusion time computation of the force movie in **Figure 4**, when analyzed using Formula 1, demonstrates not only total shorter time of disclusion but fewer combinations of interfering posterior teeth in each segment.

1. Habitual closure post-treatment is at .520 sec
   force movie frame 37
2. Excursion begins from .520 sec → .580 sec = .060 sec
   force movie frame 40
   In this segment, M_W, M_B approach 0 (immediate molar disclusion); P_W and P_B are in contact.
3. From .580 to .620 = .04 sec
   force movie frame 42
   In this segment, anterior guidance begins; P_W, P_B approach 0 (immediate posterior disclusion); M_W, M_B remain at 0.

Post-treatment total disclusion time = .060 + .040 = 100 sec, and the number of force movie frames = 42-37=5. A comparison between the pre- and post-treatment disclusion times reveals that in this subject, the amount of time during which posterior teeth maintain functional contact during the excursion is reduced by 87.5%.

†Parkell, Farmingdale, New York.

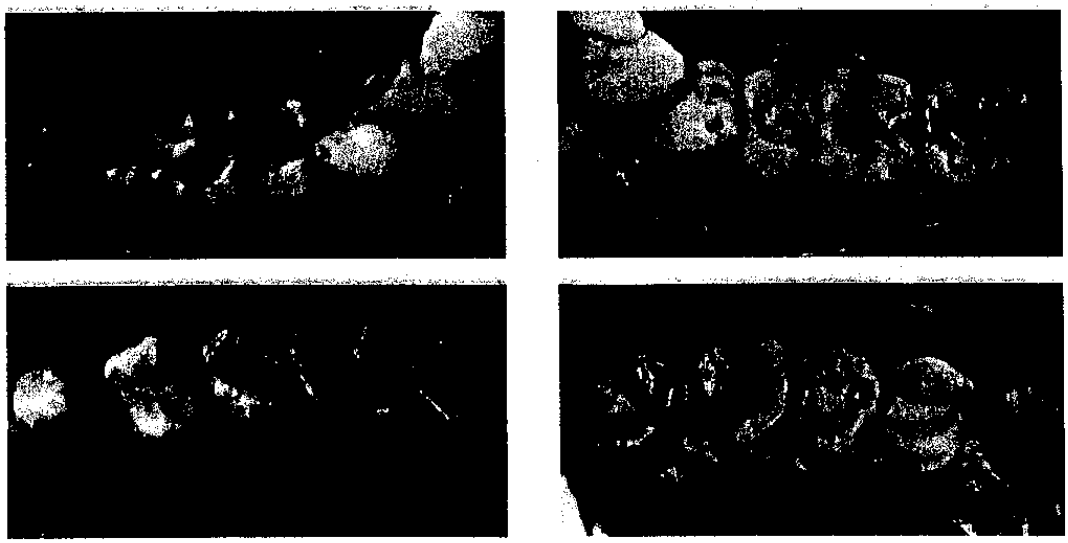


Figure 1
Quadrants of pretreatment tooth contacts showing lines of Accufilm, which represent lengthy disclusion time.

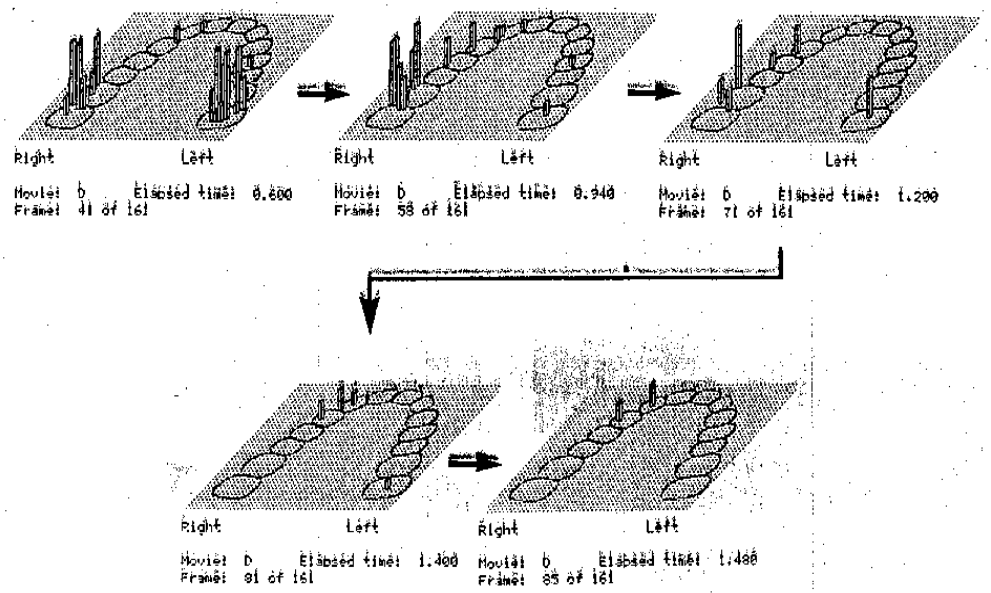


Figure 2
Pretreatment Right Working Disclusion Time Force Movie (same quadrants as **Figure 1**) representing long disclusion time.

Total disclusion time can be calculated either by: (a) the segmental method used above with Formula 1; or (b) by determining the time of last frame of the habitual closure position prior to excursive commencement, and subtracting this value from the first frame where anterior guidance is actually occurring during the excursion.[10]

Disclusion Time Theory

In an uncontrolled study of seven female patients,[10] Kerstein showed that contractile muscle activity is proportional to disclusion time CMA ~ DT such that mean lengthy disclusion time (> 0.5 sec) creates elevated levels of muscle activity in the masseter and temporalis muscles. It has been suggested that this increased quantity of muscle contraction may overuse the musculature into an atypical and spastic state. What follows is the clinical appearance of muscular dysfunction in the involved muscles.

Kerstein also showed that by lowering mean disclusion time to < 0.5 sec, contractile muscle activity in these same masseter and temporalis muscles of all seven subjects decreased significantly ($p < .05$). This resulted in resolution of almost all chronic MPDS symptoms in approximately one month's time.[10]

The clinical significance of lengthy disclusion time is that it measures the time that posterior teeth are compressing the periodontal ligaments as the teeth rub over each other during function. This compression, which occurs on the inclines of the posterior teeth, appears to relay muscle contractile impulses through the central nervous system (CNS) to the muscles of mastication via the trigeminal pathways. Extended disclusion time compresses the periodontal ligament significantly longer than short disclusion time, which therefore activates more muscles than short disclusion time.[10]

It is well known that the periodontal ligament is supplied with sensory nerve fibers capable of transmitting tactile, pressure, and pain sensations via the trigeminal nerve.[41,42] During lateral tooth contact the involved tooth rotates about an axis which may change as the force varies. The apical portion of the root moves in an opposite direction to the coronal portion. This places some proprioceptive fibers under tension. In tension areas the fibers are taut rather than wavy, which is their normal posture.[43] These tensed fibers provide proprioceptive and tactile sensitivity,[44,45] which plays an important role in the neuromuscular factors controlling the masticatory musculature. It is through this mechanism that lengthy disclu-

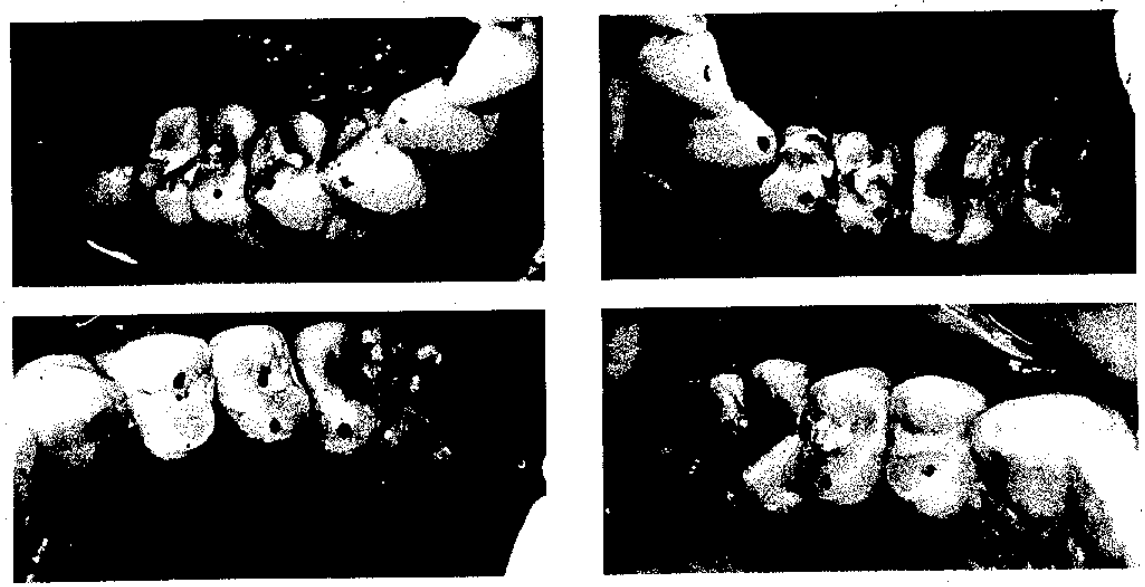


Figure 3
Quadrants of post-treatment tooth contacts showing short disclusion time.

sion time most likely activates the excessive contraction process seen in MPDS.

When ICAGD is properly accomplished, the period of working and nonworking posterior tooth contacts in the early part of the excursion is greatly shortened in time, bringing anterior teeth into control over the excursion almost immediately (**Figures 3** and **4**). Hence, the name, "Immediate Complete Anterior Guidance Development,"[10] was given to this process of occlusal adjustment. Proper modification of lengthy disclusion time is accomplished successfully by this new occlusal adjustment technique, which differs significantly from traditional occlusal equilibration in focus, sequence, and theory.[10,11,13]

Clinical Picture of Lengthy Disclusion Time

Figures 5(A), 6(A), and **7(A)** show pretreatment contact patterns of lengthy disclusion time, which is represented clinically by lines of Accufilm ink on the involved teeth. These photographs show the resultant contacts present when the patient makes both the right and left excursion with Accufilm interposed between opposing posterior quadrants. These lines have been described by Glickman[46] as Class I, II, and III interferences. Generally, these lines originate in or very near to the central fossae or marginal ridge and travel up most of the incline to the cusp tip. During treatment, these linear occlusal markings are analyzed, and the interfering inclines are successively removed from both arches over a series of excursive movements.[13] These interferences are clearly shown by the T-Scan in force movie mode, which allows for calculation of the sum time of these interferences.[10]

The corrected post-treatment patterns developed by implementing ICAGD to establish short disclusion time can be seen in **Figures 5(B), 6(B),** and **7(B)**. Note that the precise removal of all inclined plane contact lines results in the development of rounded point contact in either central fossa, cup tip, or marginal ridge locations. Note that in **Figure 7(A)** the pretreatment lengthy disclusion time contact pattern lines are present on porcelain-fused-to-metal crowns. Because the transmission of excessive muscle contraction information appears to be transmitted from the occlusal surface through the compressed periodontal ligament to the muscles of mastication, the occlusal contacting arrangement on dental restorations is most probably equally as muscle-activating as that which is present on unrestored tooth structure. Therefore, disclusion time of length on crowns and fixed bridgework is a potential etiologic component of a chronic MPDS condition.

When implementing ICAGD, the primary procedural focus is to reduce pretreatment disclusion time to < 0.5 sec in any excursion, which creates a range of mandibular motion in which posterior teeth completely pass by each other, rather than rub over each other, during function. ICAGD adjustments minimize posterior tooth lateral contacts, which in turn stops periodontal ligament compression, thereby lessening contractile muscle activity. By focusing on a functional time parameter, this procedure is

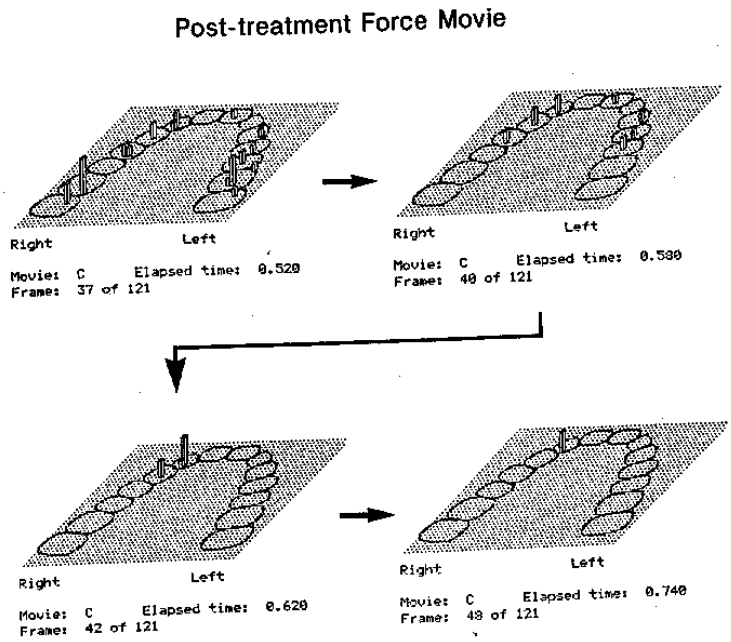


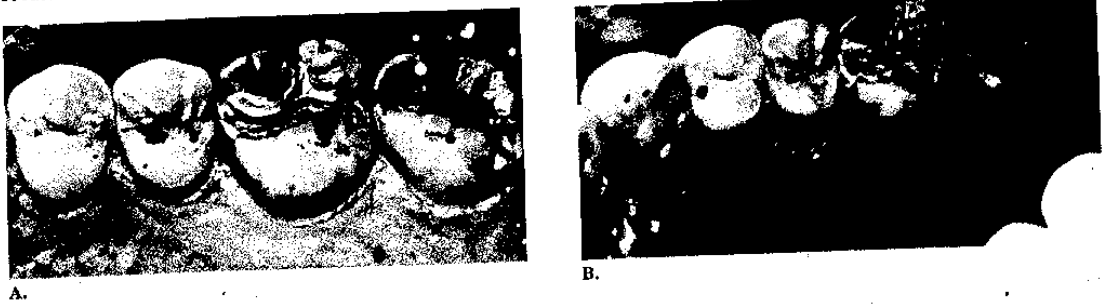
Figure 4
Post-treatment Right Working Disclusion Time Force Movie for **Figure 3.**

much more concerned with active jaw function, rather than on a perceived static jaw position (centric relation).

Sequence of ICAGD

The sequence of adjustments is completely reversed from traditional occlusal equilibration, so that all molar and premolar excursive contacts are eliminated prior to any habitual closure adjustments being attempted by the operator.[10,11,13] Working premolar contact is only desirable in the Class II occlusion where this type of contact would be the guiding contact. There is no attempt to locate centric relation, or a slide from CR-CO, and habitual closure adjustments are of secondary concern to lateral excursive contacts.

C.E. Stuart, in an unpublished manuscript (CE Stuart, *The Methods of Approach – Determinants of Occlusal Adjustment*, 1962, Van Nuys, CA), advocated eccentric adjustment procedures prior to centric relation adjustments. He proposed a sequence of first protrusive and then right and left excursive adjustments, and, finally, guided centric relation closure adjustments. This approach has much similarity to ICAGD in that it places primary adjustment focus on excursions. However, centric relation is adjusted (which is a critical difference in approach) and there is no mention of a critical specific time compo-



A. B.

Figure 5
A. Pretreament and **B.** post-treatment contacts.

A.

B.

Figure 6
A. Pretreatment and B. post-treatment contacts.

nent to disclusion. This is probably due to the lack of measurement capability and an unawareness of numerous authors as to the need for a time assessment to disclusion of the posterior teeth.

Treatment

Prior to any treatment, a T-Scan force movie analysis of all excursions is performed to determine the disclusion times of each excursion. A series of repetitive measurements (three to four) is required to ascertain the range of disclusion times. A disclusion time of > 0.5 sec indicates the need for occlusal therapy to reduce disclusion time in a chronic MPDS sufferer.[10,13]

ICAGD therapy is divided into two therapeutic phases:

Phase I: Disclusion time reduction to < 0.5 sec.
Phase II: Refinement of the habitual closure position.

Phase I is the key to muscular relaxation, as this is where the disclusion times are reduced to neuromuscular healthy levels. Phase II adjustments are accomplished only after all Class I, II, and III interferences, as described by Glickman,[46] are removed from the mandibular excursions bilaterally.[10,11,13]

During disclusion time reduction adjustments, all contacts located in central fossae, on marginal ridges, and cusp tips are left intact during the adjustments. The neighboring interfering inclines are the areas to be adjusted.[13] A properly completed contact pattern consists of solid, round contacts in central fossae and/or cusp tips and/or marginal ridges. All pinpoint Accufilm scratches should be removed and no lines of ink should be present on any posterior tooth (unless it is a premolar involved in working side guidance (i.e., in the Class II occlusal scheme)). Not all available classical, stereotypical contacts will be present at the completion of properly accomplished ICAGD[13] **(Figures 5(B), 6(B),** and **7(B)).**

This definitive lessening of posterior tooth contact is the intended design of the procedure, resulting in a direct lessening of periodontal ligament compressions and of contractile muscle activity.[10] Contrary to Schulyer's rules of adjustment, all interfering inclines on or near supporting cusps are removed from both arches during Phase I. This distributes the removal of enamel over both sets of interfering inclines so as to minimize excessive enamel reduction and enhance quick posterior tooth separation.

A new disclusion time is measured for each excursion and verified that it is < 0.5 sec. If disclusion time is not < 0.5 sec, the T-Scan force movie of the incorrect excursion will illustrate the problem areas remaining so that the

A.

B.

Figure 7
A. Pretreatment and B. post-treatment contacts on crowns.

operator can adjust until disclusion time is the correct length.

Phase II adjustments, the habitual closure refinements, are commenced after all guiding surfaces are established with immediate posterior disclusion during any mandibular excursion.[13] Habitual closure refinement usually requires two to nine visits spread over one to six months' time to complete. Treatment is terminated when the muscle relaxation process has ceased and symptom resolution has been stable for one to three months during habitual closure refinement adjustments (Phase II). The patient plays a major role in determining the comfort of their occlusion. A series of questions is asked of the patient at each visit by the operator to ascertain areas of pressure and early strikes in their occlusion while it is changing[13] **(Table 2)**.

When the operator is performing ICAGD, it is important to understand that all jaw movements, including habitual closures, are unguided by the operator so as to simulate the way a patient would function on their own. There is no bimanual manipulation, chin point guidance, leaf gauge, or anterior deprogramming jig employed. This is because there is no attempt to locate and position the mandible in centric relation, and the slide from centric relation to maximum intercuspal position is not analyzed nor treated. Primary excursive adjustments based upon a functional time parameter (disclusion time < 0.5 sec), unguided jaw movements, and the development of a non-retruded closure position represent important differences between ICAGD and traditional Occlusal Equilibration.

Finally, the theory of this occlusal adjustment approach is that excessive posterior tooth contact in time (disclusion time > 0.5 sec) elevates contractile muscle activity.[10] As a patient ages with these contacts present, dysfunctional muscle problems from fatigue develop. By removing the lateral interferences which create excessive disclusion time and not retruding the mandible into a forced posterior or superior position, contractile muscle activity is dramatically lessened, more freedom of mandibular movement is achieved, and normal muscular function returns in approximately 30 to 40 days following the first treatment appointment.[10-13]

Table 2
Patients Questions Used in Immediate Complete Anterior Guidance Development (ICAGD)

Patient Questions
1. Where is the most pressure in your bite?
2. Are there any "rocking points" present?
3. Do you land "squarely" or do you hit somewhere and "slide in" to your bite?
4. Do the right and left sides feel even?
5. Do you feel light in the back of your mouth?
6. Does biting down hurt your face, ears, neck, or temples?
7. Is there anything you don't like about your bite?
8. Do you feel blocked when you slide from side to side?
9. Is there any increase in tension in your face when you bite down?

Use of the T-Scan During Phase II

Habitual closure refinements are assisted and refined by the T-Scan. The T-Scan allows the operator to precisely refine the closure position by utilizing both the Time Mode and Force Snapshot Mode.[39] The Time Mode verifies the presence, or lack thereof, of premature contact present in the habitual closure position. The Force Snapshot Mode analyzes areas of extreme contact force in the habitual closure position. This allows the operator to locate and subsequently balance forces throughout the occlusal table.

Aside from measuring disclusion time, the force movie mode can be used to balance forces during habitual closure refinement. The patient is instructed to firmly close onto the T-Scan sensor, and hold the closure position for the full three seconds of the force movie. The resultant movie of the three second scan shows a constant view of the forces present during the closure position. This allows the operator to see which teeth are maintaining high force levels while the mandible is seated against the maxilla. These areas can then be lessened to similar levels as is present on the remaining contacting teeth.

Anterior Relaxation Shift

The relaxation that has been reported by patients to commence after the first treatment visit[10,11] when disclusion time is reduced has been reported to allow the masseter and temporalis to elongate and stretch out as they heal.[10,11,13] Their excessive contractions have been interrupted by reducing disclusion time, thereby lactic acid can be metabolized and oxygen can once again enter the muscle fibers. This process results in a less contracted group of muscle fibers; hence, a "longer muscle."

The "longer" fibers move the mandible away from the face, pushing it forward. Any attempt to retrude the mandible into a centric relation position would negate the positive physiological neuromuscular changes occurring in the musculature. This is the reason that no adjustments are accomplished to retrude or make the mandible more superior in its position. Also, this relaxation shift results in a post-treatment habitual closure position that is slightly anterior to the pretreatment maximum intercuspal position,[10,11] and certainly anterior to centric relation.

Use of Appliances

ICAGD is performed as a first line of treatment for MPDS. It has been reported that successful treatment can be accomplished without preceding occlusal therapy with appliance therapy so as to relax the musculature.[10,11,13]

Pretreatment lengthy disclusion time measurement and proper occlusal examination of all present excursive interferences, combined with a history of chronic MPDS, reveals that the occlusal components related to excessive disclusion time are arousing the contractile muscle activity in the muscles of mastication. Therefore, with proper history, examination of the occlusion, and T-Scan computerized occlusal analysis showing excessive posterior disclusion time, it is possible to commence treatment without preliminary appliance therapy.

A significant difference between traditional occlusal equilibration and ICAGD is that ICAGD does not require the use of splints. This provides a major advance in the time of treatment, patient comfort, and compliance during MPDS therapy.

Proposed Mechanism of Hypercontraction

The pretreatment hypercontracted condition of muscles and mandibular dysfunction seems to arise from the following:

1. Lengthy functional posterior tooth contact in excursions results in extended compression of the periodontal ligaments of the involved teeth;
2. Compression of the periodontal ligaments relays contraction instructions via the mandibular and maxillary branches of the trigeminal nerve through the central nervous system to the muscles of mastication for as long as the posterior teeth remain in contact;[10,31]
3. Excessive muscle contractions result from prolonged compression time, from which (during the passage of time) elevated levels of lactic acid build up in the muscles which leads to muscular toxic ischemia. What follows this phenomenon is pain, fatigue, limited chewing capability, parafunctional habits such as clenching and bruxing, as well as a range of other associated muscle contraction disorders of the head, face, and neck **(Figure 8)**. It is also quite probable that efferent excess contraction information is transmitted to other muscles innervated by V_1 (opthalmic nerve) and V_2 (maxillary nerve) (not only by V_3 (mandibular nerve)) of the trigeminal nerve. This would explain why supraorbital, infraorbital, midface, sinus region, and ocular parts of the head are often involved in the MPDS condition. This premise requires a neurophysiologic study to determine which other cranial nerves and which branches of the trigeminal nerve may receive periodontal ligament contraction impulses.

The onset of clinical symptoms may be assisted and/or accelerated by trauma or injury to the masticatory musculature. This probably results in a lessening of the patient's human physiologic tolerance[20] to the toxic muscle phenomenon, which has been previously and continuously ongoing in the musculature from the patient's occlusion since its development of posterior interdigitation. With physiologic tolerance lessened, the toxic ischemic process of muscular dysfunction overtakes the human resistance to it, and symptoms become clinically apparent rather than remaining subclinical.

The human tolerance to this mechanism most likely varies greatly among the population at large. Human physiologic tolerance in non-MPDS patients is probably stronger than in MPDS patients. The human resistance factors related to the onset and proliferation of symptomatic chronic muscular disease is, in all probability, much more resistive than those same factors in MPDS patients. In order for non-MPDS patients to not clinically suffer from the disclusion time/periodontal ligament compression time/muscle activation phenomenon, this mechanism must be inhibited somewhere along the trigeminal pathways between the periodontium and the muscles of mastication.

Three possible inhibitory locations are:

1. at the periodontal ligament. The degree of compressive forces has to surpass the threshold to instruct muscle contraction.
2. in the CNS. Despite the presence of excessive afferent contraction information coming into the CNS from the compressed periodontal ligament, it is not relayed back out of the CNS on the fibers of the trigeminal nerve to the muscles; therefore, they do not hypercontract.
3. at the muscle itself. Afferent contraction information from the CNS is inhibited at the muscle-neuron interface; outgoing excessive contraction information from the CNS does not exceed the threshold of the majority of muscle action potentials within a given muscle. Normal muscle function goes on without hypercontraction.

ICAGD most probably initiates and proliferates significant physiologic muscle relaxation in the following manner and order:

1. The prolonged compression time of the peri-

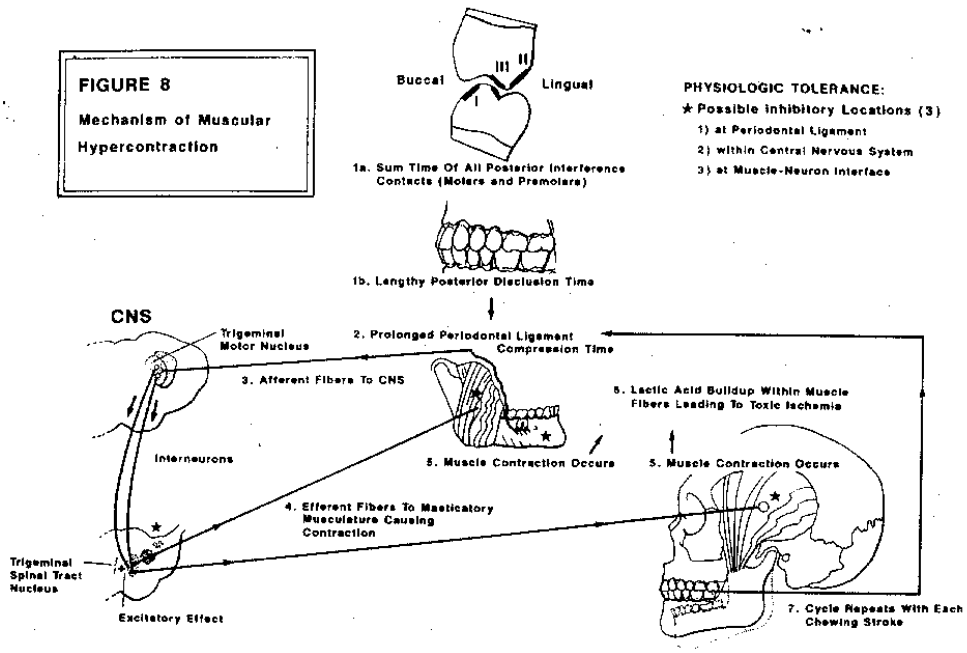


Figure 8
Proposed mechanism of muscular hypercontraction. (Figure modified from Okeson JP: *Fundamentals of Occlusion and Temporomandibular Joint Disorders*. St. Louis: CV Mosby Co, 1985: 37.)

odontal ligaments is drastically reduced when disclusion time is shortened to < 0.5 sec.

2. Drastically shortened compression time results in an interruption of the excessive muscle contraction instructions coming from the periodontal ligament, through the central nervous system along the trigeminal nerve fibers to the muscles of mastication.
3. With minimized contractions occurring within the muscle, lactic acid build-up is metabolized, which stops the ongoing state of toxic ischemia.
4. With toxic ischemia stopped, oxygenation of the muscle fibers takes place and allows for healing of the damaged tissue. Over time (approximately 30 to 40 days from initial disclusion time reduction), this results in significant physiologic muscle relaxation. During the healing period, normal muscle function begins to return in the newly relaxed state. This results in rapidly improved chewing capability, reductions in parafunction, pain, and fatigue. The relaxation exhibits permanence because disclusion time remains stable once it is corrected,[12] as it is a permanent correction to the occlusion.

Summary of Immediate Complete Anterior Guidance Development (ICAGD)

In summary, the adjustment objective of ICAGD is to quickly disclude the posterior teeth, primarily in the right and left excursion, and secondarily in the protrusive movement. A disclusion time of < 0.5 sec following treatment is the most important guideline to successful accomplishment of the procedure. When this objective is accomplished, then a new habitual, unguided, nonretruded closure position is refined over a series of weekly appointments with patient assistance and computer analysis by the T-Scan occlusal analyzer.[37-40]

Summary and Conclusions

Significant differences exist between traditional occlusal equilibration and Immediate Complete Anterior Guidance Development (ICAGD). It is important that the professional understand these differences in order to properly implement the two procedures. The differences are as follows:

1. **Traditional occlusal equilibration** emphasizes that centric relation occlusal contacts be coinci-

dent with centric occlusion through operator-guided mandibular closures. **ICAGD** emphasizes immediate posterior disclusion in < 0.5 sec in any mandibular excursion. No operator-guided jaw movements occur, and centric relation occlusal contacts are not analyzed, adjusted, or attempted to be made coincident with centric occlusion.

2. The sequential order of tooth contacts adjusted in **traditional occlusal equilibration** commences with operator-guided centric relation prematurity adjustments. This is followed by CR-CO slide removal, and is completed by elimination of excursive interferences, with working side molar and bicuspid guiding contact being deemed an accepted occlusal scheme. In **ICAGD** the sequential order of tooth adjustments begins with excursive interferences (right, left, and then protrusive). This is followed by contact removal until disclusion time is < 0.5 sec in each excursion, followed by unguided habitual closure contact adjustments. No slides from centric relation to centric occlusion are analyzed or adjusted.
3. The theoretical basis for employing **traditional occlusal equilibration** is that by locating centric relation and eliminating the interferences to that border position, the condyle disk assembly and the occlusal position will seat the temporomandibular joints in a physiologic position with the mandible being elevated by normal muscle function. It is also assumed that premature contacts in centric relation are the promoters of bruxism, muscle hyperactivity, and jaw dysfunction. The studied and measured theoretical basis for the use of **ICAGD** is that by reducing disclusion time to < 0.5 sec in each mandibular excursion, the collective elevated masticatory contractile muscle activity present before treatment is physiologically reduced by shortening the compression time of the involved periodontal ligaments. This in turn interrupts muscle contraction instruction transmission from the periodontal ligaments to the muscles of mastication. With significantly less contractions occurring within the muscle fibers, lactic acid build-up is stopped and metabolized. This allows oxygen to enter the hypercontracted muscle fibers, which initiates muscle healing with resultant physiologic, permanent relaxation. The condyle-disk assembly and its precise location are not analyzed, nor is it a significant factor in resolving muscle dysfunction when disclusion time is properly reduced to < 0.5 sec.
4. **Traditional occlusal equilibration** should be preceded by appliance therapy to "deprogram" the musculature. **ICAGD** requires no preliminary therapy, as it has been shown to "deprogram" the musculature through neuromuscular physiologic changes. This greatly reduces treatment time and increases patient comfort, treatment acceptance, and compliance.

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Discussion

A COMPARISON OF TRADITIONAL OCCLUSAL EQUILIBRATION AND IMMEDIATE COMPLETE ANTERIOR GUIDANCE DEVELOPMENT

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I appreciate the opportunity to discuss this article, as I was one of the first to work with the T-scan and find that it has many desirable applications for our patients. However, I would like to express several concerns involving this suggested occlusal adjustment technique.

Much of the supportive data presented here has been published by one author and needs to be confirmed by additional research and other impartial clinicians. In this particular report, no control group was studied, and I would recommend this feature for future studies. As the author of Occlusion and Function, which was referenced in this work (Reference #18), I have not recommended using the retruded contact position since 1972 when I taught selective grinding techniques. In 1984, the Ear, Nose and Throat Journal,[1] published my article with Dr. Suarez in which the centric relation position was anatomically related and discussed. The Federation of Prosthodontic Organization Glossary later accepted this definition of centric relation as an acceptable position for an anatomically-correct acceptable position for treatment.

In 1982, the President's Conference on Examination, Diagnosis and Management of Temporomandibular Joint Disorders[2] published terms relative to this field. At that time, the terms "TMJ syndrome" and "MPDS" were considered inaccurate. Therefore, I believe the patients in this study should have been evaluated to determine whether there were intracapsular problems (i.e., internal derangement) or extracapsular problems (i.e., myofascial pain) that were demonstrated to be improved from the use of this technique.

I recommend the use of a deprogramming device to give immediate disclusion and anterior guidance which is based on the studies of Alan Hannan. I am in agreement that the least muscle function involving the TMJ is a beneficial observation. We would use this determined occlusal position before any teeth are equilibrated. I base this on my 25 years of teaching experience, which has been supported by our own anatomic and imaging studies,[1-3] and electromyographic studies of others.[3,4]

I believe that Okeson and Dawson accept the second step in my outlined sequence of adjustments to be followed in occlusal equilibration. Dawson, in particular, recommends a bimanual manipulation to first establish that position prior to defining the need for adjustment of the patient's dentition.

In finalization of treatment for these patients, I support the development of an anterior guidance with posterior disclusion as essential in the management of the case. I recommend the use of an occlusal deprogramming appliance or device before any occlusal adjustment is made. By keeping the procedure reversible and using this as a guide prior to initiating any irreversible process, the amount and frequency of occlusal equilibration can be minimized, as well as the length of the overall treatment program.

It is very important with today's challenges to various dental techniques to know where you are when you initiate a procedure, where you are going, and how you can accomplish getting there before you initiate an irreversible procedure. I have endorsed this approach since 1972.

In summary, I congratulate the author on this article for his enthusiasm, the use of the T-scan, and its helpful ways to define certain procedures. We may have differences in the original direction, but the end point is to make our patients comfortable.

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