Cervical dentin hypersensitivity. Part III: Resolution following occlusal equilibration

Thomas A. Coleman, DDS[1]/John O. Grippo, DDS[2]/Keith E. Kinderknecht, DMD[3]

Objective: This retrospective study was designed to investigate changes of cervical dentin hypersensitivity (CDH) in response to occlusal equilibration. **Method and materials:** Written records for 250 active-care patients were randomly selected and analyzed for associations between CDH, and its resolution following occlusal equilibration. Patients in group A (treatment) and B (delayed treatment) received occlusal equilibration following the detection of verified CDH using the air indexing method. Group C patients were not detected with verified CDH during the study period of 17 years. The resolution of CDH was measured by the loss of a positive patient threshold response to air stimulation. **Results:** Significant associations existed between CDH, hyperfunction, parafunction, and abfractive lesions. Furthermore, it was found that occlusal equilibration resulted in the long-term resolution of CDH. **Conclusions:** The resolution of CDH by occlusal equilibration, thus negating the null hypothesis, suggests that further studies are indicated to evaluate the impact of these findings upon restoring and maintaining health of the masticatory system.
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Key words: abfractive lesions, air indexing method, cervical dentin hypersensitivity (CDH),occlusal equilibration

CLINICAL RELEVANCE: Occlusal examination, analysis, and judicious equilibration is indicated whenever CDH is present. The reduction of CDH, measured by the air indexing method, suggests an appropriate clinical application of occlusal equilibration in the long-term management of CDH.

An air indexing method[1] was recently introduced to detect and quantify the degree of cervical dentin hypersensitivity (CDH).[2-4] Associations have been noted between CDH and abfractive lesions in that they were predominantly located on the cervical facial surfaces of premolars and molars.[4] Abfractive lesions have been theorized to develop over time in response to hyperfunctional or parafunctional forces, which result in microfractures in cervical dentin.[5] These stress-induced hard tissue lesions appear to be exacerbated by erosion-corrosion and toothbrush/dentifrice abrasion.[6,7] Horizontal loading forces have been implicated in the formation of abfractive lesions.[8-17] Cervical dentin hypersensitivity seems to be coincident during the formative stage or active period of abfraction.[4]

The masticatory system comprises three basic components: temporomandibular (TM) joints, muscles of mastication, and teeth. A nondeflected centric relation (CR) where centric occlusion (CO) equals maximal intercuspation (MI) with a fully seated position of the temporomandibular condyle/disc assembly in the fossa as defined by Dawson[18] and others,[19-21] was utilized during occlusal analysis in the present study. Dawson introduced a classification system for dental occlusions that relates maximal intercuspation in CR to TM joint health and masticatory muscle response to tooth deflections.[22] Williamson and Lundquist[23] found that canine-guided laterotrusion or anterior guidance in protrusion decreased masseter and temporal muscle contractility, whereas posterior occlusal contact during

[1]Private Practice, Shaftsbury, Vermont.

[2]Senior Lecturer, Department of Biomedical Engineering, Western New England, Springfield, Massachusetts.

[3]Director of Graduate Prosthodontics, School of Dentistry, West Virginia University, Morgantown, West Virginia.

Reprint requests: Dr Thomas A. Coleman, Shaftsbury Medical Building, Box 230, Shaftsbury, VT 05262. Fax: 802-442-2072.

these two excursions produced more intense muscular contraction. These concepts have been verified by Kerstein and Wright[24] and Kerstein[25] with the use of a T-Scan to demonstrate that reduced posterior contact in eccentric movements or laterotrusion reduces masseter and temporalis EMG activity. The T-Scan II is a Microsoft Windows R (Microsoft) complaint computerized occlusal analysis system that gathers occlusal contact force and time sequencing data through an intraoral electronically powered pressure-measuring sensor.[26] The dynamic interrelationships of teeth, periodontium, muscles of mastication, and temporomandibular joints under function are the basis for occlusal therapy designed to alleviate pathology related to the masticatory system.[18,27]

Historically, occlusal therapy has been provided by clinicians based upon the signs of chronic periodontal hyperfunction, such as tooth hypermobility and/or vertical bone loss.[27–31] The introduction of occlusal prematurities as little as 80 μm may result in a 70% increase in occlusal forces upon teeth.[30] Occlusal deflections of 500 μm stimulate periodontal receptors which, in turn, can induce reflex contraction by the muscles of mastication.[32] Occlusal devices may reduce occlusal stress to teeth and therefore the tone of contractile muscles of mastication.[31,33,34] Options for the treatment of periodontal deflections are occlusal equilibration or occlusal device fabrication.

A neurologic influence upon the contraction and relaxation cycles of the muscles of mastication may also result from pulpal stimulation.[35] Cervical dentin hypersensitivity has been identified as a neurogenic pulpal response to mechanoreceptor stimulation from open dentin tubules to cold, air, electrical stimulation, acid exposure, tactile stimulation, or combinations of these stimuli.[36–47] Neurogenic inflammation may also mediate or intensify the pulpal response of CDH to these stimuli.[44] The association of CDH to the presence of abfractive lesions by location and distribution indicates that CDH may result from excessive functional or parafunctional occlusal stress.[4]

Occlusal prematurities and deflective occlusal contacts resulting in CDH, abfractive lesions, or periodontal mobility can be so minor that they are neither perceived by patients nor detected by dentists. The ability of a dentate individual to perceive an occlusal prematurity occurs at between 20 to 90 μm.[48] Tactile sensitivity during chewing has been identified as detecting differences as small as 0.035 inches.[49] In mathematic conversion, 20 μm equals 0.0008 inches, and 80 μm equals 0.0031 inches. Articulating papers in standard use for clinical dentistry are between 0.0015 and 0.0035 inches thick. The use of articulating papers to obtain information during occlusal analysis/equilibration is challenging to the clinician due to moisture of the oral cavity and deflection by the tongue, cheek, or lips. Local anesthesia, muscle fatigue, and the dentist-patient relationship may also hinder occlusal evaluation and therapy. Although not used during this retrospective study, computerized force analysis may improve the detection and quantification of tooth contacts.[50]

Successful occlusal analysis and restorative treatment requires recognizing the dynamics of the masticatory system to both vertical and horizontal stresses upon teeth.[51] Mounted study casts may aid the clinician in the analysis of static occlusal contacts, but they lack information regarding the horizontal loading forces upon teeth. Dental/neuromuscular, gravitational/postural, skeletal/structural, or systemic occlusal modifiers may alter occlusal stress upon teeth in function and parafunction.[52] Spranger's in vitro analysis of study casts found that working and nonworking excursive forces produce 10 to 20 times greater flexure to teeth than do vertical loading forces.[12] Clinical data suggests that flexural stress seems to be a contributing etiologic factor in the genesis of both CDH and the formation of abfractive lesions.[4]

The purpose of this retrospective clinical study was to evaluate changes of CDH in response to occlusal equilibration in that CDH may be a precursor and pathognomonic sign of active abfraction. The null hypothesis is that occlusal equilibration has no effect on CDH.

METHOD AND MATERIALS

Database

A population of 250 active-care patients older than 20 years of age at the end of the 1979–1996 retrospective study period were randomly selected from a general dental practice. These patients were examined for the presence or absence of CDH using the "air indexing method."[1,4] Groups A and B included only those patients detected with a "verified positive threshold patient response" to an air stimulus (ie, sensitive to air), whereas group C were those patients without a verified positive air index (ie, insensitive to air).[4]

Occlusal therapy was provided for patients in groups A and B to teeth detected with a verified positive response to air stimulation (CDH). Patients were assigned to group A (treatment) when occlusal therapy was provided at less than 30 days from the detection of verified CDH. Group B (delayed treatment) were those patients treated by occlusal equilibration at an interval of 30 days or more from the diagnosis of verified CDH. None of the patients in group C were diagnosed with verified CDH; however, some did receive occlusal therapy based upon clinical and/or radiographic signs and symptoms of secondary occlusal trauma. These signs and symptoms included vertical bone loss and/or increased mobility of individual teeth associated with functional and parafunctional forces.

The data analysis excluded patients of less than 1 year, those lacking completion of regular dental care, and those whose last treatment date was prior to 1994. Retrospective analysis included examination of written records from 1979 to 1996 for all 250 patients who were then assigned to groups A, B, or C on the basis of the air indexing method.[4] Collection of additional data included patient age, Angle's classification of occlusion, number of treatment years, number of teeth, air indexing data, type of occlusal interference, abfractive lesions, and signs/symptoms of active parafunction. The data were processed on a personal computer using a spreadsheet program (Excel 5.0, Microsoft).

Occlusal analysis

Routine occlusal analysis was provided for all patients in this retrospective study based upon patient complaints, detection of cervical dentin hypersensitivity, and/or periodontal signs of traumatic occlusion. Findings of radiographic evidence of vertical bone loss, tooth mobility, CDH, mastication sensitivity, bruxism, or patient complaint of occlusomuscular pain were the indicators for occlusal equilibration. Patients were examined using a variety of standard articulating papers, occlusal indicator waxes, analysis of mounted study casts, excursion limits, comparisons of current/previous intraoral radiographs, and CR techniques. The long-term nature of this retrospective study (1979–1996) and the goal of successful patient treatment occasioned technical changes, such as improvement of articulating papers, the introduction of the fluid control block,[1] and the use of bimanual manipulation for CR were implemented for more precise occlusal analysis as state-of-the-art advances occurred.

Occlusal analysis included radiographic evaluation; direction of tooth deflection for mobile teeth that interrupt the arc of mandibular closure in CR; a verification (7 to 10 days) following a diagnosis of a positive air index; an attempt to retain centric holding cusp contacts; and location of occlusal interferences during mandibular movements. During occlusal adjustments, an attempt was made to gain or retain cuspid-rise laterotrusion when possible.

Patients were excluded from occlusal equilibration groups A and B when the etiology of CDH seemed related to causes other than deflective occlusal contacts. These exclusions included a restoration that lacked a protective base, a tooth that had a recent vital pulp exposure, a diagnosis of irritation from a protective base or cement, acidic dietary influences, or when excessively abrasive oral hygiene habits existed. Furthermore, patients with a recent (7 to 14 days) history of periodontal surgery or exodontia also were excluded from both groups A and B.

Occlusal equilibration

Occlusal equilibrations to enamel and/or restorations estimated at 100 µm or less were performed, guided by articulating paper and occlusal indicator wax. These equilibrations were provided to teeth diagnosed with CDH using the air indexing method.[1] All patients diagnosed with verified CDH received equilibration and were assigned to groups A or B, except those excluded as described. Excluded patients and those without a diagnosis of a verified positive threshold response to air stimulation were assigned to group C. Some members of group C received occlusal equilibration based upon traditional signs or symptoms of secondary occlusal trauma/occlusomuscular disharmony. Patients who never received occlusal equilibrations during the 17-year study period were also assigned to group C. Equilibrations were performed with abrasive discs or high-speed burs with a gentle brushstroke, to reduce the articulation recordings.

RESULTS

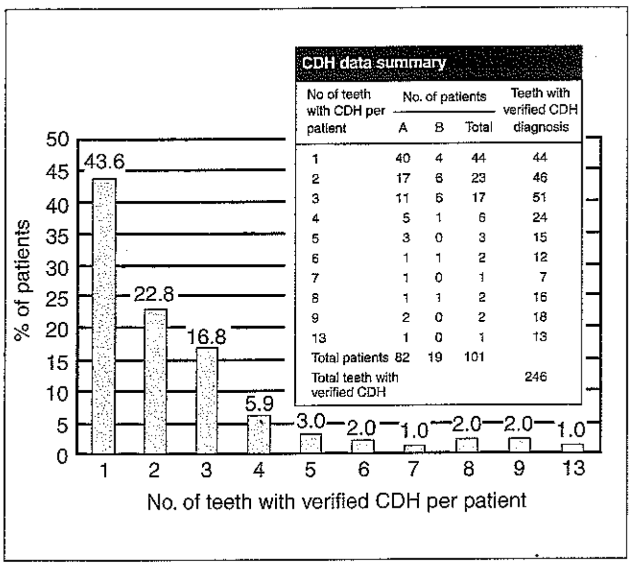
Table 1 comparisons of age, number of teeth, and years in treatment disclosed similarities in the study samples for groups A, B, and C. The sums of groups A and B correspond to group I of the previous retrospective study by Coleman et al.[4] Group B (delayed treatment) included 19 patients, whereas group A (treatment) disclosed 82 patients with verified positive threshold patient responses to air stimulation. Group C (149 patients) corresponds to group II from the previous study by Coleman et al.[4] This previously published retrospective study associating patients with verified CDH to abfractive lesions found that 76% of patients in groups A and B were detected with abfractive lesions. Only 39% of the patients within group C were detected with this type of hard tissue lesion.[4] Active parafunction was diagnosed in 50% of group A, 47.4% of group B, and only 15.4% of group C patients.

The number of teeth diagnosed with CDH for both groups A and B is illustrated in Fig 1. It was found among the 101 patients in these two groups that 43.6% had CDH involving one tooth, 22.8% with two teeth, and only one patient with 13 teeth sensitive to air stimulation. A total of 246 teeth were diagnosed with verified CDH in these two groups over the 17-year study period.

TABLE 1 Summary of comparisons of groups A, B, and C (1979 to 1996)

	Groups								
	A			B			C		
	Female	Male	Both	Female	Male	Both	Female	Male	Both
No. of patients	42	40	82	13	6	19	77	72	149
Age at beginning of dental care									
Mean	37	41	39	32	45	36	39	42	40
Median	48	46	47	38	46	41	35	41	38
Standard deviation	11	12	12	10	13	20	19	15	17
Mean no. of teeth	26	27	26	26	26	26	25	24	24
Mean years in treatment	9	10	10	13	17	14	9	9	9
No. of patients with active parafunction (%)	23	18	41 (50.0%)	7	2	9 (47.4%)	12	11	23 (15.4%)

A = patients with verified CDH equilibrated within 30 days; B = patients with verified CDH equilibrated 30 days or greater; C = patients with no verified CDH.



No of teeth with CDH per patient	No. of patients A	B	Total	Teeth with verified CDH diagnosis
1	40	4	44	44
2	17	6	23	46
3	11	6	17	51
4	5	1	6	24
5	3	0	3	15
6	1	1	2	12
7	1	0	1	7
8	1	1	2	16
9	2	0	2	18
13	1	0	1	13
Total patients	82	19	101	
Total teeth with verified CDH				246

Fig 1 Distribution of patients with cervical dentin hypersensitivity (CDH) when groups A and B are combined (n = 101).

Table 2 discloses correlations between the detection and resolution of CDH following the equilibration of teeth in groups A and B. All teeth diagnosed with a verified CDH, except those excluded, received occlusal equilibration irrespective to the presence or absence of prior restorative care. Retrospective analysis found documented resolution of CDH for all 246 teeth within this study. The results revealed that an average of two equilibration visits were required to resolve CDH for both groups A and B. Recurrent CDH in the same treatment quadrant over the 17-year study period was 15% for group A and only 5% for group B. This CDH was resolved by occlusal equilibration on an average of two visits for group A and three visits for the one patient in group B. Only 12% of patients within either group required four or more equilibration visits to resolve CDH. Correlation analysis found that 31% of group A and 48% of group B incidents of CDH diagnosis had an etiology related to hyperfunctional contacts from recent dental treatment. The nonmeasured results of periodontal deflections after equilibrations for group C patients were not included with the CDH data presented in Table 2.

Tables 3a and 3b present the statistical analysis of occlusal equilibration in groups A and B. The time interval between diagnosis, using the air indexing method and initial occlusal equilibration, was an average of 7 days in group A and 92 days (delayed for various reasons) in group B. Second, third, or fourth equilibration visits occurred if CDH was not resolved at subsequent appointments. All patients in group C were without verified CDH and were not included in Tables 3a and 3b.

TABLE 2 Equilibration data and equilibrated CDH associated to recent dental treatment for groups A and B

	Groups					
	A (n = 82)			B (n = 19)		
	Female	Male	Both	Female	Male	Both
Total equilibration visits for positive air indexed teeth*			220			30
Mean visits to resolve CDH			2			2
Total patients relieved of CDH by occlusal equilibration			82			19
Patients with recurrent CDH following equilibration (%)			12 (15)			1 (5)
Total equilibration visits for secondary positive air indexed teeth*			19			3
Average no. of visits to resolve secondary occurence of CDH			2			3
Percentage of patients requiring 4 or more visits of occlusal equilibration to resolve CDH			12			10
No. of incidents of CDH†	66	55	121	15	6	21
No. of incidents of CDH related to dental treatment (%)†	19 (29)	18 (33)	37 (31)	9 (60)	1 (17)	10 (48)
Operative	8	9	17	4	0	4
Crown	5	4	9	5	1	6
Fixed bridge	6	3	9	0	0	0
Extractions (more than 7 days postop)	0	1	1	0	0	0
Partial denture	0	1	1	0	0	0

A = patients with verified CDH equilibrated within 30 days; B = patients with verified CDH equilibrated 30 days or greater.
*One treatment visit may relate to equilibration of several teeth diagnosed with verified CDH.
†Note that some patients had multiple CDH teeth.

TABLE 3a Distribution of occlusal equilibrations for groups A and B

	Groups			
	A		B	
Treatment time	Mean no. of days	Total incidents	Mean no. of days	Total incidents
Between diagnosis and first treatment	7	121	92	21
Between first and second treatment	17	57	19	7
Between second and third treatment	15	26	14	3
Between third and fourth treatment	8	15	12	2

A = patients with verified CDH equilibrated within 30 days; B = patients with verified CDH equilibrated 30 days or greater.

TABLE 3b Location of occlusal equilibrations for groups A and B

	Treatment stage							
	Group A				Group B			
Adjustment	First	Second	Third	Fourth+	First	Second	Third	Fourth+
Working	65	31	10	3	8	2	0	0
Nonworking	10	1	0	0	3	2	1	1
Centric	5	1	1	1	1	0	0	0
Protrusive	4	1	0	0	3	0	0	0
Working and nonworking	28	19	11	8	6	3	2	1
Centric and protrusive	2	0	0	0	0	0	0	0
Working and centric	5	2	2	1	0	0	0	0
Working/nonworking/centric	2	2	2	2	0	0	0	0
Total	121	57	26	15	21	7	3	2

A = patients with verified CDH equilibrated within 30 days; B = patients with verified CDH equilibrated 30 days or greater.

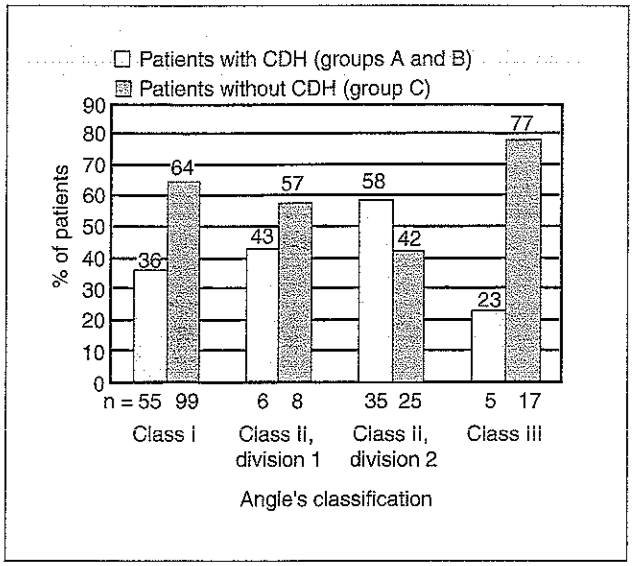


Fig 2 Association of Angle's classification to patients with and without verified cervical dentin hypersensitivity (CDH).

Tables 3a and 3b also identify various types of deflective or premature contacts that were adjusted on teeth with a verified and quantified CDH. The greatest number of adjustments to both groups A and B occurred on working cusp inclines, which corresponds to the overwhelming buccal locations of CDH.[4] Locations of premature occlusal contacts were similar for both groups A and B.

Figure 2 correlates the percent frequency of CDH detected for each Angle's classification group. Among the total 250 patients, approximately 40% (groups A and B) were diagnosed with CDH and 60% (group C) without CDH. Fifty-eight percent of Class II, division 2 patients were detected with CDH and 77% of Class III patients without CDH. The detection of CDH among Class I and Class II, division 1 patients was 36% and 43%, respectively.

DISCUSSION

The interrelationships between TM joint function, contraction and release cycles of the muscles of mastication, and occlusal contacts between teeth must be understood prior to providing any occlusal therapy. For example, a MI position may yield different recordings of tooth contacts when compared to those recorded in the CO position with the condyles in CR.

Groups A, B, and C (see Table 1) were evaluated in this correlative retrospective study based upon the presence or absence of a verified CDH diagnosed by the air indexing method. The results of this study support the contention that excessive misdirected functional or parafunctional forces upon teeth appear to be related to the presence of CDH. The formation of groups A and B provides study groups, wherein the only variable is the time between diagnosis and occlusal adjustment.[4]

Cervical dentin hypersensitivity most frequently involved only one tooth (see Fig 1). As the number of sensitive teeth per patient increased, the number of patients with CDH decreased. Although not illustrated by Fig 1, a similar distribution between CDH and abfractive lesions was found.[4] Sharav et al[35] found that pulp stimulation may alter contractility of masseter and temporalis muscles. Chronic pulp stimulation such as that occurring with CDH creates the potential for masticatory muscle accommodation. Since the masking of CDH by desensitizing dentifrices alters clinical air indexing data, it is likely that increased risk of tooth fracture, pathologic muscular accommodation, or tooth mobility may result when occlusal disharmony remains uncorrected. Palliative treatment of CDH without occlusal equilibration may contribute to future dental problems.

Data summarized in Table 2 revealed that CDH resolved on average after two visits following occlusal equilibration for both the active and delayed-treatment groups. Delayed-treatment group B included only one patient with recurrent CDH in the same equilibration quadrant. The resolution of CDH in only one patient who required three equilibration visits is not significant for data interpretation but follows the same clinical pattern of the loss of dentin sensitivity following occlusal treatment. Most significant was the finding that all of group A and B patients were relieved of CDH, which strongly supports the previously stated contention that chronic occlusal disharmony can be a significant etiologic factor of CDH. Recent dental treatment was associated with the initiation of CDH for one third to one half of the incidents for patients in groups A and B. The resolution of verified CDH by occlusal adjustment was found to be long lasting, with only 15% and 5% recurrence rates for groups A and B, respectively, over an average patient treatment period of approximately 10 years. The data strongly supports the rejection of the null hypothesis that occlusal equilibration has no effect on CDH.

Tables 3a and 3b disclose occlusal equilibration statistics for groups A and B. Cervical dentin hypersensitivity was resolved by occlusal equilibration, whether this treatment was rendered after an average of 7 days (group A), or an average of 92 days (group B) following detection of a verified positive response to air stimulation. If occlusal disharmony results in forces on teeth that produce cervical microfractures with open dentin tubules faster than saliva can remineralize or occlude them, mechanoreceptor hypersensitivity from this exposed dentin may occur.

The events of microfracture or physiochemical loss of hydroxyapatite crystals in cervical regions may also lead to a pulpal neurogenic inflammatory response in actively abfracting teeth. Pashley[44] has stated that the release of neuropeptides such as substance P (SP), calcitonin gene-related peptide (CGRP), and neurokinins (NKA and NKB) may promulgate and intensify dentin hypersensitivity. Whether by mechanoreceptor stimulation or neurogenic inflammation, the etiology of chronic CDH appears to be related in part to occlusal disharmony. The data from Fig 1, Tables 2, 3a, and 3b suggest that the detection and quantification of CDH by the air indexing method is a reliable tool for identifying teeth with potential occlusal disharmony and evaluating the efficacy of occlusal equilibration.

Coleman et al[4] revealed a predominant buccal location of both CDH and abfractive lesions in premolars and molars. Tables 3a and 3b illustrate that equilibration to mostly working contacts/inclines led to CDH resolution. Laterotrusive occlusal contacts are located on the buccal cusp inclines except for Angle's Class III patients.

Figure 2 compared distributions of patients for each Angle's classification with the presence or lack of CDH. Forty percent of patients (groups A and B) in the study of 250 patients were detected with CDH. Nearly 40% of Class I and Class II, division 1 patients were detected with CDH. Angle's Class II, division 2 patients were detected with the highest percentage (58%) of CDH, whereas Class III patients had the least (23%). These results suggest that restricted arch forms characteristic with Class II, division 2 patients, who lack anterior guidance, increase the incidence of CDH from occlusal stress. A low risk of CDH is associated with Class III patients where horizontal occlusal stresses are at a minimum.

Dawson[18] and others[19-21] have described a CR position of the condyle and disc within the fossa and an occlusal classification system for categorizing TM health or lack thereof. Rüse and Sheikholeslam[32] and Holmgren et al[33,34] found that occlusal prematurities stimulated periodontal receptors which altered the contractility of masseter and temporalis muscles. Several papers have related chronic pulp stimulation to occlusal stress within the masticatory system.[1,4] Both a nondeflected CR (CO = MI) and the elimination of misdirected occlusal forces resulting from functional or parafunctional tooth contacts are described as requirements for optimum dental health.[18]

Coleman and Kinderknecht[1] introduced the air indexing method as a convenient quantitative method for diagnosing the degree of dentinal hypersensitivity. Coleman et al[4] established the association of CDH with abfractive lesions. The present study disclosed the resolution of CDH following occlusal equilibration. The use of desensitizing dentifrices, cervical restorations, dentin bonding agents, or medicaments to resolve CDH may inadvertently mask this symptom of occlusal disharmony.

CONCLUSION

The data from this long-term, correlative, retrospective study (1979–1996) confirms that verified and quantified cervical dentin hypersensitivity is directly related to occlusal disharmony. Judicious occlusal analysis and equilibration are indicated and can predictably eliminate CDH. Furthermore, these results negate the null hypothesis that occlusal equilibration has no effect on CDH. Additional clinical studies are suggested to corroborate these findings and to evaluate the relationship of CDH upon the health of the total masticatory system.

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