The Relationship Between Excessive Anterior Overlap And Dental Status

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THE RELATIONSHIP BETWEEN EXCESSIVE ANTERIOR
OVERLAP AND DENTAL STATUS

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ABSTRACT
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Aim: This study was designed to analyze the third National Health and Nutrition Examination Survery (NHANES III) database to determine whether excessive overlap of the anterior teeth was related to an increase in structural dental problems.

Materials and Methods: The NHANES III database was procured from the National Center for Healthcare Statistics for the purpose of investigating whether a relationship exists between tooth condition and occlusal characteristics of horizontal and vertical overlap. The sample population was limited to those aged 18-50 to incorporate those people who had both Restoration and Tooth Condition Scores and Occlusal Characteristics. The subject set was statistically analyzed using SAS v9.2 software to demonstrate any possible relationships.

Results: Our study reaffirmed the characteristics of naturally occurring occlusions. It was shown that 59.5% of the population has a horizontal overlap between 1-3mm, 56% of the population has a vertical overlap of 1-3mm, and 4.6% of the population has an open bite. It was also suggested that the majority of the population has a sound dentition with 83.61% of all teeth recorded being sound. The anterior relationship to tooth condition score comparison was also made for individual at-risk teeth. Teeth numbers 9 (maxillary left central incisor), 12 (maxillary left first premolar), and 14 (maxillary left first molar) were analyzed. The vast majority of teeth were again found to be sound, approximately 85% (tooth 9), 75% (tooth 12), and 71% (tooth 14). No association was found between overlap and tooth condition scores for any individual tooth.

Conclusions: According to the NHANES III data file documentation currently available through the Center for Disease Control and Prevention, no relationship exists between the degree of anterior overlap and tooth condition. Due to large differences in the raw data found within this database when compared to previously published data, the reliability of the NHANES III database can be called into question.

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CHAPTER I

INTRODUCTION

Over the course of the last half century dentistry has made major advances in its ability to treat caries and periodontal disease. The discovery of the bacterial etiology of these diseases allows treatment to be directed at the cause of the problem rather than at its effect. Unfortunately, other dental problems do not present with such clear cause and effect relationships. Most common among these is the issue of dental malocclusion. Malocclusion is defined by the glossary of prosthodontic terms as, "any deviation from a physiologically acceptable contact between the opposing dental arches."[1] The profession's ability to define 'physiologically acceptable contact' is handicapped by the lack of evidence clarifying the consequences of not having this very thing.[2] The true etiologies of caries and periodontitis were in part able to be determined because researchers could visualize the presence or absence of the disease due to destruction of dental or periodontal tissue. Consequences of malocclusion on the other hand may be slow to develop or only seen at certain thresholds of deviation from normal. In an attempt to address this situation we felt it worthy to consider whether having malocclusion or certain specific malocclusion traits do in fact predispose an individual to dental problems.

CHAPTER II

REVIEW OF LITERATURE

Recording malocclusion

As the dental profession became more sophisticated in its approach to solving complex biologic and physiologic problems, attempts were made to assess and grade malocclusions. Much focus was given to this topic as dentistry attempted to determine to what extent malocclusion was a problem within the population. Several reviews summarize the numerous attempts and goals of the measuring systems used for these purposes.[3,4] The most popular system of diagnosing malocclusion also happens to be among the oldest.[5] Angle's classification is based on the positional relationship of the permanent first molars and was published in 1899. Normal occlusion, according to Angle is one where the maxillary and mandibular molars are related so that the mesiobuccal cusp of the maxillary molar occludes in the buccal groove of the mandibular molar and the teeth are arranged in a smoothly curving line of occlusion. He argues a class I malocclusion has a normal molar relationship, with the malocclusion usually confined to the anterior teeth. Class II malocclusions describe retrusion of the mandible, with distal occlusion of the mandibular teeth. He further breaks down Class II malocclusions into two divisions. Division 1 describes a narrow maxilla with lengthened and prominent maxillary incisors and lack of nasal and lip function. Division 2 encompasses people with a slight narrowing of the maxilla, crowding, overlapping, lingual inclination of the maxillary incisors, and normal lip and nasal function. Finally, class III malocclusions show a protrusion of the mandible, with mesial occlusion of the

mandibular teeth and lingually inclined mandibular incisors and cuspids. Graber further

specified Angle's classifications and described common findings for each of the

classifications.[6] Prominent among the common findings discussed were the overlap

relationships of the incisor teeth and how they differed in each class. Due to its

popularity, several negative aspects of this classification system have been frequently

discussed.[7,8] These included the lack of quantitative measurement, lack of three

dimensional analyses, and ignorance of facial and skeletal features. Alternative

diagnostic systems have been presented.[9-11] Some have gained significant popularity, as

in the case of the incisor classification first described by Ballard and Wayman.[12] This

system is based on the positional relationship of the anterior rather than posterior teeth.

As highlighted by Tang, Angle proposed his classification as a prescription for treatment

and not as a means to index malocclusion.[3] This was pointed out early by D'Alise in his

defense of the system; "the classification is useful to the orthodontist, and especially the

beginner, because it enables him to form a sound opinion on what has to be done."[13]

Authors aware of these limitations proposed alternative assessment indices for

the purpose of large scale epidemiologic or treatment need investigations of

malocclusion.[14-21] Draker discussed the alternative purpose of such an index and how it

should measure the degree of handicap and avoid classifying malocclusion.[22] In this

discussion he quotes Hagan who said, "a large percentage of persons with occlusions

departing from 'normal' that the clinical orthodontist views as needing treatment are not

public health problems."[23] In its attempt to determine the level of handicap Draker's

HLD index observes a total of 9 criteria.[22] Among these are; severe traumatic

deformities, cleft palate, vertical overlap, horizontal overlap, and openbite the later three

of which are recorded in millimeters. In 1967 Grainger described the earlier development and use of a method of assessing the severity of the most common types of malocclusion.[24] He then provided a means for ranking individuals according to their severity of malocclusion. Grainger classified ideal occlusion as; "the norm and the point from which variation is measured."[24] In addition Grainger described several situations as indicative of a handicap. These prerequisites included the following: unacceptable esthetics, significant reduction in the masticatory function, a traumatic occlusion which predisposes to tissue destruction in the form of periodontal disease or caries, speech impairment, lack of stability so that the present occlusion will not be maintainable over a reasonable period of time, and traumatic defects such as cleft palate, pathological or surgical injuries. The resulting assessment tool was Grainger's Orthodontic Treatment Priority index (TPI).[24] Grainger's TPI has 11 weighted and defined measurements, and seven malocclusion syndromes. It includes for example, horizontal overlap as a measurement in millimeters. Vertical overlap was rated according to five scores of increasing handicap rather than with a simple millimeter measurement. For the purpose of his calculations a normal horizontal overlap was considered 2 millimeters and was one-third for vertical overlap. Several epidemiologic surveys have used Grainger's TPI as a basis for assessing malocclusion.[25-27]

Summer's occlusal index (OI) was formulated in part using the TPI and also evaluated overlap of the anterior teeth as a key component of the calculation.[28] Salzmann in 1968 also had vertical and horizontal overlap as a weighted measurement in his handicapping malocclusion assessment to establish treatment priority.[29] He considered incisor contact against mucosal tissue a treatment need criteria. This system

is called the Handicapping Malocclusion Assessment Record (HMAR) and was accepted by the Board of directors of the American Association of Orthodontists and two councils of the American Dental Association. Indices have also been created to look at specific occlusal conditions such as anterior crowding. Little in particular felt that mandibular anterior crowding was a precursor to maxillary crowding and deepening of the vertical overlap.[30] As insurance companies and public health programs gained prominence, multiple national-based assessment tools were developed.[31-33] In addition, due to the influence of malocclusion on facial esthetics, systems were developed to assess malocclusion or orthodontic treatment need from the perspective of appearance.[34-37]

Whatever the purpose of these various assessments, they almost universally measure the overlap of the anterior teeth as part of the method. **Table 1** lists some of the more popular epidemiologic and diagnostic systems and how they record horizontal and vertical overlap of the anterior teeth.

Table 1: Data classification for anterior overlap* by selected authors

REFERENCE	HORIZONTAL OVERLAP	VERTICAL OVERLAP
Fisk	Millimeters	Millimeters
Bjork	Grade 1 = 6-9mm Grade 2 = 9mm & >	Grade 1 = 5-7mm Grade 2 = 7mm & >
Draker (HDI)	Millimeters	Millimeters
Grainger (TPI)	Millimeters	Score 1 = Edge-edge to 1/3 Score 2 = Middle 1/3 of less protruded tooth Score 3 = >2/3 Score 4 = Past lower gingival margin Score 5 = Biting on soft tissue
Poulton (OFI)	0 = 0-1.5mm 1 = 1.5-3mm 2 = 3mm & >	0 = Incisal 1/3 of mandibular incisors is covered 1 = Middle 1/3 2 = Gingival 1/3

Summers (OI)	Same as TPI	Same as TPI
Salzmann (HMAR)	Scored positive if palatal tissue contact	Scored positive if palatal or gingival tissue contact
WHO	0 = Edge-edge to <6mm 1 = 6mm <9mm 2 = 9mm & >	0 = Edge-edge to <2/3 1 = 2/3 to 1 2 = 1 & >
Kinaan	Millimeters	Millimeters

* Note: Openbite and mandibular overlap generally recorded using same but opposite indicators

Many of these indices preferred quantitative data and choose to record the overlap in millimeters. Multiple indices did not differentiate a specific millimeter measurement at which the overlap would be considered more severe. Of the ones that did, 6mm of horizontal overlap was considered to be moderate in nature and 9mm or more to be severe. While it was less common to make this differentiation for vertical overlap, Bjork considered 5-7mm to be moderate and 7mm or more to be severe in nature. Those studies looking more directly at treatment need tended to record anterior overlap in a qualitative manner. A frequent indicator of treatment need was considered incisal edge to soft tissue contact, either palatal or gingival.[24,28] Dividing the vertical overlap into thirds and considering any overlap greater than two-thirds indicative of treatment need was also common. Considering the differing goals, regions, populations, and creators of these systems it is interesting that there appears to be significant agreement on the points at which overlap is significant. However, since it was not their expressed goal, these articles did not address any specific evidence for why that particular amount of overlap would create dental problems and thus require treatment.

Defining natural occlusion

These systems have been very helpful in collecting information on malocclusions. For results to be meaningful one must compare the information to a standard or natural occlusion. The question of what constitutes natural occlusion is to a certain extent, still under debate. The theories of what defines natural occlusion are based on tooth contacts. The literature has given to us four separate concepts of occlusion: balanced occlusion,[38-47] group function,[48-50] cuspid rise,[51] and mutual protection.[52,53] While these concepts have differences; they are more alike than initially envisioned. All accept the fact that when the jaw closes, the vast majority of the posterior teeth make contact in habitual closure. Most accept the observation that in habitual closure the vertical stop contacts of anterior teeth tend to be lighter than the posterior vertical stop contacts.

The differences among the competing theories of occlusion are the accepted tooth contacts that occur during eccentric movements. During eccentric movements in balanced occlusion; multiple teeth contact simultaneously on the working side and the balancing side. During eccentric movements in group function; multiple teeth contact simultaneously on the working side while no contact occurs on the balancing side. During eccentric movements in cuspid rise there is exclusive contact between the working side cuspids. No contact occurs on the balancing side. During lateral excursive movements in mutual protection there is exclusive contact between the working side cuspids. No contact occurs on the balancing side. During a protrusive eccentric movement, there is exclusive contact between the incisors and no contact of posterior teeth.

The above differences within the competing theories on eccentric tooth contacts initially seem dramatic; until the reader recalls the words of Shaw. In 1924 he stated that

in moving away from "centric" the area of possible simultaneous contact is progressively decreased and tends toward the minimum while in the most lateral position, occlusal contact is restricted to the opposing canines.[54] Shaw's 1924 observation is stunningly accurate and demonstrates that the key to summarizing observations concerning eccentric tooth contacts is timing. Hanau and Beyron made very similar statements to Shaw's regarding the timing of occlusal contacts.[38,48-50] What contacts during which part of the eccentric stroke requires careful and meticulous observation. It seems likely that all of our historic writers were accurate to a point.

If the timing of occlusal contacts is the key to observing occlusions then perhaps the overlap of the anterior teeth is the primary factor in diagnosing a malocclusion? As mentioned, those recording malocclusions almost universally utilized this factor in their assessments. Likewise, the debate over natural occlusions differentiated the four concepts primarily by the degree of anterior guidance. Anterior guidance is defined as the influence of the contacting surfaces of anterior teeth on tooth limiting mandibular movement.[1] The degree or timing of this anterior guidance is the result of various amounts of overlap. Therefore, the overlap of the anterior teeth may be the key component in a malocclusion.   Unfortunately the debate between the four concepts has not delivered a suggested or standardized amount of overlap of the anterior teeth.

Authors have dealt with this lack of clear data for overlap in differing ways. Grainger's TPI for example defined normal overlap as the average findings from the population tested.[24] He then utilized his index to define how far from average each individual deviated. One issue for the average restorative dentist to consider is that most all of the malocclusion assessments and findings are from children or youthful

populations. If information is collected on adult populations it tends to be from much smaller samples or from populations without the influence of dental disease. With that in mind when one wishes to consider the normal adult occlusion a more appropriate source of evidence may be from studies evaluating details of naturally occurring adult dentitions.

These studies are exceedingly rare and those of greatest significance were published four decades ago. First among these was Beyron, who in 1958 studied the occlusion of 46 adolescent and adult Australian aborigines.[50] Examination included clinical evaluation, examination of articulated dental casts and cinematography. He found naturally occurring group function within this population. In addition, the overlap dimensions decreased as the subjects age increased. The over 45 age group had zero millimeters of vertical overlap and three millimeters of horizontal overlap. With this reduction in overlap it makes sense that a group function type of occlusion was found.[50] Beyron also published findings of occlusal changes over time in 44 Europeans.[48] After an observation period of eight to twelve years he concluded that "occlusal changes consist of attrition, tipping, and migration of teeth." He believed these changes develop in accordance with the individual pattern of gliding movements with the teeth in contact.[48] He also suggests that steep guidance with few tooth contact areas tend to be avoided while flat movement paths with several teeth in contact are preferred. Scaife and Holt in 1969 studied the natural occurrence of cuspid guidance.[55] Of those participants that were Class II; 67% had bilateral cuspid guidance during lateral excursive movements. Class I patients had bilateral cuspid guidance 56% of the time while Class III only had the same 13% of the time. No detailed analysis of the overlap of the anterior teeth was given.

In 1974 Bohl and Waliszewski used methods similar to Beyron to compile data on the occlusions of 100 subjects displaying bilateral Angle Class I occlusions.[56,57] The same authors also assessed 25 angle Class II and 10 angle class III subjects.[56,57] These subjects had natural dentitions with no missing teeth excluding third molars, no crowns or restorations replacing a cusp, no previous occlusal adjustment of their teeth and no previous orthodontic treatment. Each tooth was analyzed for contact in centric occlusion, protrusive mandibular movement, working mandibular movement, and balancing mandibular movement. This project factually demonstrated many of the static and functional aspects of naturally occurring occlusions as they exist (**Figures 1-3**).

Figure 1: CO Contacts
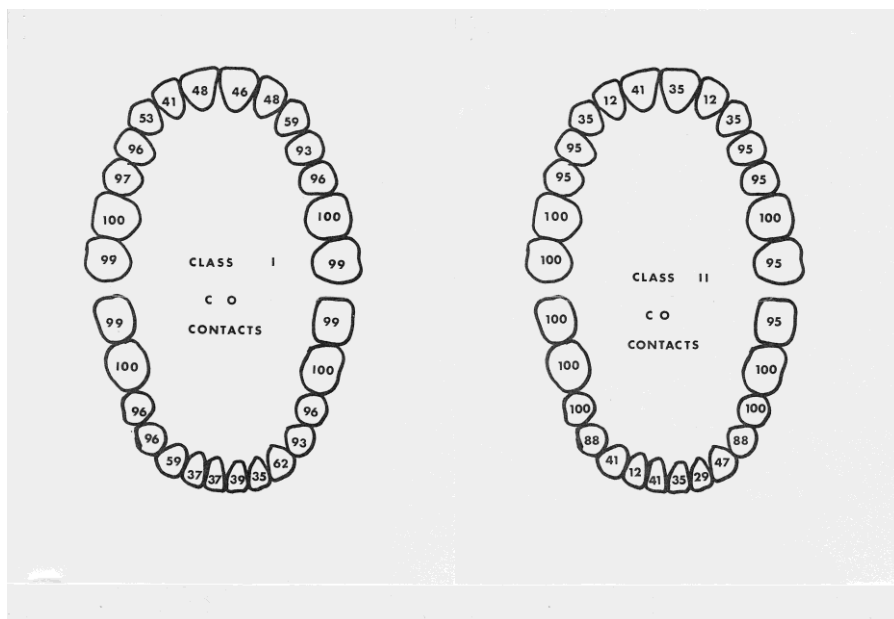
Figure 2: Working Contacts
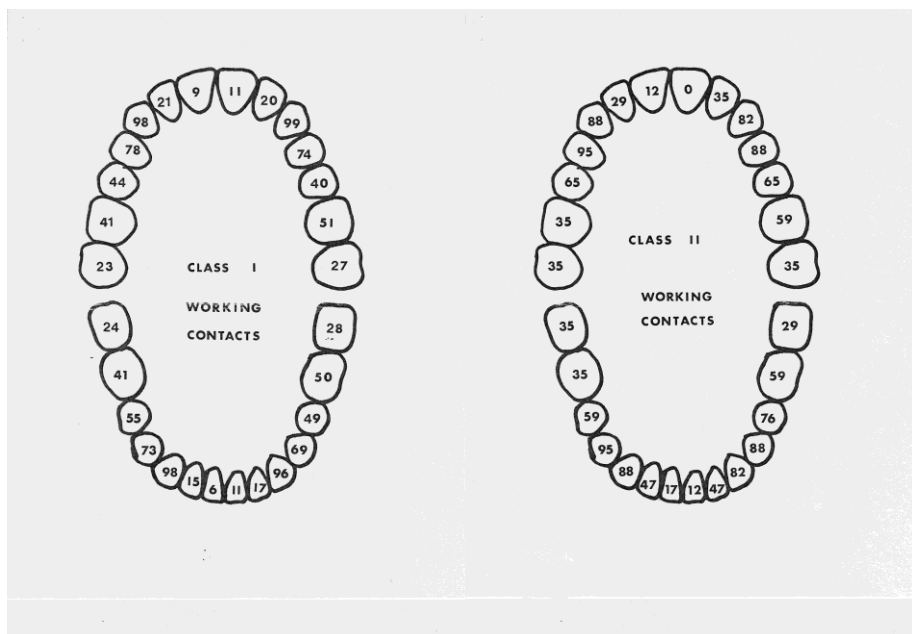
Figure 3: Balancing Contacts
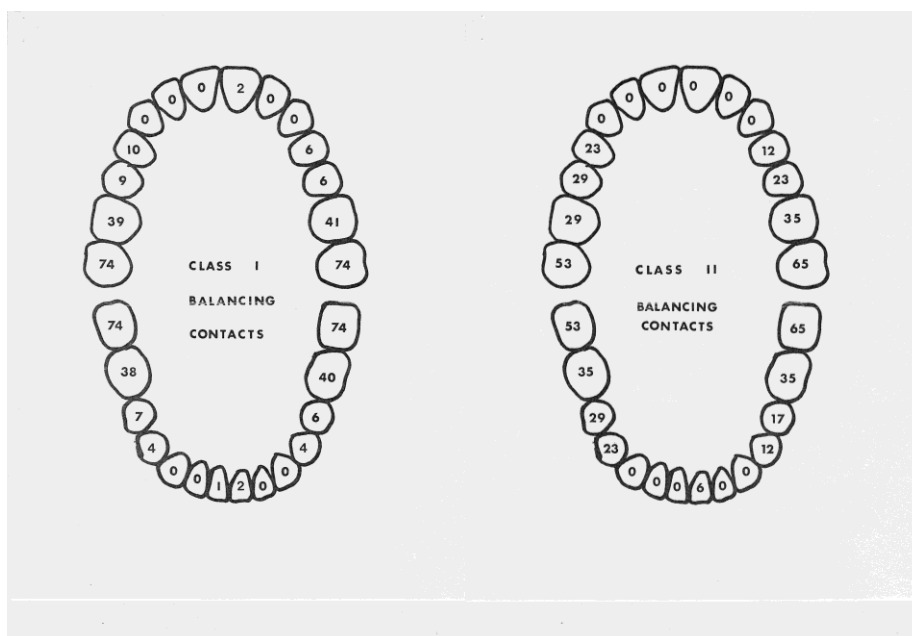
It also highlighted the importance of timing as it relates to eccentric contacts.

More recently Panek et. al. published findings of a dynamic occlusion analysis in 2008.[58] Patients with single unit restorations and single missing posterior or anterior teeth were included. Occlusal contacts were analyzed using thin articulating paper up to

2 millimeters of lateral stroke from centric occlusion and up to edge-edge during protrusion. Similar to the findings of Beyron, an increased percentage of group function occlusion was found in the older populations. Combined together these studies give a baseline for what is a naturally occurring dentition.

Demographics of Malocclusion

Despite deficiencies the existing knowledge of occlusion has allowed investigations to analyze the population for major deviations. While debate continues for what the exact cut-off points are for certain criteria there is often agreement regarding gross anatomic outliers. These are considered malocclusions. The vast majority of investigations into the prevalence of malocclusions within the population reviewed children or teens.[9,14,17,21,24,27] Several reasons exist as to why this population would not demonstrate valuable information in regards to the effects of malocclusion. First, young patients will likely demonstrate occlusal changes due to continued facial growth. While classifications or general occlusal traits are likely to be maintained, there can be significant changes in specific criteria such as crowding. In addition, delayed passive eruption or dentoalveolar growth can continue after growth is considered complete.[59,60] Second, the damaging effects of certain occlusal traits may take several years to develop. While traumatic injury is instantaneous, attrition or wear of teeth is likely to take several years. Dental disease processes compound the difficulties in finding a relationship since missing, deformed, or mobile teeth can contribute to the development of a malocclusion. For these reasons investigating a fairly disease free adult population is more appropriate when attempting to determine the consequences of malocclusion.

Few studies exist that look specifically at the prevalence or type of adult

malocclusions. Several projects from other countries demonstrate a high incidence of

malocclusion.[61-64] Angle's Class II malocclusion for example ranged in prevalence from

20-25% of the populations surveyed. Ingervall found 10% of Swedish men with extreme

Maxillary horizontal overlap issues and 16% with a deep vertical overlap.[61]

The primary source of this type of information in the United States comes from

two large national surveys. The first was the Health and Nutrition Exam Survey

(HANES I) conducted for adults from 1971-1974.[26] The second was the National Health

and Nutrition Exam Survey (NHANES III) also conducted on adults from the years 1988-

1991.[25] Occlusal data was recorded for subjects 8-50 years of age. Adults over the age

of 50 did not receive the orthodontic portion of the examination in order to save time.

Five categories were recorded for over 4,000 patients within the 18-50 year old adult age

range, with the exact number for each parameter dependent upon missing teeth or other

recording issues. The five categories included; incisor alignment (using the irregularity

index by Little[30]), presence of maxillary midline diastema, presence of cross-bite,

horizontal overlap, and vertical overlap. The average horizontal overlap for the 18-50

year old group was 2.9 millimeters while the average vertical overlap was 2.8

millimeters. 18.6% of the 18-50 year old group responded that they previously had

orthodontic treatment. A summary of the presented raw data can be found in **Table 2**.[25]

Table 2: Prevalence and Distribution of Selected Occlusal Characteristics among US
persons
ages 18-50, 1988-1991[26]

	Incisor Alignment Score[31]	Maxillary Diastema (Mean Percentage	Prevalence of Posterior Crossbite in Relation to	Mean Horizontal Overlap	Mean Vertical Overlap

		Present)	Maxillary Alignment Group		
Total Average	Upper = 2.6mm Lower = 2.9mm	9.9%	Excellent (0) = 8.5% Good (1-2mm) = 8.6% Fair (3-5mm) = 12.5% Poor (+6mm) = 10.1%	2.9mm	2.8mm

Looking at the averages for this large survey one notices that the averages for horizontal and vertical overlap are beyond what orthodontic authorities consider normal. According to Proffit, horizontal overlap of 1-2mm is considered normal.[2] Proffit also correlates the horizontal dental relationship to Angle's classification of malocclusion by quantifying 3 or more millimeters of horizontal maxillary anterior overlap as a dental class II patient, and zero or more millimeters of horizontal mandibular overlap as a dental class III patient.[2] Consequently, Proffit's analysis of the NHANES III data found that 51.1% of adults were considered Class II due to a horizontal overlap greater than 3mm in the anterior.[65] 47.7% also had vertical overlap in the anterior that was considered a 'deep bite' at over 3mm. In contrast, 5.8% of the population was considered Class III due to a horizontal mandibular overlap of zero or greater.[65]

These higher percentages of Class II patients are concerning if one believes that they put that patient at risk for dental problems. Higher percentages of Class II patients have also been noted within the edentulous population.[66] While this is likely due to the use of centric relation as a reference position rather than maximal intercuspal position, it is possible that certain Class II patients experience higher rates of tooth loss. Within the prosthodontic community there is belief that these occlusions do in fact have significant

biologic cost in the form of wear, fracture, and reduced longevity of restorations.[67-72]

Perhaps this is why the authors feel that a larger percentage of their patient practice base

is Class II when compared to the average general dentist. This in turn implies that

patients with these malocclusions and perhaps with malocclusions in general have

significant dental consequences.

Consequences of Malocclusion

The consequences that may result from protruding, irregular, or maloccluded teeth

can be divided into three general areas: (1) poor dental and facial esthetics resulting in

social and/or psychological consequences, (2) difficulties with oral function, and (3)

greater susceptibility to structural dental problems. Extensive time and effort is expended

by the orthodontic community and patients in an attempt to prevent these problems.

Proffit estimates that of the 1.2 million individuals in the present population with

problems severe enough to require surgical-orthodontic intervention, approximately 58%

of them have class II malocclusions and another approximately 37% have issues related

to class II and class III groups.[73] Thresholds given for surgical therapy include severe

malocclusion, 10mm horizontal overlap, 5mm reverse overlap, severe crowding, and

severe facial asymmetry among other findings. All of these would be considered high

level orthodontic treatment need thresholds. If treatment need is perceived to be this high

one would assume that patients in this category who do not receive treatment will

experience some sort of negative dental outcome. Proffit and other authors involved with

treatment priority indices also discuss lower level need thresholds. With millions of

American's in active orthodontic treatment every year there are motivating factors for the

public, even for less complex malocclusions. Since it is perhaps the most common

motivating consequence of malocclusion, especially at the lower threshold levels,

esthetics will be considered first.

Treatment of malocclusion – Esthetics

Gross morphologic alterations to the face and smile are common with significant

skeletal malocclusions. The general population easily notices these gross esthetic

discrepancies,[74-78] but will also notice relatively minor esthetic discrepancies on a fairly

routine basis.[79-84] These studies demonstrate the fact that the general population not only

notices abnormalities in dental appearance but that they also rate these abnormalities as

less appealing. Perhaps this is why dental and/or facial appearance is a primary factor in

patients seeking dental or orthodontic care. In prosthodontics, the appearance of the

prosthesis is frequently considered the most important property of the teeth.[85,86] Likewise

for orthodontics, the lower ratings for certain parameters demonstrate motivation on the

patients' part to seek esthetic corrections.

The abnormalities researched are frequently directly related to specific types of

malocclusions. When looking at 8 clinical indices Katz found Angle classification to be

the best predictor of self-satisfaction.[74] Among specific attributes, large horizontal

overlap of the anterior teeth has been found to be statistically related to a less appealing

dentofacial appearance or need for treatment.[75,78] While one research project did not find

a correlation between vertical overlap of the anterior teeth and self-image in regards to

esthetics,[87] another found significant vertical overlap to be indicative of the need for early

orthodontic treatment.[78] Ker recently determined thresholds for acceptability of vertical

overlap.[84] Using computerized images with standard alterations in occlusal or esthetic parameters, lay-person respondents were asked to rate the most ideal image in the sequence and the first image they felt was unattractive. In regards to vertical overlap, the ideal value was found to be 2mm. The maximum tolerable amount of vertical overlap was 5.7mm and the minimum tolerable value was 0.4mm.

Authors frequently discuss the positive psychosocial benefits of physical attractiveness and dental attractiveness in particular.[88-90] A pleasing dental and therefore facial appearance outcome has been shown to have a positive influence on prosthodontic treatment success rates.[91-94] This may be due in part to the fact that prosthetic therapy tends to be comprehensive in nature thereby dealing with the interrelated esthetic and functional issues inherent with various malocclusions.[95] Dental treatment has also been shown to have a positive effect on patients' self-esteem or self-image.[92,96-98] It is not a surprise then that a patients' self-image is statistically significantly correlated to various malocclusion indices or traits.[24,87,99,100]

Dentofacial esthetics also influences the perceptions of the viewer.[101] Various malocclusions, crowding for example, have been shown to elicit negative responses from viewers.[102,103] The psychological interaction of dentofacial esthetics is therefore three fold; the patient, the dentist, and those that the patient will interact with. This implies then three influences for driving the patient to choose to treat the malocclusion. Their desire for improved appearance, the dentists desire to improve the occlusion, and peer-pressure from viewers who make judgments based on dentofacial abnormalities. Albino and colleagues extensive research on the topic concluded; "dental-facial esthetic and self-perceptions are extremely important factors in most decisions to obtain orthodontic

treatment."[104] Taken together, correction of malocclusion has direct and discernible esthetic and therefore psychological benefits.

Treatment of malocclusion – Function

It is possible that malocclusion could complicate an individual's oral function and is therefore a second possible motivating factor for treatment. Presentation includes reduced ability to chew or increased episodes of facial pain. Research into the effects of malocclusion on masticatory efficiency has been inconclusive.[105-107] There are few instances of specific occlusal variables demonstrating a cause-effect relationship on reduced function. Akeel summarizes this situation as corroborating a previous observation that there is no correlation between the subjective experience of masticatory performance and the objective masticatory efficiency.[106] A search for issues related specifically to overlap of the anterior teeth yielded little information. The higher masticatory efficiency with smaller horizontal overlap relationship found by Henrikson was in 11-15 year old girls.[108] Likewise, the complaints with chewing in extreme horizontal overlap cases in Helm's research were found thru questionnaires.[109] Little guidance exists as to the effect of particular occlusal variables on chewing function.

It has long been theorized that malocclusion could influence Temporomandibular disorders.[110] An extensive volume of literature on this topic exists. When vertical and horizontal overlap is considered, there is disagreement. In a retrospective review of adolescents that were now between 28-34 years old Helm used questionnaires to determine if malocclusion was related to functional disorders.[109] He found no increased risk of dysfunction with increased vertical or horizontal overlaps. Al-Hadi found a sharp

increase in the percentage of TMD symptoms when the horizontal overlap was 6mm of greater.[111] They used non-specific TMD diagnoses of abnormal joint sounds, muscle tenderness, joint tenderness, or a combination of the three. Kahn also found an increase prevalence of TMD and disk displacement when the horizontal overlap was 4mm or more when compared to an asymptomatic group without disk displacement.[112] Using a questionnaire for part of their data, Celic found symptomatic patients had a statistically significantly higher prevalence of vertical and horizontal overlaps over 5mm.[113]

As statistical methods and diagnosis for TMD research has become more specific there is a growing body of quality evidence that suggests occlusal factors are not significantly associated with TMD. Among studies specifically assessing overlap Pullinger and colleagues found TMJ tenderness and sounds were not associated with vertical overlap relationships.[114] An analysis of 655 adults and 1367 seniors in Germany looked specifically at overlap dimensions and their relationship to self-reported TMD symptoms.[115] No association was found. As with all of the cited projects, the low percentage of cases in the extreme ranges reduced confidence in the results when considering those far beyond the normal range. Soon after this, a separate research group in Italy published a series of studies analyzing the relative risk of occlusal variables for several types of Temporomandibular disorders.[116,117] Using the RDC/TMD diagnosis system this group reviewed several types of axis I patients. Landi found no association between vertical or horizontal overlap and myofacial pain (axis I group I).[116] Chiappe, also of the Italy group, found no statistically significant association between overlap measurements and disk displacements (Axis I group IIa).[117] While every measurement individually had a higher prevalence of TMD than in the control group, when the

multiple regression analysis was done only weak associations for three non-overlap variables were found. Fantoni modified the previous criteria and method of this group to publish on an all-female group with only muscle disorders (Axis I group I).[118] Despite recording 13 instead of 8 occlusal variables no statistically significant associations were found. In particular, no increased risk of myofacial pain was found with overlaps greater than 4 millimeters.[118]

A systematic review of malocclusion and TMD in adults highlights the weak nature of the vast majority of the published research.[119] Out of 74 articles deemed worthy of analysis only 22 were utilized in the review and a mere 4 papers met the inclusion criteria for the analysis. This was out of an original pool of 349 papers. While occlusal variables are no longer considered the lone or even primary etiologic factor for TMD they are still considered one of the multiple cofactors to be considered. When overlap is considered individually in an adult population there does not appear to be a correlation.[109,114-118,120] However, Pullinger states that single variables have more limited predictive value for multifactorial problems because they cannot exist in isolation.[120] In addition he says that "although the association of occlusion is definitely not zero, it should not be overstated." This fits well with John's analysis of the same issue; "Wide ranges of overbite and overjet are compatible with normal function of masticatory muscles and the TMJ as perceived by the individual."[115] Many therefore agree with John that "attempting to prevent TMD by creating more normal values of overbite or overjet with dental treatment is not supported by this study."[115]

The fact that the wide range of patient adaptability mentioned by John exists may in part be explained by the type of dysfunction these overlaps may influence. In regards

to mandibular function it is possible that the traditional criteria of pain, joint sounds, and muscle tenderness are not the only symptoms of dysfunction. Several authors have discussed mandibular dysfunction in terms of the damage it can cause to the dentition itself. This type of dysfunction may have symptoms of increased rates of attrition, periodontal concerns, or fracture. In some examples this type of dysfunction has been described as traumatic occlusion.[121-123] If muscle forces and mandibular movement patterns are not in harmony with the hard tissue determinants of occlusion (namely the teeth), excessive and more frequent contact of the opposing teeth may result.[124] This philosophy explains how it is the relationship between muscle function and occlusion rather than either individually, that causes dysfunction. Certain patients with extreme overlaps may therefore function without physiologic or physical disturbances. These patients likely have muscle patterns that are not restricted by their unusual relationships.[125] In other patients a fairly minor overlap relationship may interfere with normal muscle function and create problems.[126,127] Traditionally this philosophy of tooth restricted mandibular movement has been described as long-centric or freedom in centric.[44,128] When searching for the definition of long centric in the glossary of prosthodontic terms one is referred to the term intercuspal contract area. This is defined as the range of tooth contacts in maximum intercuspation.[1] This implies that a range of unrestricted movement exists for maximum intercuspal position in certain occlusions. More recently the terms restricted envelop of motion or function have been used to describe a situation where tooth contacts interfere with an individual's mandibular movement pattern.[126,129,130] While specific maxillomandibular relationships have been implicated as risks, it is more frequent that excessive anterior guidance is the responsible

factor for restricted mandibular movement. Increased vertical overlap of the anterior

teeth will necessarily increase the anterior guidance. This would therefore increase the

possibility of interference with that particular patients envelop of motion. The types of

structural dental problems that result are not uniform or clearly understood.

Treatment of malocclusion – Structural dental problems

Trauma

There has been extensive epidemiologic research into trauma and its relationship

to certain aspects of occlusion. Multiple studies have shown that an increased horizontal

overlap is a risk factor for maxillary incisor trauma.[131-139] Most of these looked at school

aged children and generally found an increasing risk with increasing overlap. Nearly all

classified 3 millimeters of horizontal overlap as the upper end of normal and over 6mm

as extreme. Ghose also found that the degree of trauma was worse when the overlap was

greater than 6mm.[136] A strong relationship between trauma and the amount of lip

protection for the teeth was found by some indicated multiple risk factors.[137] For those

that specifically looked at vertical overlap measurements no associations were found with

dental trauma risk.[136,138]

More recently, Shulman and Peterson found that the odds of trauma generally

increased with age.[140] Their sample came from the third NHANES and therefore

included 13,057 subjects between the ages of 8 and 50 years old on whom occlusal

characteristics were recorded. This project is one of the few that looks at trauma

prevalence in an adult population. The association between horizontal overlap and

trauma was statistically significant beyond 3 millimeters and vertical relationships were

not related. This may encourage further research into trauma within more adult populations. This trauma has an economic and functional impact on the person. Scant research on trauma prevention by treating occlusal characteristics exists. However, a study by Koroluk investigated early treatment of horizontal overlaps greater than 7mm.[141] They concluded that early treatment may reduce trauma risk for this childhood population. It was noted that the cost to treat the overlap was greater than the cost to treat the theoretically prevented trauma. When adult populations are considered the issue of trauma is generally regarded as more of an internally rather than externally occurring event. Akerly discussed 'traumatic overlap' and how it is generally manifested through clinical signs such as; abrasion, mobility, and displacement or migration of the teeth which will be discussed further.[67]

Periodontal condition

It is currently accepted that periodontitis largely stems from various biologic, systemic, and pro-inflammatory mediators.[142] Yet, modern periodontal texts still attribute malpositioned teeth as disease risks which tend to experience occlusal trauma.[143] In the 1960s researchers began clarifying the connection between malocclusion and periodontal disease. Some of the early studies during that time period could not link malocclusion to gingivitis and/or periodontitis.[144-147] Other studies found specific associations between crowding, overlap, or other occlusal traits and inflammation or plaque accumulation.[148-152] However, the studies both for and against are often criticized for having small sample sizes, young study subject ages, and the inability to account for many of the variables in the occlusal-periodontal complex.[153]

Arguably the most thorough study looking into occlusion and periodontal disease was carried out by Arnold Geiger and Bernard Wasserman.[154-160] These authors studied the clinic population at Columbia University School of Dental and Oral Surgery, Division of Periodontics. A total of 516 subjects were evaluated to determine the health of the periodontium and the amount of gingival inflammation and periodontal destruction at every tooth in every subject. They discovered that most factors of malocclusion such as spacing, cross-bite, and mesiodistal relationships of teeth were not associated with periodontal destruction.[155-157,159,160] Anterior horizontal and vertical overlap was associated with more inflammation in the extremes of both groups. This association in the extreme malocclusion groups was found by others.[145,152] Further analysis showed that the increase in inflammation was associated with severe horizontal overlap but not severe vertical overlap.[156,158] As with many articles on this topic the number of patients in the extreme overlap groups was small and limits the power of the findings. This may help explain contradictory findings. Silness for example stated that large vertical overlaps with relatively small horizontal overlap were the most periodontally favorable cases.[147]

In 1994, Bjørnaas and Bøe compared a normal overlap group to a group with severe overlap.[161] The vertical overlap group had patients with a minimum of 6 millimeters of overlap while the horizontal overlap group had a minimum of 8 millimeters. The normal group had overlaps of between 1.5 and 4 millimeters. A statistically significant difference in distance from the CEJ to the alveolar crest was found. The mean distance in the horizontal overlap group was 1 millimeter greater than in the normal group indicating either more bone loss or a significant anatomic difference. Since this was in a group of 19 year old males this finding is concerning for long-term

periodontal health of these extreme overlap groups. So despite early conflicting research there is concern for patients with greater overlaps, horizontal in particular.

Caries

Dental caries is the result of a complex but direct etiologic relationship among bacteria, diet, and host. Despite our current understanding, other factors are sometimes considered to effect caries experience. Malocclusion traits such as horizontal and vertical overlap have been investigated as possible risk factors for dental caries. The relationship is thought to be indirect and due to challenges with oral hygiene measures related to the malpositioned teeth. Older epidemiologic research found a relationship between malocclusion and dental caries.[162-164] When the traditional research on this topic is reviewed it is frequently biased by two major issues. First, the populations studied are almost always children or adolescents.[163,167-169] Second, rarely were cofounding variables considered in the statistical analysis.[162,164,166-168] Namely, oral hygiene and fluoride exposure were generally not analyzed. One of the few studies that did account for oral hygiene found no statistically significant relationships between overlap and dental caries experience.[170]

One study population of interest was followed in a longitudinal fashion to see how malocclusion influenced caries and tooth loss.[171,172] Adolescents 13-19 years old were followed up 15 years later with questionnaires and later examinations. The authors stated that malocclusion traits did not imply an increased risk of tooth loss by the age of 30.[171] In addition, DMFS scores did not differ between groups with or without malocclusions.[172] Certain specific relationships showed findings of interest. The first

article found that extreme maxillary horizontal overlap correlated with unsatisfactory biting ability. The second article also found DFS scores were higher for maxillary incisors with increased horizontal and vertical overlap. Although not statistically significant this may imply a difference in how the anterior and posterior teeth are affected.

The lack of research on this topic complicates conclusions. Other than those mentioned the only article located that looked at adults over the age of 40 found little effect on the loss of teeth.[173] This article found that the older population averaged 1.1 millimeters less horizontal overlap and .8 millimeters less vertical overlap than the younger dentition samples. Counter-intuitively they also found that the older segment had nearly all of the vertical overlaps that were greater than 8 millimeters. These findings are complicated by the authors biased selection of the sample. Dentitions with minimal problems were analyzed in the hopes of finding "successful occlusions." Perhaps this is why the average values for overlaps are close to what is considered normal.

Knowing the etiologies for dental caries, one group of authors approached the question of an indirect relationship from the perspective of behavior.[174] They were asking if malocclusion influences the maintenance of teeth. They separated the direct biologic effects (eg. caries) from indirect effects (eg. oral hygiene). One of their primary hypotheses was that a patient's perception of their malocclusion influences their behavior in regards to their teeth. They hypothesized, "a malocclusion leading to dissatisfaction may have a negative influence on a person's dental behavior." Conversely if the patient perceives that they have quality teeth they would be more likely to take care of them.

Interestingly this hypothesis was supported by their findings. When particulars were evaluated, horizontal overlap was statistically significant with vertical overlap somewhat less so. If this is the case the benefits of occlusal correction may be more psychological than biologic.

Attrition

Among the structural dental problems that have been implicated with malocclusions, attrition has received increasing attention over the past decade. Attrition is the act of wearing or grinding down the contacting surfaces of the teeth by friction.[1] This must be separated from abrasion or erosion as the term 'wear' is often used without giving consideration to its multifactorial etiology.[175-177] It has been clinically estimated that enamel is lost at a rate of 18 micrometers for premolars and 30 micrometers for molars per year.[178] If consistent it would therefore take 33 years for a molar to wear one millimeter. Multiple authors concur that tooth structure is lost over time.[179-184] In addition, the anterior teeth appear to be affected more frequently and to a greater extent than the posterior teeth.[179,183,185-187] One likely explanation for this difference is occlusal.

Depending on the relationship of the teeth, certain patients may experience a greater frequency and or intensity of tooth contact during mandibular movements. In particular there has been consistent discussion for some time of whether Class II malocclusions are at greater risk for attrition.[125,188] Once research was undertaken on the topic several authors failed to find a consistent relationship between several types of malocclusion and wear.[183,189-193] These and other studies with similar findings are on adolescent populations, often look at non-specific occlusal features, or are not

longitudinal in nature. The changing nature of these young occlusions, lack of time to develop the slow process of measurable wear, and failure to have a time dependent comparison reduces the validity of their findings. In addition, the rare nature of the occlusions which are hypothesized to be the most at risk for wear frequently complicates statistical analysis. Seligman for example only had data on four Class II Division II patients yet is commonly referenced as evidence of these malocclusions not being at risk.[189]

More recent research has tried to address these shortcomings. Multiple authors have concluded that increased vertical overlap of the anterior teeth will result in increased prevalence and rate of attrition.[181,182,194] Ritchard published research from a clinical orthodontic practice in direct response to Seligman's findings.[181] Only attrition of the mandibular anterior teeth was recorded. The attrition score increased as the vertical overlap increased. He concluded that this evidence supports clinical observations and supports the provision of orthodontic correction of excessive vertical overlap. Soon after, Silness published longitudinal observations of wear in non-orthodontically treated patients.[182] 51 patients had casts made in 1973 and then again in 1985 all the while being maintained in a school or private practice based setting of one of the authors. There was a statistically significant association between wear of the maxillary and mandibular central incisors and vertical overlap. Patients with deep vertical overlaps in 1973 showed the most severe wear in 1985. Likewise, small vertical overlaps in 1973 showed minor wear in 1985. A third longitudinal follow-up by Carlsson found that Class II malocclusions increased the odds ratio for tooth wear by a factor of 7.3.[194] This 20 year follow-up also found that those with more extensive anterior tooth wear at age 35 had a

greater horizontal overlap than other subjects at age 15. These authors hypothesized that patients "unconsciously protrude the mandible to improve the profile of the face."[194] Similar hypotheses have been made by other authors, in particular those discussing the traditional concept of "long-centric."[125,182]

The idea of different tooth contact patterns dictating different wear patterns was recently investigated in regards to Class II malocclusions.[193,195] Despite using a very young population between 13 and 14 years old interesting differences were seen between untreated Class II division I and Class II division II subjects. The Class II division I patients were found to have less wear in the anterior compared to normal occlusions.[193] The authors hypothesized this was due to the larger horizontal overlap discluding the teeth less, in essence reduced anterior guidance compared to normal Class I occlusions. In contrast to this they found Class II division II subjects had greater wear on the labial surfaces of the mandibular incisors than the normal occlusion group.[195] They hypothesized this was due to the reduced amount of horizontal overlap and therefore the increased amount of anterior guidance that results. These studies are in agreement with the longitudinal studies mentioned earlier and demonstrate that distinct differences in occlusal relationships may influence wear patterns.

Treatment implications

With these findings in mind several unique studies involving treatment outcomes are informative. Knight and colleagues at the University of Washington published a longitudinal tooth wear analysis of orthodontically treated patients.[196] Comparing pretreatment casts to those obtained at least ten years after completion of treatment no

association was found between overlap and wear. As an example, the vertical overlap was reduced from an average 4.2 to 2.9 millimeters in the males. No patient had an overlap greater than 6.4 millimeters. Perhaps this is why none of the adult subjects had a wear score of 3 or greater. The authors discuss bruxism as the primary remaining etiologic factor for the small amount of wear observed in this orthodontically corrected population.

A rare look into longer term restorative issues with overlap was given by Berge and Silness.[197] 176 full coverage crowns with resin facings on canine teeth were evaluated either at 1, 3, 6, or 9 years after placement. It was found that the vertical overlap to horizontal overlap ratio was statistically significantly correlated to the degree of wear on the facings. When the ratio was ≥1.21 (typical of a Class II division II malocclusion) 61% of the teeth had wear scores of 3 or 4. When the ratio was ≤ .8 (typical of a Class II division I malocclusion with large horizontal overlap) only 29.6% of the teeth had wear scores of 3 or 4. The authors stated that there "was more pronounced wear with high VO/HO ratio."[197] This finding is in agreement with the previously mentioned authors that found vertical overlap to be more detrimental to wear than horizontal overlap. In addition, wear of the mandibular facings was more pronounced than the maxillary which agrees with the functional hypotheses being proposed to explain this wear.

Carlsson published a unique look at a group of patients that have already been affected by significant wear.[198] 18 patients with significant wear reaching into the dentin were selected, photographed, and had casts of the teeth made 6-10 years previously. The casts and photographs were then compared. A comparison group of 12 patients with

slight wear was also utilized. Of note, the wear group of patients had splints made that were to be worn at night only. Using a specific scale to record changes in observable wear a median value score was found. This meant that within the 7 year follow up period the median change was visible but without a measurable reduction in tooth length. This is in agreement with the previous findings that most wear occurs slowly over time. None-the-less, an observable change was noted within this population whose average female age at the initial exam was 34 years. In addition, 9 of the patients had received crown and bridge therapy during the intervals between the records. This is an excellent example of the complicated issues facing restorative dentists who maintain patients with significant wear. Whether due to fracture or the request to improve the appearance of the teeth, patients with wear often eventually pursue treatment.

The focus on younger orthodontic populations within this topic is understandable considering orthodontic goals and practices. However, restorative dentists deal with attrition and its relationship to anterior overlap on a daily basis within the adult population. Prosthodontists in particular tend to see the patients on the extreme limits of overlap relationships. The complex diagnostic and treatment issues of this excessive overlap patient population have been discussed frequently.[67-72] It is the belief of the authors that the complex nature of these treatments combine with the increased functional risks mentioned previously to result in more frequent technical and biologic failures.

Summary

This review has focused on overlap of the anterior teeth and its consequences for the adult population. It is interesting that amidst the myriad of specific and complex

occlusal criteria the influence of overlap of the anterior teeth is consistently discussed. The influence of this specific factor appears to be the one most likely to cause structural dental problems. There is growing evidence that demonstrates excessive anterior overlap is a risk factor for attrition.[181,182,194] Weaker evidence exists for periodontal, and restorative issues.[161,197,198] There is also evidence that excessive overlaps influence the patients' motivation to both seek treatment and maintain their dentition.[78,84,174] This could have an indirect effect upon a person's dental condition. It appears that a fairly normal vertical or horizontal overlap dimension is between 2 and 3 millimeters. Any dimension of 6 millimeters or greater appears to be excessive or abnormal.

The lack of research volume for this common clinical problem is likely due to the complex nature of these interactions. This could also help explain, along with the critiques mentioned throughout this review, why the existing research is often not definitive. Unfortunately the complex whole-mouth issues that these patients tend to present with as well as their relative rarity within the general population precludes standardized research. Perhaps the influence of excessive overlap is increased when the normal biologic condition of the patient is disrupted by restorative procedures and tooth loss. In essence, a biologic problem like caries weakens the restorative condition of the teeth creating the environment where malocclusions are now much more influential. The implication would then be that significant malocclusions are tolerated without biologic complications until the physiology is disrupted. Once it is disrupted, these malocclusions may need correction to prevent increased chances of structural dental issues. If a relationship between overlap of the anterior teeth and structural dental problems can be

more clearly shown, the true etiologic factor for these problems can be more successfully managed.

There is need to clarify the risk that these conditions may present. This is due to several factors that may be contributing to an increase in prevalence of excessive overlap. First, it has been shown that the degree of vertical overlap of the teeth increases with age.[172] Second, there is evidence of evolution towards a more Class II relationship in man.[199,200] If true, this will increase the frequency of excessive overlap of the anterior teeth and thereby increase the frequency of the complex dental issues discussed here.

For these reasons a search was conducted for further data on the relationship of anterior overlap and structural dental problems. It is the purpose of this investigation to analyze the NHANES III data file documentation to determine whether excessive overlap of the anterior teeth was related to an increase in structural dental problems.

CHAPTER III

MATERIALS AND METHODS

The National Center for Healthcare Statistics (NCHS) conducted the National

Health and Nutritional Examination Survey (NHANES III) over a 6 year period from

1988 - 1994. The purpose was to report data on the health and nutritional status of the

civilian U.S. population. Approximately 40,000 civilian non-institutionalized people

ages 2 months and older were selected at random to participate in the study. To ensure a

representative sample of the U.S. population was included, the study was designed to take

into account estimates for whites, blacks, and Mexican-Americans.   In order to achieve

its objective, the NHANES III used a complex survey design to produce the necessary

unbiased estimates of population values from the data recorded. Further details on the

sample design have been published.[201]

NHANES III included a clinical oral examination component. An overview of

the oral health component of NHANES III is available.[202] The disease experience,[203-205]

tooth condition,[206] and occlusal charateristics[25,65] within this database have been

previously analyzed and reviewed. In the NHANES III, the survey locations were

randomly divided into 2 phases. The first 3-year survey period (phase 1) extended from

1988 – 1991, and the second 3-year period (phase 2) extended from 1991 – 1994.

According to the NCHS there is no valid statistical test for examining differences

between phase 1 and phase 2. The total NHANES III data (1988 – 1994) was procured

from the NCHS for the purpose of investigating whether a relationship exists between

tooth condition and the occlusal characteristics of horizontal and or vertical overlap. The NHANES III database is an open-source database available at cdc.gov/nchs/nhanes.htm.

The following is a summary of the data collection methods and is reproduced from the Westat outline accompanying the database. The Oral Examination Component of the NHANES III as outlined by Westat states the objectives of the occlusal and dentofacial characteristics component of the NHANES III were to: determine the prevalence of selected occlusal and dentofacial characteristics in a national sample; provide a basis for comparing with future surveys; provide baseline data for possible follow-up of selected sub-samples; and provide a basis for future development of estimates of treatment needs. This data was only recorded for patients 8 years to 50 years old. No occlusal characteristics were recorded for subjects outside this age range. The examination scored five characteristics: incisor irregularity, posterior crossbite, overjet, overbite/openbite, and maxillary diastema. Our analysis focused on the overjet and overbite/openbite which will subsequently be referred to as horizontal overlap and vertical overlap respectively. According to the Oral Examination Component, these criteria were scored as follows:

Horizontal Overlap

It is measured to the lowest whole millimeter using the periodontal probe, from the mid-point of the labial surface of the most anterior lower central incisor to the mid-point of the labial surface of the most anterior upper central incisor, parallel to the occlusal plane (Figure 4).

Figure 4: Horizontal Overlap
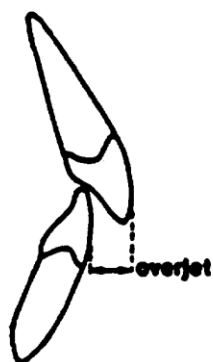
The horizontal overlap is positive if the maxillary incisor is labial of the mandibular incisor, zero if the maxillary and mandibular incisors are edge to edge, and negative if the mandibular incisor is labial to the maxillary incisor. If any one of the four central incisors is missing, fractured, or not fully erupted, then horizontal overlap was not measured. A score of "Y" was then recorded.

Recordings were made by having the subject close together there posterior teeth normally and measure the horizontal overlap, up to the labial edge of the outer tooth, rounded to the lowest full millimeter, using the periodontal probe. If the central incisors were not in a similar anterior position an average judgment was made.

Vertical Overlap

Vertical overlap was recorded as positive if the incisors overlapped vertically, zero if they were edge to edge, and negative if they were vertically separated. Therefore, negative vertical overlap described an openbite relationship (Figure 5).

Figure 5: Vertical Overlap

openbite   edge-to-edge   overbite
-         0   +

The assessment of vertical overlap was made on the maxillary right central incisor using a NIDR periodontal probe. If either the maxillary or mandibular central incisors were not fully erupted, missing, or fractured, the left permanent central incisor was substituted. If the left central incisors could not be scored, no further substitution was possible, and a score of "Y" was recorded. Rotated teeth were measured from the center of the teeth. Measurements were rounded down to the nearest whole millimeter. Only one of the following three conditions was present and recorded in any one subject.

When a positive vertical overlap existed, two measurements were made and their difference was the vertical overlap. First, with the teeth separated, the distance from the gingival margin of the mandibular incisor to its incisal edge is measured. If the cement-enamel junction is exposed, measure from the incisal edge to the cement-enamel junction. Second, with the subject's teeth together, measure from the same point on the gingival margin or the cement-enamel junction as before to the incisal edge of the upper central incisor (Figure 6). The difference between these measurements was vertical overlap.

Figure 6: Positive Vertical Overlap
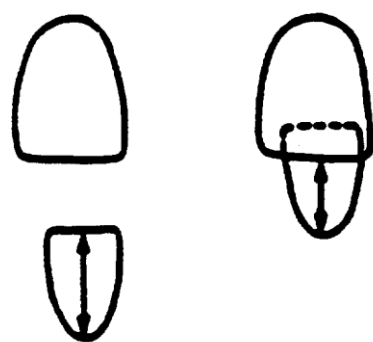
a.   b.

If the vertical overlap was so great that the maxillary incisor closes beyond the

gingival margin of the mandibular incisor and it was totally covered with the posterior

teeth together, two measurements were made. The first was the crown height of the

mandibular incisor measured as above. The second measurement was made with the

teeth together. The amount of vertical overlap of the gingival margin, or the cement-

enamel junction as appropriate, by the maxillary incisor was measured. The distance was

obtained by laying the handle of the mouth mirror horizontally at the level of the incisal

edge of the maxillary incisor and measuring the distance from the handle to the gingival

margin of the mandibular incisor rounded down to the lower millimeter (Figure 7).

Figure 7: Negative Vertical Overlap
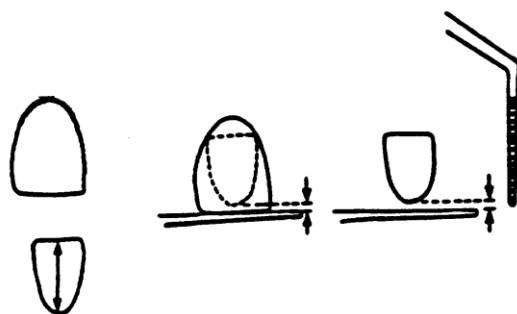
a.   b.

The vertical overlap was the total of the first measurement (crown height) and the second one (overlap). This measurement was recorded as negative vertical overlap.

If openbite was present, a single measurement was made. With the posterior teeth in occlusion, the vertical distance in millimeters from the edge of the mandibular central incisor to the edge of the maxillary central incisor was measured (Figure 8).

Figure 8: Open Bite
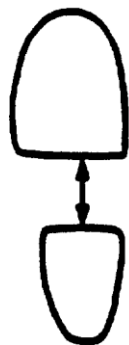
Tooth condition

The dental examination of the NHANES III included an assessment of restoration and tooth condition for individual teeth. The objective of this assessment was to determine the prevalence and severity of selected physical and biological oral conditions related to individual teeth that are not measured by the periodontal or caries assessments. Tooth condition was only measured for subjects between the ages of 18 to 74. Table 3 outlines the 10 possible codes for tooth condition.

Table 3: Codes Assigned for Tooth Condition Scores

Clinical Condition	Defect Site	RCTA Score
Defective intracoronal	• Margin on	• Code 1

restoration	restoration • Missing, partly missing, loose, fractured, or temporary restoration • Recurrent decay with an intracoronal restoration	• Code 2 • Code 3
Defective crowns and bridges	• Recurrent decay on crown or bridge abutment • Missing crowns or bridges, loose crowns or bridges, or temporary crowns or bridges, broken bridge connectors, and/or missing occlusal veneer material on posterior crowns or bridges	• Code 4 • Code 5
Gross loss of tooth structure	• Gross fracture of tooth structure associated with an intracoronal restoration, crown, or bridge	• Code 6
Pulpal involvement	• Pulp	• Code 7
Retained roots	• Retained roots evident	• Code 8
Non-replaced missing tooth	• Missing tooth	• Code Y
Replaced removable prosthesis	• Replaced teeth	• Code Y

These describe progressively more serious condition issues range from defective margins,

to residual roots, to missing teeth. Primarily healthy teeth were scored "0," meaning that

the teeth or tooth spaces did not meet any other tooth condition criteria. A "0" score

included: unrestored, non-carious teeth, teeth with intact intracoronal restorations,

crowns, or bridge abutments without evidence of periapical involvement, and tooth

spaces with intact pontics. Teeth with primary dental caries also were scored as "0",
since information on these teeth could be obtained in the DMF index.[203] The Restoration
and Tooth Condition Assessment (RTCA) criteria were applied to 28 permanent teeth or
tooth spaces. Third molars, primary teeth, unerupted permanent teeth, unreplaced
missing permanent teeth, and missing permanent teeth replaced with a removable partial
denture were scored code "Y".

In order to examine the relationship between anterior overlap and tooth condition
our population sample was limited to those patients in the NHANES III database that had
both sets of data. This was subjects aged 18 to 50 years of age. This subject set was then
statistically analyzed using SAS v9.2. (SAS Institute, Cary, NC, USA) software.
Descriptive statistics, chi-squared tests, and linear regression analyses were then utilized
to demonstrate any possible relationships. The linear regression was adjusted for the
complex survey design, where the dependent variable was the tooth condition group.

CHAPTER IV

RESULTS

The anterior tooth relationships for the 18-50 year old age range of the study are presented in Table 4.

Table 4: Anterior Relationships for NHANES III subjects aged 18-50

Anterior Relationship	Vertical Overlap	Horizontal Overlap	Openbite
≤-2	4	48	26
-1	0	58	0
0	1157	519	103
1-3	4978	5263	250
4	1102	1203	27
5	531	501	12
6	274	312	4
7	83	124	2
8	58	80	2
9	26	54	1
≥10	25	49	0
Missing (99)	614	641	8425
Total	8852	8852	8852

59.5% of the total sample had a horizontal overlap of 1 to 3 millimeters. 56% of the total sample had a vertical overlap of 1 to 3 millimeters. 4.8% of the total sample had an anterior open bite relationship. Table 5 demonstrates the prevalence of RTCA scores for each of the 9 codes.

Table 5: Tooth Condition Scores for the NHANES III Subjects Aged 18-50

Clinical Condition	RCTA Score	All Persons 18-50 Years of Age
Sound	Code 0	8402 (83.61%)
Defective Intracoronal Restoration	Code 1 – Defective Margin	58 (0.58%)
Defective	Code 2 – Missing, partly missing,	98 (0.98%)

Intracoronal Restoration	loose, fracture, or temporary restoration	
Defective Intracoronal Restoration	Code 3 – Recurrent Decay	115 (1.15%)
Defective Crowns and Bridges	Code 4 - Recurrent decay on crown or bridge abutment	8 (0.08%)
Defective crowns and bridges	Code 5 - Missing crowns or bridges, loose crowns or bridges, or temporary crowns or bridges, broken bridge connectors, and/or missing occlusal veneer material on posterior crowns or bridges	54 (0.54%)
Gross loss of tooth structure	Code 6 - Gross fracture of tooth structure associated with an intracoronal restoration, crown, or bridge	5 (0.05%)
Pulpal involvement	Code 7 – Pulp	63 (0.63%)
Retained Roots	Code 8 – Retained roots evident	49 (0.49%)
Nonreplaced missing tooth	Code Y – Missing tooth	1197 (11.91%)

As shown in the table, 83.6% of the total sampled teeth were sound.

Tables 6, 7, and 8 compare specific anterior relationships and tooth condition score.

Table 6: Total Horizontal Overlap and Tooth Condition Scores

	Tooth Condition Score									
Horizontal Overlap (mm)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
≤-2	45	0	0	1	0	1	0	1	0	48
-1	49	3	1	3	0	0	0	1	1	58
0	495	1	2	8	1	5	0	4	3	519
1-3	5060	31	50	60	1	19	4	27	11	5263
4	1135	12	22	15	0	5	1	8	5	1203
5	476	4	4	6	0	4	0	5	2	501
6	294	3	4	6	0	1	0	2	2	312
7	112	4	3	3	0	0	0	0	2	124
8	79	0	0	0	0	0	0	1	0	80
9	53	0	0	0	0	0	0	1	0	54
≥10	49	0	0	0	0	0	0	0	0	49
Missing (99)	555	0	12	13	6	19	0	13	23	641

Total	8402	58	98	115	8	54	5	63	49	8852

Table 7: Total Vertical Overlap and Tooth Condition Scores

	Tooth Condition Score									
Vertical Overlap (mm)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
≤-2	4	0	0	0	0	0	0	0	0	4
0	1106	1	11	18	2	5	0	9	5	1157
1-3	4739	41	53	68	1	25	2	31	18	4978
4	1048	7	12	14	1	6	2	8	4	1102
5	495	3	12	7	1	3	1	6	3	531
6	261	2	3	3	0	1	0	3	1	274
7	77	2	3	1	0	0	0	0	0	83
8	57	0	0	0	0	0	0	0	1	58
9	25	0	0	0	0	0	0	1	0	26
≥10	23	1	0	0	0	0	0	0	1	25
Missing (99)	567	1	4	4	3	14	0	5	16	614
Total	8402	58	98	115	8	54	5	63	49	8852

Table 8: Total Open Bite and Tooth Condition Scores

	Tooth Condition Score									
Open bite (mm)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
≤-2	22	0	0	0	0	0	0	0	3	28
0	102	0	0	0	0	1	0	0	0	103
1-3	245	1	0	0	1	1	0	2	0	250
4	26	0	0	0	0	1	0	0	0	27
5	12	0	0	0	0	0	0	0	0	12
6	4	0	0	0	0	0	0	0	0	4
7	2	0	0	0	0	0	0	0	0	2
8	2	0	0	0	0	0	0	0	0	2
9	1	0	0	0	0	0	0	0	0	1
Missing (99)	7986	57	98	115	7	50	5	61	46	8425
Total	8402	58	98	115	8	54	5	63	49	8852

No significant relationship was found between increased vertical or horizontal overlap and increased tooth condition scores. Likewise, anterior open bites did not contribute to tooth condition score increases. As previously discussed, the vast majority, 83.6%, of

teeth were sound. Even those patients with significant overlaps had few tooth condition problems.

The same anterior relationship to tooth condition score comparison was then made for individual at-risk teeth. Teeth numbers 9 (maxillary left central incisor), 12 (maxillary left first premolar), and 14 (maxillary left first molar) were analyzed and the findings shown in Tables 9-17.

Table 9: Horizontal Overlap and Tooth Condition Scores – Tooth #9 (Upper Left Central Incisor)

Horizontal Overlap (mm)	Tooth Condition Score										
	0	1	2	3	4	5	6	7	8	Y	Total
≤-2	53	0	0	1	0	1	0	0	0	2	57
-1	58	1	1	2	0	0	0	2	0	0	64
0	537	1	1	3	0	1	0	2	1	4	550
1-3	5404	16	19	22	1	6	1	8	3	19	5499
4	1219	9	10	6	0	0	0	2	2	4	1255
5	522	2	1	1	0	2	0	1	0	6	535
6	315	3	3	1	0	0	0	0	1	1	324
7	123	4	2	3	0	0	0	0	0	2	134
8	85	0	1	0	0	0	0	0	0	1	87
9	54	0	0	0	0	0	0	0	0	1	55
≥10	49	0	0	0	0	0	0	0	0	0	49
Missing (99)	695	0	7	5	3	0	0	21	17	630	1392
Total	9114	36	45	44	4	27	1	36	24	670	10001

Table 10: Vertical Overlap and Tooth Condition Scores – Tooth #9 (Upper Left Central Incisor)

Vertical Overlap (mm)	Tooth Condition Score										
	0	1	2	3	4	5	6	7	8	Y	Total
≤-2	4	0	0	0	0	0	0	0	0	8	12
0	1197	1	4	6	0	1	0	5	1	23	1238
1-3	5124	23	20	25	1	12	1	15	8	60	5289
4	1120	7	7	5	1	3	0	3	2	10	1158
5	541	0	9	2	1	2	0	0	0	1	556
6	283	2	1	0	0	0	0	1	0	3	290
7	84	1	2	2	0	0	0	0	0	2	91
8	63	0	0	2	0	0	0	0	0	1	66
9	32	0	0	0	0	0	0	0	0	0	32

≥10	27	0	0	0	0	0	0	0	0	0	27
Missing (99)	639	2	2	2	1	9	0	12	13	562	1242
Total	9114	36	45	44	4	27	1	36	24	670	10001

Table 11: Open Bite and Tooth Condition Scores – Tooth #9 (Upper Left Central Incisor)

	Tooth Condition Score										
Open bite (mm)	0	1	2	3	4	5	6	7	8	Y	Total
≤-2	28	0	0	0	0	1	0	3	0	54	86
0	105	0	0	0	0	0	0	0	0	1	106
1-3	267	2	0	0	1	0	0	0	0	4	274
4	27	0	0	0	0	0	0	0	0	0	27
5	13	0	0	0	0	0	0	0	0	0	13
6	5	0	0	0	0	0	0	0	0	1	6
7	2	0	0	0	0	0	0	0	0	0	2
8	2	0	0	0	0	0	0	0	0	0	2
9	1	0	0	0	0	0	0	0	0	0	1
Missing (99)	8664	34	45	44	3	26	1	33	24	610	9484
Total	9114	36	45	44	4	27	1	36	24	670	10001

Table 12: Horizontal Overlap and Tooth Condition Scores – Tooth #12 (Upper Left 1st Premolar)

	Tooth Condition Score										
Horizontal Overlap (mm)	0	1	2	3	4	5	6	7	8	Y	Total
≤-2	52	0	1	0	0	0	0	0	0	4	57
-1	50	1	2	0	0	0	0	0	2	9	64
0	490	1	3	2	0	1	0	4	7	42	550
1-3	4835	44	26	21	0	8	4	16	26	519	5499
4	1096	10	2	3	0	1	1	3	10	129	1255
5	464	4	5	5	0	3	1	3	7	43	535
6	283	4	1	2	0	0	1	2	3	28	324
7	116	0	2	0	0	0	0	1	1	14	134
8	77	0	0	1	0	0	0	0	1	8	87
9	51	0	0	0	0	0	0	0	1	3	55
≥10	44	0	0	1	0	0	0	0	0	4	49
Missing (99)	805	6	8	14	0	5	3	5	29	517	1392
Total	8363	70	50	49	0	18	10	34	87	1320	10001

Table 13: Vertical Overlap and Tooth Condition Scores – Tooth #12 (Upper Left 1st Premolar)

Vertical Overlap (mm)	Tooth Condition Score										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Y**	**Total**
≤-2	6	0	0	0	0	0	0	0	0	6	12
0	119	2	4	5	0	2	0	9	10	87	1238
1-3	4616	31	23	22	0	5	6	18	37	531	5289
4	985	18	8	6	0	2	2	5	6	126	1158
5	476	7	4	3	0	2	0	1	4	59	556
6	254	4	5	2	0	0	0	1	1	23	290
7	78	0	0	0	0	0	1	0	0	12	91
8	60	0	1	1	0	1	0	0	0	3	66
9	24	1	0	0	0	0	0	0	0	7	32
≥10	21	0	0	0	0	0	0	0	2	4	27
Missing (99)	724	7	5	10	0	6	1	0	27	462	1242
Total	8363	70	50	49	0	18	10	34	87	1320	10001

Table 14: Open Bite and Tooth Condition Scores – Tooth #12 (Upper Left 1st Premolar)

Open bite (mm)	Tooth Condition Score										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Y**	**Total**
≤-2	41	0	1	0	0	0	0	0	7	37	86
0	97	0	0	0	0	1	0	0	0	8	106
1-3	250	3	1	1	0	1	0	0	2	16	274
4	23	0	0	0	0	0	0	0	1	3	27
5	13	0	0	0	0	0	0	0	0	0	13
6	5	0	0	0	0	0	0	0	0	1	6
7	2	0	0	0	0	0	0	0	0	0	2
8	2	0	0	0	0	0	0	0	0	0	2
9	1	0	0	0	0	0	0	0	0	0	1
Missing (99)	7929	67	48	48	0	16	10	34	77	1255	9484
Total	8363	70	50	49	0	18	10	34	87	1320	10001

Table 15: Horizontal Overlap and Tooth Condition Scores – Tooth #14 (Upper Left 1st Molar)

Horizontal Overlap (mm)	Tooth Condition Score										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Y**	**Total**
≤-2	44	0	0	0	0	0	0	0	1	12	57
-1	48	1	0	0	0	0	0	0	1	14	64
0	437	7	8	4	0	2	2	7	10	73	550
1-3	4551	68	98	33	0	17	22	28	47	635	5499
4	1032	20	15	10	0	5	03	6	12	152	1255
5	411	8	11	3	0	2	1	4	6	89	535

6	255	7	8	3	0	2	0	2	5	42	324
7	104	5	1	2	0	0	2	1	1	18	134
8	74	1	1	0	0	0	0	2	2	7	87
9	45	1	1	1	0	0	0	0	0	7	55
≥10	43	2	2	0	0	0	0	1	0	1	49
Missing (99)	659	9	12	13	1	2	8	8	19	661	1392
Total	7703	129	157	69	1	30	38	59	104	1711	10001

Table 16: Vertical Overlap and Tooth Condition Scores – Tooth #14 (Upper Left 1st Molar)

	Tooth Condition Score										
Vertical Overlap (mm)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Y**	**Total**
≤-2	4	0	0	0	0	0	0	0	1	7	12
0	1008	8	13	9	0	3	2	11	17	167	1238
1-3	4278	59	84	34	0	15	23	31	55	710	5289
4	950	25	21	8	0	7	3	4	8	132	1158
5	468	12	12	2	0	2	1	2	3	54	556
6	231	9	5	3	0	0	1	4	3	34	290
7	57	2	5	0	0	0	2	1	0	24	91
8	55	0	4	1	0	1	1	0	1	3	66
9	23	1	2	0	0	0	0	0	0	6	32
≥10	22	0	0	0	0	0	0	0	0	5	27
Missing (99)	607	13	11	12	1	2	5	6	16	569	1242
Total	7703	129	157	69	1	30	38	59	104	1711	10001

Table 17: Open Bite and Tooth Condition Scores – Tooth #14 (Upper Left 1st Molar)

	Tooth Condition Score										
Open bite (mm)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Y**	**Total**
≤-2	31	0	0	1	0	0	0	0	2	52	86
0	88	1	2	1	0	1	0	1	3	9	106
1-3	225	5	6	3	0	1	0	2	3	29	274
4	22	0	0	0	0	0	0	0	0	5	27
5	12	0	0	0	0	0	0	0	1	0	13
6	4	0	0	0	0	0	0	0	0	2	6
7	2	0	0	0	0	0	0	0	0	0	2
8	1	0	0	0	0	0	0	0	0	1	2
9	1	0	0	0	0	0	0	0	0	0	1
Missing (99)	7317	123	149	64	1	28	38	56	95	1613	9484
Total	7703	129	157	69	1	30	38	59	104	1711	10001

The vast majority of teeth were again found to be sound, approximately 85% (tooth 9),

75% (tooth 12), and 71% (tooth 14). No association was found between overlap and

tooth condition scores for any individual tooth.

Table 18 illustrates the tooth condition assessment as separated by those patients

with a tooth condition score greater than or equal to 4 and those patients with a tooth

condition score less than 4.

Table 18: Results – Tooth Condition Assessment

	Tooth	Tooth Condition Score	N	Mean	Std Error of Mean	95% CL for Mean	F Value	Pr > F
Horizontal Overlap	9	<4	8531	2.76	0.02	2.72 – 2.80	0.05	0.8189
		≥4	77	2.70	0.27	2.17 – 3.23		
Vertical Overlap	9	<4	8590	2.43	0.01	2.39 – 2.47	7.99	.0047
		≥4	157	2.05	0.13	1.79 – 2.31		
Open Bite	9	<4	424	1.64	0.07	1.49 – 1.78	0.10	0.7494
		≥4	7	1.86	0.68	0.51 – 3.20		
Horizontal Overlap	12	<4	7698	2.76	0.02	2.71 – 2.80	1.22	0.2704
		≥4	910	2.83	0.06	2.71 – 2.95		

Vertical Overlap	12	<4	7780	2.40	0.02	2.36 – 2.44	9.33	0.0023
		≥4	967	2.59	0.06	2.48 – 2.71		
Open Bite	12	<4	398	1.65	0.08	1.49 – 1.80	0.06	0.8001
		≥4	33	1.58	0.26	1.06 – 2.10		
Horizontal Overlap	14	<4	7364	2.77	0.02	2.73 – 2.81	0.74	0.3892
		≥4	1244	2.72	0.05	2.61 – 2.83		
Vertical Overlap	14	<4	7411	2.43	0.02	2.39 – 2.48	1.81	0.1781
		≥4	1336	2.36	0.05	2.26 – 2.46		
Open Bite	14	<4	373	1.60	0.08	1.45 – 1.75	1.50	0.2210
		≥4	58	1.90	0.23	1.45 – 2.35		

For both sets of patients the average overlap distance was calculated. There was no statistically relevant difference noted in overlap for those patients with a tooth condition score greater than or equal to 4 and those with a tooth condition score less than 4.

Finally, high risk anterior relationship patients were analyzed by separating the sample according to the vertical to horizontal overlap ratio. The higher the ratio-value to greater the amount of anterior guidance present. This ratio analysis is shown in table 19.

Table 19: Ratio Analysis and Tooth Condition

Tooth	Ratio	N	Tooth Condition Score (Mean)	Std. Dev.
9	<1	4394	0.26	1.41
	1-2	4219	1.31	3.12
	>2	826	0.06	0.60
12	<1	4394	0.99	2.75
	1-2	4219	1.82	3.56
	>2	826	0.87	2.60
14	<1	4394	1.52	3.26
	1-2	4219	2.16	3.75
	>2	826	1.16	2.88

Despite using dramatic ratio threshold, no statistically significant correlation was found with tooth condition scores.

83.6% of the total teeth analyzed with the NHANES III data currently available through the CDC were recorded as sound. This percentage is in sharp contrast to what White and colleagues found when looking at Phase I of the NHANES III sample and determined only 58.6% of the teeth sampled to be sound.[206] Even more interesting is the fact that they examined 6,767 participants, only 2,085 people less than our sample, which encompassed the entire NHANES III population and yet still found a greater total number of tooth condition problems. Also, it appears as though those 6,767 people were not accounted for with the entire NHANES III dataset currently available through the CDC. Granted, the studies were not carried out exactly the same; however, the differences were still worth noting.

CHAPTER V

DISCUSSION

No relationship was found between excessive anterior overlap and structural dental problems. Classically, we have been taught that the anterior teeth protect the posterior teeth in lateral and protrusive movements and the posterior teeth protect the anterior teeth in centric closure. Essentially, most practicing clinicians have been taught, and to some degree, accept the idea of mutual protection in natural dentitions. This patient population of over 8,000 individuals demonstrated a majority of vertical and horizontal overlaps within the 1-3 millimeter range that is considered normal. However, 40.5% of individuals had horizontal overlaps either less than 1 millimeter or greater than 3 millimeters while 43.8% of individuals showed the same for vertical overlap. This is concerning if these traits are considered risk factors for dental problems. Our assumption was that since the majority of people display anterior guidance, an absence or excess of anterior guidance would lead to structural dental problems. Therefore, it was surprising to find that the amount of overlap played no role in structural dental problems. Most restorative dentists put a large effort into restoring anterior guidance. Yet, our data indicates that the presence or absence of anterior guidance alone plays no discernible role in dental deficits.

There are likely several explanations as to why the data indicates no clear relationship between overlap and structural dental problems. The first of which is that there is likely a certain threshold that must be met with regards to the amount of overlap present prior to seeing dental problems. This threshold is likely higher than what most

people in the data-set displayed. Secondly, there is not enough dental disease present in the NHANES III data. This is interesting because it illustrates that the majority of individuals do not have large dental problems, and it proposes that malocclusion becomes more detrimental only when dental disease breaks down the masticatory system. Structural dental problems resulting from overlap of the anterior teeth take several decades to develop. Since our study only analyzed people aged 18 – 50, perhaps the sample was too young to exhibit problems seen from varying degrees of overlap. For example, attrition is a specific implication of overlap that often takes several decades to manifest; however, the NHANES III Oral Examination Component did not evaluate this occlusal condition. Another explanation could be that certain patients with structural dental problems were artificially not included in the NHANES III Oral Examination Component data. For example, patients without maxillary central incisors did not have overlap recorded and were given a score of "Y" for the Restoration and Tooth Condition Assessment. This "Y" score was incorporated into the statistical analysis as a missing tooth, but its overlap value could not be determined. Finally, severe overlaps may actually result from dental problems rather than cause them. As previously discussed, this is possible because as the masticatory system breaks down due to dental problems such as disease, malocclusion becomes more detrimental.

Despite the NHANES III giving us a large patient pool to describe natural occlusion, it also presented a problem for us in regards to the management of the data. According to this database, no relationship exists between degree of anterior overlap and tooth condition. This finding, in and of itself is not cause for alarm. What is concerning about this is that the prevalence of problematic tooth condition scores from the same

database does not agree with previously reported studies, specifically that published by White et. al.[206] While some differences are expected due to the narrower age range for occlusal and tooth condition scores, the prevalence of dental disease should be similar. Likewise, White analyzed only Phase 1 data. Nonetheless the numbers produced were substantially different with regards to the tooth condition scores reported. The difference is dramatic enough to question whether these were completely different sets of data. Approximately 60% of the patients in the White article had a totally sound dentition; whereas, we found 83.6% of the population to have a sound dentition. What is also interesting is that the White article found approximately 35% of people aged 18 – 34 to have structural dental problems. Consequently, the article displayed more overall dental disease in his young age cohort than we had in our entire sample. Despite thorough attempts, we are unable to explain the two differing interpretations of what we believe to be the same database. Our study used the entire NHANES III Oral Health Component data that is currently available through the CDC, used SAS statistical software, and was analyzed by two experienced statisticians familiar with the NHANES III data. Our study, as carried out, is a reliable analysis of the database received. However, the reliability of the database itself may be called into question due to the differing presentations within the literature.

What this study does tell us about the general United States population is that the majority of people are healthy and free of dental disease. It also suggests that malocclusion may not be a diagnosis that always needs to be treated. As clinicians, we often attempt to "fix" anything that is not ideal. The data presented here shows that malocclusion in and of itself may not always be a reason to recommend treatment,

especially if the patient is not requesting a change. However, in the presence of dental disease, malocclusion seems to exacerbate the problems. Perhaps overlap becomes significant only when healthy, normal physiology is disrupted. As prosthodontists, perhaps this is where our bias lies, because it is typically at this point that the patient presents for treatment.

As a follow-up to this study, further inquiry needs to be completed with the NCHS with regards to the differing results between this study and the White article. In addition, one area that has not been touched on at length is the role wear plays in patients with excessive overlap. The literature does suggest that there is an increase in attrition with an increase in vertical overlap, and since the NHANES III data did not include wear, it would be of interest to learn at what value of overlap there is an increase in attrition, if any.

Clinically, perhaps the influence of excessive overlap is increased when the normal biologic condition of the patient is disrupted by restorative procedures and tooth loss. In essence, a biologic problem like caries weakens the restorative condition of the teeth creating the environment where malocclusions are now much more influential. The implication would then be that significant malocclusions are tolerated without biologic complications until the physiology is disrupted. Once it is disrupted, these malocclusions may need correction to prevent increased chances of structural dental issues.

CHAPTER VI

SUMMARY AND CONCLUSIONS

- According to this database, no relationship exists between degree of anterior overlap and tooth condition.

- The reliability of the NHANES III databases can be called into question.

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