# THE PREVALENCE OF OCCLUSAL TRAITS IN A WESTERN CAPE POPULATION

BY

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# DECLARATION

I ........................... declare that "The Prevalence of Occlusal Traits in a Western Cape Population" is my own work and that all the sources I have quoted have been indicated and acknowledged by means of references.

Signed: ...................

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# DEDICATION

This thesis is dedicated to my family, especially my parents whose guidance and sacrifice has made my education possible.

# SUMMARY

At the University of the Western Cape there has been a rapid increase in the number of patients requesting orthodontic therapy. The extent of the problem in this area is not known as no studies have been undertaken in this regard. The purpose of this study was to determine occlusal trends in a Western Cape population, to establish norms with a view to ascertaining treatment needs.

The sample comprised of 14-year old schoolchildren (n=166) taken from "Coloured" senior secondary schools within the greater Cape Town area. They were examined and recorded according to the methods set out by Baume et al. (1973). Twelve occlusal features divided into three components, namely dentitional status, space conditions and occlusal relations, were investigated.

Results for bilateral molar relationship were: normal - 32.1%, mesial - 1.2% and distal - 4.9%. Anterior crowding was present in more than 20.0% of the subjects and spacing more than 10.0%. The mean overbite and overjet were 2.0 mm and 2.5 mm respectively. In the posterior segments, open-bites accounted for approximately 6.0% and crossbites for 4.0%. On comparison with established international norms these results suggest that the occlusal traits of this Western Cape population sample differed significantly in certain aspects.

## OPSOMMING

Aan die universiteit van Wes-Kaapland was daar 'n vinnige aanwas in getalle van pasiente wat ortodontiese terapie verlang het. Die omvang van die probleem in hierdie area is egter nog onbekend aangesien daar tot dusver nog geen grondige studie in hierdie verband gedoen is nie. Die strekking van hierdie studie was om die okklusale neigings in die bevolking van Wes-Kaapland te bepaal met die doel om norme vas te stel en behandelings-vereistes te bepaal.

Vir die ondersoek is 14-jarige skoolkinders (n=166) geneem uit senior sekondêre kleurlingskole uit die groter Kaapstadgebied. Hulle is ondersoek en die bevindings aangeteken volgens die metodes deur Baume et al. (1973) uiteengesit. Twaalf okklusale eienskappe is opgedeel in drie komponente en ondersoek, naamlik dentisionale status, spasiëring en okklusale verhoudings.

Die resultate vir bilaterale kiestandverhoudings was as volg: normaal - 32.1%, mesiaal - 1.2% en distaal - 4.9%. Bondeling van die voorstande was teenwoordig in meer as 20.0% van die gevalle en spasiëring in meer as 10.0%. Die gemiddelde oorbytig en voorbytig was 2.2 mm en 2.5 mm respektiewelik. In die agterste segmente was 'n oorbyt eenwoordig by 6.0% en 'n kruisbyt by 4.0%. In vergelyking met gevestigde internationale norme, dui

hierdie bevindings daarop dat die okklusale karaktertrekke van die monstergroep van genoemde Wes-Kaapse bevolking in sekere aspekte betekenisvol verskil.

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"Go where we will, wander down the village street or the crowded avenues of great cities or wherever humanity congregates, and we will be confronted by these (occlusal) deformities in such number that we are amazed at their prevalence..."

Edward H. Angle.

# INTRODUCTION

Malocclusion has often been reported as being a disease of civilization, the prevalence of which is on the increase in developed, urbanized populations (Corruccini, 1984). Garn (1961) emphasized the extent of the problem by stating that malocclusion was a health problem of major magnitude, which was under-emphasized, under-investigated, and grossly under-supported insofar as research was concerned.

One major drawback facing epidemiologists in their attempts to assess the prevalence of occlusal disorders is the lack of agreement concerning definitions of what constitutes normal and abnormal occlusion (Summers, 1971). The definition of malocclusion (occlusal disorders) is unique in that it is not only made by dental researchers, but the affected person explicitly or implicitly plays a role in its conception (Jago, 1974).

For an adequate assessment to be made a reliable index has to be formulated and it is evident from the literature that, to date, such an index does not exist although many have been developed (Summers, 1966; Draker, 1960; and Salzmann, 1968).

A review of the literature reveals that there are differences in occlusal traits within different population groups (Dockerell, 1958; Horowitz, 1970; Akpata and Jackson, 1979; and de Muñiz, 1986). In a heterogeneous society like

South Africa, it is imperative that research be undertaken within the different racial groups so as to establish a database of such information.

At the University of the Western Cape there is an overwhelming demand for orthodontic treatment. Whilst treatment is rendered predominantly to the Coloured population in the area, the magnitude of the problem is not known as no studies have been undertaken as yet to determine the prevalence of occlusal traits in this population group. The need for such a study is, therefore, clearly evident.

The purpose of this study was to examine occlusal traits in a Western Cape sample to provide baseline data for future surveys.

# REVIEW OF THE LITERATURE

# INTRODUCTION.

Occlusion is a concept that is central to the study of the science of orthodontics (Moorrees et al., 1971; Cons et al., 1978; Tulley and Houston, 1986). However, despite its importance there seems to be a lack of concordance amongst orthodontists concerning its definition (Draker, 1960). Lombardi (1981), highlighted the problem by describing it as an "imprecise word, generally used in an imprecise way".

Occlusion, by dictionary definition, refers to the act of closure or being closed (The Shorter Oxford Dictionary, 1970). In dentistry, the word occlusion has both a static, morphological, tooth contact connotation (Jacobson, 1967; Lundeen and Gibbs, 1982), as well as a functional one involving the entire masticatory system (Draker, 1960; Salzmann, 1968; Celenza, 1978; Thompson, 1981; Ramfjord and Ash, 1983). Occlusion is also often evaluated on an aesthetic basis, which may relate only remotely to the functional aspects of the dentition (Draker, 1960; Cohen, 1970; Cohen and Horowitz, 1970; Baume, 1974; Jago, 1974; Shaw et al., 1975; Cons et al., 1983).

Within the different disciplines of dentistry one similarly encounters differing views on occlusion. One which has been propounded by the prosthodontists is that of balanced occlusion, which can be defined as that state in which the occlusal contact of the teeth on the working side of the jaw is accompanied by harmonious contact of the teeth on the opposite (balancing) side with all mandibular excursive movements. Studies by Stallard and Stuart (1963) have shown this to be unphysiological for natural dentitions and is therefore of little use in orthodontics. In accordance with this viewpoint D'Amico (1958) and Standlee and Caputo (1979) propose that "unbalanced" or anterior guided occlusion is biologically correct. Unbalanced occlusion is the state where the guidance of the articular surfaces of the incisors and the canines causes disclusion of the posterior teeth during excursive jaw movements (Thompson, 1975; Lundeen and Gibbs, 1982).

An additional problem facing researchers is that, in nature, occlusal features vary from the ideal to the severest of malalignments and constitutes a continuum with no demarcations separating the varying degrees (Bushel and Ast, 1953; Draker, 1960; Summers, 1971; Foster and Day, 1974; McLain and Proffit, 1985). Thus terms like ideal occlusion, normal occlusion and malocclusion may have different meanings for different investigators (Summers, 1971; Cons et al., 1978; Ramfjord and Ash, 1983).

It is therefore germane to this study that these terms be examined and an acceptable definition be sought.

## IDEAL OCCLUSION.

Northcroft in 1924 described ideal occlusion as the "hypothetical standard which one dreams about, but never sees - 100% perfection - the correction of both form and function in that matured combination which produces the greatest beauty in most harmonious action" (cited by Jacobson, 1967).

Ideal occlusion presupposes that every tooth in the dentition is in exact alignment and occlusion, that is absolute perfection in the anatomy and the positioning of each individual tooth, and in the relationship of the arches to each other in the craniofacial complex (Maxwell, 1937; Massler and Frankel, 1951; Altemus, 1959). For ideal occlusion to exist it would therefore require an unblemished heredity, an optimum favourable environment and a developmental history devoid of any unfavourable influences. Furthermore, for this state of perfection to be maintained throughout life, it is required that the teeth remain static in both wear and positioning; something that does not occur at all (Salzmann, 1974). Ideal occlusion, therefore, cannot exist in man (Hellman, 1921; Northcroft, 1924; Draker, 1960; Jacobson, 1967).

## NORMAL OCCLUSION.

John Hunter in the 18th century was the first to introduce the concept of normal occlusion. Over the years this was developed to eventually yield a working definition of normal occlusion as being the good interdigitation of both arches with only a few teeth slightly out of perfect alignment (Ackerman and Proffit, 1969). Many investigators have since attempted to improve on this arbitrary definition, resulting in three broad views, namely static occlusion (Angle, 1899; Stoller, 1954; Ackerman and Proffit, 1969; Andrews, 1972), biometric occlusion (Hellman, 1921; Dempster et al., 1963; Baume and Maréchaux, 1974) and attritional occlusion (Begg, 1954).

### Static Occlusion.

Edward Hartley Angle (1899) published his classification of malocclusion which not only subdivided major types of malocclusion but also included the first clear and simple definition of normal occlusion in the natural dentition. His postulates were based on a skull he called "Old Glory" from the collection of the Dutch anthropologist Broomel. The configuration of the arches and the characteristic relations of the dental units within this formed the basis of his classification. He stated that when the mesiobuccal cusp of the upper first molar articulates in the buccal groove of the lower first molar a class I relationship exists. If this is found in conjunction with the teeth being arranged on a smoothly curving line of occlusion then normal occlusion would be the result (Ackerman and Proffit, 1969; Akpata and Jackson, 1979).

This classification was readily accepted by the dental profession as it brought order to a confused state regarding dental relationships (Proffit et al., 1986). A major shortcoming of this postulate is that it assumes the position of the maxillary molar to be static (Akpata and Jackson, 1979).

Stoller (1954), also a proponent of the static viewpoint, embellished on the Angle molar relationship. He related the upper first molar to both the lower first and second molars. According to him the Angle class I molar relationship cannot be achieved unless the distal inclined plane of the distobuccal cusp of the maxillary first molar makes contact with the mesial inclined plane of the mesiobuccal cusp of the mandibular second molar.

Andrews (1972) using the concepts of previous workers formulated his six keys to normal occlusion. Mention is made of the molar relationship, the angulation and inclination of the teeth, interdental spacing, rotations and the depth of curve of Spee. Although he perpetuated the static concept he made comment on the erroneous manner in which orthodontists often use only the molar relationship and interincisal angle in their assessment of occlusion.

**Biometric Occlusion.**

The statement by Simon in 1926 that "All we ever find are variations, endless variations; an exact ideal norm does not exist, can not exist. And this is our enigma: in theory we will never find the normal, in practise we forever feel its need and apply it constantly" focuses our attention on the vagaries of the "norm" (Ackerman and Proffit, 1969).

Hellman (1921) introduced the biometric approach to the study of occlusion. From this he concluded that the concept of an ideal occlusion has no biologic justification nor any scientific foundation. He stated that "Nature's ideal" can be represented by the average (normal) and the type (the range of variability).

Dempster et al. (1963) in their study showed that there is considerable variation in the axial inclination of teeth from one individual to the next. Based on these findings they concluded that so-called ideal arches do not exist.

A major problem encountered in defining normal occlusion is the presumption that it is synonymous with ideal occlusion (Johnson, 1919; Lombardi and Bailit, 1972; Lombardi, 1982). This definition would have to be based on concepts requiring precisely defined ideal "types" which are static and unchanging, without the range of variation that is evident in natural phenomena. If these concepts are then applied to the dentition, the likelihood of anyone having a normal occlusion would be unlikely. Therefore in the biologic sense, normal occlusion implies a range of variation in tooth alignment and jaw relationship which are compatible with normal function and in the absence of disease (Hellman, 1921, Johnson, 1919; Lombardi and Bailit, 1972; Lombardi, 1982).

**Attritional Occlusion.**

Anthropologists have asserted that technologically primitive populations have a better aligned dentition than civilized populations (Keith, 1923; Campbell, 1925; Drennan, 1929; Collins, 1932; Steadman, 1937; Niswander, 1967; Lombardi and Bailit, 1972; Evans <u>et al</u>., 1984).

Wood Jones (1916) postulated that the human evolutionary trend toward smaller teeth and jaws has been accelerated by the consumption of processed foods. This hypothesis implies that the jaws of civilized man receives too little functional stimulation to realise their full growth potential, resulting in tooth and jaw malrelations. Man living under primitive conditions with a supposedly rougher and thereby functionally more stimulating diet are therefore free of these aberrations of growth.

Keith (1931), while recognizing the evolutionary reduction in jaw size, attributes these anomalies to causes inherent in the physiology of the body, rather than of an exogenous nature, such as dietary changes or modifications in cultural patterns.

Begg (1954) also believed that the high incidence of crowded and malpositioned teeth in civilized people is related to the nature of the diet. He observed that diet only affected the teeth and not the jaws and postulated that interproximal attrition compensated for the progressive mesial migration of posterior teeth. He hypothesized that in populations having an abrasive diet the teeth, which are normally larger than could be accommodated by the arches, are gradually worn by the grit contained in the food. Aligning the teeth is thus made possible, whilst still providing sufficient tooth mass for efficient mastication. Survival to reproductive age is thus attainable.

Numerous other studies on the occlusion of Australian Aborigines have led investigators to deduce that the lack of attrition in modern man's dentition contributes to the dental and orthodontic problems (Begg, 1938 and 1954; Cran, 1960; Wolpoff, 1971; Begg and Kesling, 1977).

In keeping with these are the observations by Drennan (1929) that the South African Bushman also have well aligned teeth.

However, in contradistinction are the reports that crowding of anterior teeth is seen in primitive people (Lombardi and Bailit, 1977; Lombardi, 1982; Evans et al., 1984). The corollary has also been postulated namely, that in some dentitions with reduced attrition, no crowding is evident (Brace, 1977; Lombardi, 1982).

NORMAL OCCLUSION - DEFINED.

In orthodontics it is accepted that the concept of the norm is an essential fiction necessary for the definition and therapy of malocclusion (Simon, 1926; Draker, 1960; Jacobson, 1967).

The process of evolution has developed many variations in the size, shape and range of function of the teeth, jaws, arch form and the temperomandibular joint. It is obvious that one cannot establish a template and try to make every occlusion conform (Giordano, 1962). An occlusion may be considered normal for a particular individual if it enables the masticatory mechanism to carry out its physiological functions while all associated structures maintain their health and integrity (Johnson, 1919; Giordano, 1962; Thompson, 1975; Ramfjord and Ash, 1983).

For a particular population the definition of normal occlusion would thereby be a statistical one. It would include ranges of acceptable variation compatible with health and normal function, together with stated probability (Altemus, 1960; Lombardi, 1982). The theory of the individual normal, as postulated by Altemus (1960) emphasizes the infinite variety which exists in any particular race group within a range that can be called normal.

**MALOCCLUSION.**

Malocclusion has been described as an imprecise word used in a precise way (Summers, 1971) or as an imprecise term used for an ambiguous concept (Lombardi, 1982), thereby highlighting the uncertainty regarding its conception. A review of the literature reflects wide divergence of opinion concerning its definition (Draker, 1960; Mills, 1966; Moorrees et al., 1971; Summers, 1971).

The World Health Organization (1962) categorizes malocclusion under the heading "Handicapping Dentofacial Anomaly", which is defined as an anomaly causing disfigurement or which impedes function, and which requires treatment (Baume and Maréchaux, 1974).

Grainger (1967) and Summers (1971), observed that the term malocclusion was commonly used to describe the prevalence of occlusal disorders. These comprised a number of characteristics or variables whose deviation from the norm resulted in structural disharmony of the teeth and jaws.

A value-judgment has to be made to determine the extent that a particular occlusion may be labelled a malocclusion. This is based on a number of criteria, such as cultural norms, the body-image and aesthetic values of individuals and groups, the anatomic deviations from morphological norms as defined by clinicians, and functional considerations which impair mastication or enunciation (Salzmann, 1968; Jago, 1974; Prahl-Andersen, 1978).

The lack of consensus in the individuals appraisal of the problem is evident by the reasons patients present for treatment (Cohen, 1970; Baume and Maréchaux, 1974; Shaw et al., 1975). Much of the treatment done is purely for aesthetic reasons (Howitt et al., 1967; Prahl-Andersen, 1978; Isaacson, 1983; Tulley and Houston, 1986). Individuals vary so greatly in their perception of the need for and the desirability of orthodontic treatment that any attempts at obtaining a suitable definition of what constitutes malocclusion are further compromised (Secord and Backman, 1959; Cohen, 1970; Moorrees et al., 1971; Jago, 1974; Isaacson, 1983; Tulley and Houston, 1986; Downer, 1987).

Mervyn Susser in 1973 proposed various definitions concerning states of health (cited by Jago, 1974). He defined disease as a process that creates a state of physiological and psychological dysfunction confined to the individual; illness as a psychological awareness of dysfunction by the individual; sickness being a state of social dysfunction which affects the state of one's relations with others; impairment refers to an individual's persisting physical or psychological defect; disability refers to an individual's persisting physical or psychological dysfunction, and handicap refers to persisting social dysfunction which is a social role assumed by the impaired and disabled individual and expected by society.

Although malocclusion is not a pathological state (Solow, 1970; Jago, 1974; Corruccini, 1984; Proffit, 1986) it is postulated that it may embrace all the terms defined by Susser (1973). Furthermore, unlike other pathological conditions the definition of malocclusion is unique in that it is not only made by dental scientists, but also the affected person explicitly or implicitly plays a role in its conception (Young and Zwemer, 1967; Cohen, 1970; Prahl-Andersen, 1978).

Many investigators have viewed malocclusion as an invariable state (that is either you have a malocclusion or you do not) rather than a continuum of many variables (Moyers and Summers, 1970; Solow, 1970; Lombardi, 1982). In reality it is not a single entity (Scivier et al., 1974; Harris, 1975) but a complex morphological and functional phenomenon which is manifested in the disharmony of two or more features of the jaws, teeth and soft tissues, each in itself constituting a problem (Van Kirk and Pennell, 1959; Grainger, 1967; Summers, 1971). These features tend to produce similar types of disharmony which have formed the basis of several systems of classification (Freer, 1970).

Due to the vagueness of the terms normal occlusion and malocclusion (Draker, 1960; Summers, 1971; Lombardi, 1982) researchers have sought to establish alternate definitions (Lombardi, 1982). For epidemiological purposes the concept of occlusal traits has been proposed. This encompasses all variations (good occlusion to malocclusion) and implies a continuum rather than discrete entities (Lombardi and Bailit, 1972; Corruccini, 1984).

The term occlusal disorder would therefore designate any variation in occlusion which is unacceptable aesthetically or functionally to either the patient or the examining dentist (Moyers and Summers, 1970; Jago, 1974). This term, though not precise nor etymologically better than the word malocclusion, does not carry the preconceptions of malocclusion and conveys variability. Thus leaving the investigator free to designate degrees of occlusion rather than just the invariable state (Summers, 1971).

## HISTORICAL PERSPECTIVE.

### Early Man.

Malocclusion is considered by some scientists as being "a disease of civilization", signifying that it is found (or at least reported) primarily in developed, urbanized populations (Corruccini, 1984; 1985). The contention held by earlier workers was that malocclusion with its associated dentofacial anomalies was rarely present in primitive man (Keith, 1925; Campbell, 1925; Collins, 1932; Brash, McKeag and Scott, 1956).

Other investigators, however, disagree and contend that malocclusion was not uncommon in man's ancestors and thus is not a new phenomenon (Jacobson, 1967; Baume, 1974; Proffit, 1986). Displacement or malocclusion of individual teeth is evident from Neanderthal and Upper Paleolithic man to modern man. Abnormal jaw relations in sagittal, vertical and lateral planes appeared in Neolithic populations, and the number of dentitions with malocclusions gradually increased, to almost present day proportions in the late medieval European groups (Lavelle, 1976).

Crowding of the teeth was noted by Ruffer (1921) in predynastic Egyptian skulls. This was also observed by Robinson (1956) in the anterior teeth of Australopithecus, and by Tobias in 1957 in Zinjanthropus (cited by Jacobson, 1967). Neanderthal man (50 - 60,000 years ago) had abnormalities in the position and morphology of the teeth. Supernumerary, retained, unerupted and impacted teeth were also evident (Anderson, 1948). The mesiocclusions of the paleolithic skulls of "La Ferracie" and of the African Cro-Magnoide of Meckta bear testimony to the great antiquity of mandibular prognathism. Early paleopathologic studies on the origin of malocclusion support the theory that, phylogenetically, distocclusion is a rather recent feature. One of the first known instances of distocclusion, was shown in an Alemanic skull dating back to the sixth century. It interestingly revealed anthropomorphic features of racial intermixture (Baume, 1974).

**Ancient Man.**

Orthodontics can be said to have a long history but a short record, as references concerning the prevalence of occlusal disorders have been made through the ages from the times of antiquity. The earliest record of malocclusion was probably made by Hippocrates (460-377 B.C.) in his sixth book of Epidemics where he remarked on the relationship between tooth irregularity and malformation of the skull and palate (Baume, 1970).

Celsus (25 B.C.-50 A.D.) was the first to record the need to extract retained deciduous teeth and the subsequent correction of the displaced successor using finger pressure. In his works Natural History, Caius Plinius Secundus alias Pliny (A.D. 23-79) advocates the filing of elongated teeth to bring them into proper alignment. Claudius Galen (A.D. 130 - 200) first described, and formulated treatment of traumatic occlusion. Paul of Aegina (A.D. 625 - 690) the last classical Greek author prescribed the removal of supernumerary teeth if it caused an irregularity (Anderson, 1948).

THE PREVALENCE OF MALOCCLUSION.

Numerous prevalence studies have, to date, been undertaken and differing features of occlusal disharmony have been assessed (Jago, 1974). This combined with the usage of different definitions and methods of measurement, have yielded a vast range of findings rendering comparison of these studies almost impossible (Salzmann, 1968; Lombardi and Bailit, 1972; Jago, 1974; Infante, 1975; Lavelle, 1976).

Other significant factors contributing to this disparity have been the small sample size and the varied age groups which had been selected (Helm, 1968; Jago, 1974). Despite these limitations, Freer (1970) is confident that valuable information could be gleaned from these studies.

It is apparent that many factors have an effect on occlusal patterns worldwide, both between different populations and within the same population (Dockerell, 1958). The more important factors would appear to be ethnicity, age, sex, geographical location, social stratum, diet, oral conditions and personal developmental history (Jago, 1974).

## Ethnicity

Notwithstanding the heredity versus environment controversy in the determination of occlusion and malocclusion (Smith and Bailitt, 1977; Harris, 1975; Harris and Smith, 1980; Corruccini and Potter, 1980; Corruccini, 1984; Lundström, 1984; Proffit, 1986) it is widely accepted that the different ethnic groups display different distributions of occlusal traits (Björk and Helm, 1969; Horowitz, 1970; Baume, 1974; Ingervall and Hedegaard, 1975; Akpata and Jackson, 1979). It has been suggested that these ethnic differences are a reflection of the different genetic distributions (Foster, 1942; Dockerell, 1958; Altemus, 1959 and 1960; Emrich, Brodie and Blayney, 1965; Wood, 1971; Jago, 1974).

Sclare (1945) found in a 12-year old, West Yorkshire population that Class I malocclusion accounted for 30%; Class II for 27% whilst 1.0% of the subjects had Class III malocclusions. Björk in 1947 studied a Scandinavian population and found that there were 51.8% with Class I, 18.9% with Class II and 2.8% with Class III malocclusions (cited by Isiekwe, 1983). An even greater variation is evident when these results are compared with the investigations of Gardiner (1956) and Roberts and Goose (1979). They reported Class I constituted 66% and 62-66%; Class II, 8.2% and 26-27% and Class III, 1.0% and 6-9%

respectively. These variations are more likely to be due to differences in the interpretation of the definition and in the measuring techniques of malocclusion, rather than actual physical differences.

Dockerell (1958) suggested that white populations show similar prevalence of malocclusion at any given age, while any notable variations probably result from inbreeding in small, isolated communities. He further suggested that marked differences exist between whites and other races.

Emrich, et al. (1965) examined 12 to 14 year old Causasian children and reported an incidence of 84% class I molar relationships (that is both normal occlusion and class I malocclusion). Furthermore 7% had class II and 3% exhibited class III malocclusions.

The earliest study on a Negroid sample was done by Altemus in 1959. He found in a group of 12 to 16 year old Black American children that 3.69% had ideal occlusion, 12.79% displayed normal occlusion and 66.4% were class I; 12% were class II and 5% were class III. Altemus compared his results to that of Massler and Frankel (1951), whose findings in a comparable White sample showed an ideal and normal occlusion of 2.93% and 18.23% respectively, 19.4% were Class II and 9.4% were Class III. In the Black group the proportion of normal and Class I occlusions was significantly higher, while Class III malocclusions were lower. These findings of Altemus were substantiated by the work of Bowbeer and Day (1969).

Emrich et al. (1965) in Illinois found twice as many distocclusions in whites than Black Americans, while Bowbeer and Day (1969) in a similar study in Michigan found 34% and 0% for Whites and Blacks respectively. Horowitz (1970) reported three times as many distocclusions (34%) in American Caucasians when compared to American Negroes (11%) from the same district of Tennessee.

Horowitz (1970) compared Black Americans to Caucasians in the 9 to 14 year age group and found an advanced dental development in the black sample. The distribution of malocclusion was class I, 76.8% for Blacks and 53.6% for Whites; class II, 11.4% for Blacks and 33.6% for Whites; Class III, 6.3% for Blacks and 4.7% for Whites.

Lavelle in 1970 determined the frequencies of maxillary midline diastema to be 3.5% in Caucasoids, 5.2% in Negroids and 3.4% in Mongoloids. Richardson et al. (1973) also found that Negroes had a higher incidence of maxillary midline diastema than their White counterparts.

Richardson and Ana (1973) reported that Class II malocclusion is lower in Lagos, Nigeria than in Europe or North America. The converse being true for Class III molar relationships. Akpata and Jackson (1979) in their study of 15 to 21 year old subjects, in Lagos, found that the mean overjet value, which they considered to be an indication of antero-posterior occlusal relationship, to be very similar to that found in York, England. Isiekwe (1983) in his study of 10 to 19 year old children in the same city observed that the frequency of Class I occlusions were 76.8%, Class II malocclusion accounted for 14.7% and for Class III malocclusions the prevalence was 8.4%. Grewe and associates (1968) observed in a study of American Indians in Minnesota that 15% of those with less than 50% Indian ancestry had distocclusion while those with more than 50% ancestry had only 8%.

Infante (1975) compared a 2 to 5 year old group of Black, Caucasian and Apache children and reported a prevalence of Class I occlusions of 88.7% in the Black group, 89.3% in the Indian group and 79.9% in the White group. Class II malocclusions were evident in 4.3% of the Black children, in 2.7% of the Indians and 19.1% of the Whites. The Black, Indian and White children displayed a 7.1%, 8.0% and 1.0% prevalence of Class III malocclusions respectively. Therefore the prevalence of Class II malocclusions was significantly greater in White children. There was a greater frequency of Class III in Black and Indian children. The presence of both anterior and posterior crossbites were greater in the Indians.

Baume (1974) in an extensive study in the Philippines reported an extremely low prevalence of malocclusion in Samoans when compared with a racially mixed sample. A comparison between groups geographically distant, but akin in ethnic origin namely that of Samoa and the Australes revealed a similar percentage distribution of distocclusion. Baume (1974) attributed the increased frequency of distocclusion to racial inbreeding and suggested that it had a genetic basis.

These findings were in accordance with those of Davies (1956). He compared the prevalence of malocclusion in both the White and indigenous populations on Pukapuka in the Cook Archipelago and found that the latter had a lower incidence. Freer (1970) stated that the White population had less than 8% class III occlusions compared with that of Davies which showed 33.9%. Thus making the postulate of genetic influence in mesiocclusion a tenable one. By the same token, Baume (1974) postulates that, racial intermixture with Caucasians appears to reduce the frequency rate of mesiocclusions.

In 1932 Collins compared the incidence of crowding between unhybridized and mixed Alaskan Eskimos. In the former it was 14.5% while in the latter it was 25.9%. He reported an incidence of only 2.8% in the museum Eskimo crania of an earlier period.

In a study of dried skulls of the South African Bantu, Jacobson (1967) found that class I occlusion (neutro-occlusion) occurred in 96.4%, class II in 2.9% and class III in 0.7% in males. In the females class I accounted for 97.4%, class II for the remaining 2.6%.

Louw (1982) in his study done in the Western Cape reported that 24.9% of his sample presented with dentofacial anomalies (defined by him as being defects in the tooth-arch form or relationship between tooth arches). He further stated that these conditions were more prevalent in White pupils than in Coloureds at the age of 6 years, the inverse being true in the 15 - 17 year old age group.

In a sample of 14 year old Whites, Zietsman (1979) found the distribution of normal occlusion and Class I malocclusion to be 23.3% and 47% respectively; 24.5% had Class II while 1.0% had Class III malocclusions.

In a study on 12 year old urban Black children in Soweto, Johannesburg Hirshowitz et al. (1981) found that malocclusion was rare, affecting only 11% of the children. Class I malocclusion was commonest (8.8%), followed by Class II (1.3%) and Class III (1%).

**Age**

Stallard (1932) reported a 56% and 86% prevalence of malocclusion in two samples aged 5-6 and 13-14 years respectively. In a similar study Barrow and White (1952) reported an incidence of 61% and 88% in a sample of 5 and 16 year old subjects. Emrich et al. (1965) observed a 15% increase in malocclusion in the period 6-8 years to 12-14 years for children in St. Louis. This increase in the prevalence of malocclusion with age has also been reported in other surveys (Helm, 1970; Ingervall, 1974; Helm et al., 1975; Järvinen, 1981).

Other investigators, however, have reported a decrease in the incidence of malocclusion with age (Moore, 1948; Goose, Thompson and Winter, 1957). Miller and Hobson (1961) observed an increased prevalence from 4 years until 11-12 years followed by a decrease, a feature also noted by Knutson (1965) and Cons et al. (1978) in their studies. Knutson (1965) termed this phenomenon as a self correcting tendency.

Helm (1970) felt that malocclusion was a manifestation of morphological variations which are related to the development of the dentition rather than to the chronological age of the individual. He investigated the prevalence of occlusal anomalies in schoolchildren in relation to specified stages of dental development. During the development of the dentition, changes in the frequency of crowding in both arches, and also in the frequency of spacing in the maxilla, was observed. Spacing decreased anteriorly from the second dental stage to the fourth dental stage*, but increased laterally. His findings determined the direction of changes but not the total frequency of the anomaly at the different dental stages. These findings are consistent with those of previous investigators who found low to moderate associations between dental maturation and chronological age only (Jago, 1974).

In a study of the incidence of maxillary midline diastema Richardson et al. (1973) reported a decreased frequency with age, in a sample of American Blacks and Whites. They also found a reduction in arch width.

***Dental Stages** (Björk et al., 1964)

Teeth anterior to first molars:

DS 1 = incisors erupting.
DS 2 = incisors fully erupted
DS 3 = canines or premolars erupting
DS 4 = canines and premolars fully erupted

Molars:

DS MO = first molars not fully erupted
DS M1 = first molars fully erupted
DS M2 = second molars fully erupted
DS M3 = third molars fully erupted

Baume (1974) observed a decrease in the frequency of crowding with advancing age, in the Philippines, which would seem to suggest self-correction due to prolonged arch development.

In a study done in Lagos, Akpata and Jackson (1979) detected no difference in the overjet values of their sample at the age intervals of 15, 19, 20 and 21 years.

The ambiguity in these reports indicates that age, per se, is not a reliable variable with which to correlate malocclusion (Helm, 1968).

**Sex**

Emrich and his co-workers (1965) reported that boys showed almost twice as much class II malocclusions when compared with girls. Similarly, Richardson and associates (1973) reported an increased frequency of maxillary midline diastema in boys.

Helm (1968) reported no significant difference between the frequencies of total malocclusion of boys and girls. He, however, stated that specific attributes may differ. He reported crossbites more frequently in girls during dental stages three and four. Overbites were more common in boys, but this frequency decreased with age (Helm ,1970).

Most other investigators, however, reported little or no differences between boys and girls in the prevalence of malocclusion (Miller and Hobson, 1961; Akpata and Jackson, 1979; Altemus, 1959; Erickson and Graziano, 1966; Helm, 1970; Foster and Day, 1974; Thilander and Myrberg, 1973).

**Geographical Location**

Barnard (1956) reported that normal occlusion was more common in rural than in urban areas. Goose and associates (1957) found a significant difference between rural and urban children. The overall prevalence of malocclusion, particularly crowded Class I dentitions and Class II division 1 was higher in the urban population.

Several researchers have reported on the relationship between malocclusion and the level of fluoride in the drinking water. Hill and co-workers (1959) and Pelton and Elsasser (1953) reported no correlation between fluoridation and the prevalence of malocclusion. While Ast et al. (1962) reported a definite decrease in malocclusion associated with water fluoridation. Erickson and Graziano (1966) observed a greater prevalence of malocclusion in areas with nonfluoridated water. They advocated the need for fluoridation as an effective measure not only in reducing tooth decay, but also in reducing the prevalence of malocclusion. No consensus has been established to show that fluoridation per se decreases the prevalence of malocclusion.

Corruccini and Lee (1984) found that occlusal traits examined in immigrant Chinese (who were raised in less developed areas), were significantly different compared with their offspring who were born and bred in the United Kingdom. This seems to indicate that genetic influences on malocclusion are minimal and the reason for the deterioration in occlusion had to be environmental in nature.

**Social Stratum**

Not much work has been done on the correlation between social stratum and occlusal disorders. That is the effects that occupation, education and income etc. have on the prevalence of malocclusion (Jago, 1974). Davis and coworkers (1964) reported a positive association between overjet and socio-economic status. Tewari (1966) in India reported prevalence as being 45.3% upper class, 40.6% middle class and 25.7% lower class. He found that Class I malocclusion was higher for the lower class and that the converse was true for Class II malocclusions (cited by Jago, 1974). In a study of two population groups in Argentina, de Muñiz et al. (1986) noted a significant difference in certain occlusal traits which they ascribed to the difference in education and socioeconomic factors. This they suggested determined the type of treatment received. The importance of the socio-economic aspect of occlusal and dentofacial anomalies has been stressed by many epidemiologists (Van Kirk and Pennell, 1959; Draker, 1960; Grainger, 1967).

**Diet**

The proponents of the attritional occlusion concept assert that the technologically primitive populations have better aligned dentitions than their civilized counterparts. They reason that this difference is due to the consumption of processed foods by the latter (Wood Jones, 1916). Begg in 1954 postulated that the nature of the diet (in this case abrasive) was an important factor in the loss of excess tooth material. This interproximal attrition was compensated for by the progressive mesial migration of posterior teeth. A contention also held by Wood (1971), as pertaining to the Eskimos.

Although this postulate sounds plausible, it is observed that in some populations, despite abrasion and an associated occlusal adjustment with a coarse diet, there remains a high frequency of crowding (Brace, 1977; Lombardi, 1982; Evans et al., 1984).

Moss and Picton (1967) detected a statistically significant higher number of Class II, Division 1 malocclusions in breast-fed children under the age of six years than for the bottle-fed children of the same age. Meyers and Hertzberg (1988), on the other hand, reported no correlation between the two.

The variation in occlusal traits between Chinese immigrants and their offspring in the United Kingdom is attributed to dietary changes, while the premature loss of deciduous teeth is due to increased intake of refined sugars (Corruccini and Lee, 1984).

**Oral Conditions**

Pelton and Elsasser (1953) observed that occlusal anomalies were essentially the same for children with differing caries-experience. Missing permanent first and primary second molars appeared not to influence this. Also crowded arches and caries-experience were found to be unrelated. The hypothesis that caries-experience as a primary aetiological factor in malocclusion was not supported by their data.

Adler (1956) found that groups of individuals with malocclusions had a higher DMF than those with normal occlusion and concluded that dental caries was an important causative factor of malocclusion. He found that approximately one-fifth of the malocclusions appeared to be related to the early loss of carious permanent teeth. Similarly, Hixon et al. (1962) found a significantly higher DMFS in students with severe malocclusion.

Baume (1974) observed in a group of Tahitians that the early loss of deciduous teeth did not exacerbate anterior crowding when compared with the relatively caries free Samoans. The law of space maintenance seemed not to apply to the former as their jaw growth seemed to remain adequate. Pedersen and co-workers (1978), however, reported an increase in the frequency of malocclusion with an associated loss of deciduous teeth.

The effect of fluoridation should be kept in mind when considering the effect of caries on prevalence of malocclusion (Pelton and Elsasser, 1953; Ast et al., 1962; Erickson and Graziano, 1966).

Several investigations to determine the association between occlusal anomalies and periodontal diseases have been attempted. The results of these are controversial. Numerous investigators offer evidence to support this relationship (Hellgren, 1956; Miller and Hobson, 1961; Poulton and Aaronson, 1961; McCombie and Stothard, 1964; Sutcliffe, 1968), whereas others claim that there is no relationship at all (Geiger, 1961, Beagrie and James, 1962; Grewe et al., 1968). However a partial relationship between malocclusion and gingival disease has been reported in other studies (Massler and Savara, 1951 and Gould and Picton, 1966). This relationship is dependent on the severity of the gingivitis and the age of the patient.

Hopkin and McEwen (1956) tried to determine the association between impaired speech and malocclusion. They reported that defective speech could not be attributed to malocclusion as it was also found in subjects with normal occlusions.

From the above it is evident that no definitive evidence exists of relationships between occlusal anomalies and other oral conditions be they caries and periodontal disease, or the less common conditions, such as defects of speech and oral habits.

**Individual Developmental Histories**

The relationship between developmental disorders and the prevalence of occlusal disorders have also been examined. Rosenbaum et al. (1966) investigated the relationship between birth trauma and occlusal disorders and concluded that malocclusion and the factors affecting malocclusion were not more frequent in cerebral-palsied children than in non-palsied children.

Cohen (1971) studied Down's syndrome and postulated that occlusal disharmonies were pathognomonic of the condition. He stated that a high prevalence of mesiocclusion and a high frequency of crossbites, anterior and posterior, unilateral and bilateral were evident. He did not find one instance of a harmonious occlusal relationship.

Rosenstein et al. (1971) in a study of both mongols and retarded subjects reported that the incidence of malocclusion in the former was high. However they noted no statistical difference between the retarded subjects and the non-retarded population. Vigild (1985), on the contrary, stated that retarded children had a greater frequency of certain anomalies than normal children.

## EPIDEMIOLOGY

Epidemiology is defined as the study of the distribution and the determinants of disease frequency in man. It is the field of science dealing with the relationships of the various factors which determine the frequencies and distributions of an infectious process, a disease, or a physiological state in a human community (Baume, 1963; MacMahon and Pugh, 1970; Barker and Bennet, 1976). This science arose in the era of acute infectious diseases when all of the criteria for disease was determined by the physician, not by the patient. Unlike malocclusion, where the extent of the dysfunction is a subjective decision on the part of the patient, his parents, and his dentist. As a result, limitations affecting the objectives of any assessment method abound making the epidemiology of dental occlusion a difficult task.

An alternative definition of epidemiology is that it concerns the study of the distributions and determinants of states of health in man (Mervyn Susser, 1973). This differs from the previous definition in that it deals with states of health rather than diseases, and is hence salient to the study of occlusal conditions.

TYPES OF EPIDEMIOLOGICAL SURVEYS.

Epidemiological surveys usually fall into one of three categories (Baume, 1970).

1) The **descriptive survey** which involves the determination of the geographic prevalence of a disease.

2) The **administrative survey** involves the planning of treatment and the collective prevention of a disease, as well as an evaluation of the services provided.

3) The **constructive survey** being the aetiological and ecological study of a disease by comparing the populations exposed to certain factors to those that were not.

The majority of epidemiological studies concerning occlusion fall into the realms of the descriptive and the administrative surveys.

Jago (1974) proposed that specific to orthodontics, the main reasons for the accurate measurement of occlusal variation and occlusal disorders are the determination of patient needs and also the estimation of manpower needs. He also included the establishment of a database of scientific knowledge for different population groups, the primary application of which would be the attempt at preventing or decreasing the onset of malocclusion.

PRINCIPLES.

Four basic principles by which epidemiological method could be applied to the study of any disease or anomaly, in particular dentofacial anomalies, have been proposed by Gordan (1950) and Moyers and Summers (1970).

**I Definition of the Problem.**

This is regarded as being the most important principle and, has often been the most difficult one to realise. Two aspects of the problem under scrutiny have to be defined, namely the nature and the extent of the problem.

1) Nature of the Problem.

By definition, occlusal disorders cannot be regarded simplistically as one problem, but are normally a group of associated problems giving rise to the condition. These problems constitute a continuum from the healthy to the disabled, which Gordon (1950) referred to as the biological gradient of disease. Malocclusions, per se, are not an all or nothing situation but can range from mildly displaced teeth to gross deformities of dentofacial structures. Imbalance in the normal proportions of dentofacial components may further compound the definition of occlusal disorders, for example the relationship between a maxilla and a mandible in the upper and lower ranges of normal respectively could produce an anomaly.

2) Extent of the Problem.

To ascertain the extent that occlusal disorders present in a population a reliable index has to be formulated. To this end numerous indices have been developed and used in various surveys, the findings of which, unfortunately, do not concur (Elsasser, 1951; Elsasser, 1953; Pelton and Elsasser, 1953; Massler and Frankel, 1951; Draker, 1960; Van Kirk and Pennell, 1959; Björk, Krebs and Solow, 1964; Richardson, Adams and McCarthy, 1963; Carlos and Ast, 1966; Grainger, 1967; Howitt et al., 1967; McCann, 1967; Freer and Adkins, 1968; Salzmann, 1968; Carlos, 1970; Grewe and Hagan, 1972; Freer, 1970 and 1973; Moyers and Summers, 1970; Federation Dentaire Internationale, 1973).

A positive outcome from the plethora of studies dealing with the creation of a suitable index has been the establishment of fundamental guidelines. It is required that an orthodontic index should be simple, reliable and reproducible (Barmes, 1970). Also it should be objective and yield quantitative data that could be analysed by current statistical methods (Massler and Frankel, 1951; Betteridge, 1976). This index should differentiate between handicapping and non-handicapping malocclusion. The examination required must be one that can be performed quickly, even by examiners without special instruction in orthodontic diagnosis. Furthermore, it should lend itself to modification for the collection of epidemiological data regarding individual traits instead of only the prevalence and severity of malocclusions (Jamison and McMillan, 1966 cited by Caveney, 1976).

In addition to these, the proposals by Draker (1967), need to be considered. He advocated that an index should be usable on either patients or study models, and that it should measure the degree of handicap, without classifying the malocclusion.

For any index to fulfill the requirements as proposed by Jamison and McMillan (1966) and Draker (1967) the scoring of features are of paramount importance and the following criteria need also to be considered:

a) Choice of the various characteristics.

The assessment of overjet, overbite, crossbite, molar relationship etc. and their scoring is usually subjective and could yield different methods and probably different results. It is imperative that the choice of these characteristics and the method of scoring them be universally agreed upon so as to eliminate any discrepancies that may arise.

b) Accurate definition of occlusal characteristics.

This is of utmost importance (Helm, 1968). The index should distinguish between analogous and homologous malocclusions as the characteristics of these cannot be scored as being equal. For example an openbite could be skeletal or dental, developmental or functional; these are not the same condition neither do they respond to orthodontic therapy in the same way (Ackerman and Proffit, 1969).

c) Double scoring.

This is a pitfall that should be circumvented. For example, a tooth in crossbite due to lack of space can be scored as a tooth in crossbite or a deviated tooth, it should not be scored as both.

d) Sensitivity of index.

Occlusal disorders may be due to either a basic defect or a symptom of a developmental change and the index should distinguish between the two. A basic defect is a constant occlusal dysfunction which exists before, during and after the development of occlusion. These are normally present before the development of the permanent dentition, although in certain cases they may not manifest themselves until later in the development of the individual.

A symptom of a developmental defect, on the other hand, is an adaptation to development, which may be either an accommodation to normal growth or to a basic defect. These symptoms may be constant or may vary with age (Salzmann, 1969). For example, flaring and spacing of the maxillary incisors as seen in the ugly duckling stage. The index should be sensitive enough to score symptoms of any basic defect but not features of normal development.

e) Occlusal syndromes.

Grainger (1967) postulated the concept of occlusal syndromes, which can aid in reliable and comparable scoring of occlusal characteristics. These syndromes consist of associated characteristics which comprise the basic defect and can be readily assessed once the data from the scoring has been computed. Likewise any new syndromes can be identified through further investigation.

**II Find the factors of causation.**

The second principle in the study of dentofacial anomalies requires that the aetiology and distribution of the anomaly should be determined by studying the affected population. It is imperative that the chain of events which could produce the resultant condition be identified.

**III Formulate the principles for a programme of control.**

Thirdly, the formulation of a control programme should be based upon the aetiological factors and is directed towards the prevention of the defect or disability. Control is usually accomplished by altering one or more of the links in the chain of events.

**IV Evaluate the results of the control measures.**

Finally in order to make an adequate evaluation, appropriate indices are a prerequisite. To this end Grainger (1961) postulated five types of indices, grouped into three categories.

1) Epidemiological.

a) Syndrome type indices.

Where the incidence and prevalence of specific symptoms or groups of symptoms (orthodontic syndromes) can be used in the epidemiological studies or general evaluation of public health programs.

b) Indices of incipient or potential malocclusion.

Which are necessary for the application of preventative dental health programs. The selective criteria for these indices are habits, tooth defects, growth abnormalities and other aetiologic factors.

2) Clinically Diagnostic.

Indices used as an aid to clinical diagnosis.

3) Treatment.

a) Treatment priority indices.

These indices assess the cases to be treated purely on the basis of the severity of the deformity or handicap.

b) Treatment indices.

Which point out the degree to which therapeutic requirements are being met in a population.

From the very nature of the design of these indices it is apparent that they cannot be used interchangeably.

# INDICES.

## EARLY HISTORY.

In the earlier epidemiological studies the methods of assessing malocclusions ranged from the simple designation of regular and irregular occlusion as done by Ottofy in 1888, to more complicated systems (Hellman, 1921; Simon, 1926; Korkhaus, 1928; McCall, 1944; Sclare, 1945; Moore, 1948). Most of these studies were based on Angle's definition of normal and abnormal occlusion, whereby the maxillary first molar was considered important. The studies of Hellman (1921) and Korkhaus (1928), however, introduced other factors by including the investigation of the anterior dental relationships as well.

With the shortcomings of the Angle classification as an epidemiological tool becoming more evident (Ast et al., 1965; Gravely and Johnson, 1974; Scivier et al., 1974), other indices were developed (Kinaan and Burke, 1981). Earlier indices like those of Massler and Frankel (1951) and Van Kirk and Pennell (1959) proved to be limited as their concept of the unit of occlusion was still the single tooth (Katz, 1978).

Draker (1960) devised the Handicapping Labio-lingual Deviation Index (HLD) which with the Occlusal Feature Index (OFI) developed by the National Institute of Dental Research (Poulton and Aaronson, 1961), were seen to be advances because they used the total dental arch as well as the individual tooth as the unit of occlusion. The HLD was the first index designed to fulfill the administrative need of program planners.

The Treatment Priority Index (TPI) of Grainger (1967) introduced a weighted system whereby numerical values were assigned to occlusal disorders. This ostensibly introduced a new level of sophistication as it supposedly eliminated the arbitrary nature of the earlier indices.

The assessment of aesthetics up to this stage was not addressed. This oversight was unfortunate as aesthetic appreciation plays an obvious role in the decision regarding orthodontic treatment. The first popular index to attempt this measurement objectively was developed by Howitt et al. (1967) with their Eastman Esthetic Index (EEI). They anticipated that their index would provide a good indication of those malocclusions most in need of treatment (on the basis that a high score would indicate poor aesthetics and a low score would indicate good aesthetics).

The Handicapping Malocclusion Assessment Record (HMAR) of Salzmann (1968) incorporated most of the measurements of the earlier indices and organised the data in a compact form.

Summers (1971) introduced his Occlusal Index (OI) whereby attributes measured were assigned scores to determine the degree of malocclusion. The major contribution of this index was the method whereby molar occlusion could be measured in degrees.

In 1970 the Federation Dentaire Internationale (FDI), using various features of the various indices introduced their method of measuring occlusal traits (MOT) (Baume et al. 1973)

CHARACTERISTICS EXAMINED.

It has been postulated that the combination of occlusion and position of the teeth is the observable end result of all the aetiological factors which produce it. It is thus possible to divide it into its components which could be measured reasonably accurately (Foster and Day, 1974; Gravely and Johnson, 1974). Bennett (1912) proposed that malocclusions be classified according to their deviations in the vertical, anteroposterior, and lateral dimensions. These dimensions have been related to occlusal features in an attempt to formulate an index. The occlusal features measured are usually divided into intra-arch, interarch and the more unusual individual features.

**Intra-arch Features.**

The intra-arch features measured are deviations of individual teeth from the ideal arch form. All current indices are able to measure these features. Rotation of individual teeth is usually assessed in categories corresponding to the degree of rotation. Displacement is assessed in similar categories or measured in millimetres. Crowding and spacing of teeth are also usually assessed in categories depending on the degree of space deficiency, though this is omitted from the method of Grainger (1967).

**Interarch features.**

The index of Van Kirk and Pennell (1959) is the only one to exclude the assessment of interarch features. Incisal overjet is probably the easiest and most reliable measurement to ascertain, and is usually measured in millimeters. The overbite assessment, also included in all methods, is either measured in millimetres, or in categories according to the degree of overlap of the incisors. Similarly the presence of anterior open-bite is usually recorded as a measurement. The anteroposterior relation of the dental arches is assessed in categories according to the number of cusp-width deviations from the ideal cuspal relationship (Summers, 1971, Baume et al., 1973). The accuracy of this method depends on the individual teeth remaining in their correct positions in the dental arch, which frequently does not occur. Thus considerable potential for inaccuracy exists, and this probably is one of the less valid measures of occlusal features (Katz, 1978). Lateral relations of the posterior teeth are also included in most methods, again using categories according to cuspal relationships in the occlusion. The method of Draker (1960) does not include anteroposterior or lateral relationships of the posterior teeth.

**Miscellaneous features.**

All the indices except that of Van Kirk and Pennel (1959), and Draker (1960) assess the presence of hypodontia. The number of missing teeth is recorded, although sometimes confined to anterior region. Alternatively, the presence of hypodontia is simply recorded (Björk et al., 1964; Baume et al., 1973). For hypodontia to be measured accurately in the developing dentition radiographs are necessary, which is impractical in community studies.

The assessment of occlusal features is the most satisfactory aspect of the indices which have been developed for community studies. The different indices measure similar features, often in similar ways, while only differing in detail. The purpose for which they are used causes the problems, as these measurements are often used to assess treatment need.

TREATMENT INDICATORS.

## Assessment of need for treatment.

In most indices the summation of the scores are used to indicate need. Weighting of the occlusal features is done on the assumption that some deviations are more important than others in determining treatment need. The HMAR (1968) doubles the score in the upper incisor segment. Grainger (1967) and Summers (1971) have complex systems of differential weighting for all the parameters involved. Draker (1960) also uses differential weighting by giving a numerical score to features assessed on a yes/no basis, and differential multiplication factors to the actual measurements in millimetres.

It is apparent that these methods of determining need for treatment, while appearing objective in involving measurement and mathematics, are based on the subjective concept that deviations from ideals or norms require corrective treatment, and the greater the deviation the greater the need for treatment. The addition of weightings adds to the subjectivity. Therefore it is obvious that objective measures have not been devised and are not likely to be (Jago, 1974; Katz, 1978; Zietsman, 1979).

Planning of resources for an orthodontic programme.

With regard to the type of treatment required, the assessment methods of Grainger (1967) and Summers (1971) go some way toward providing this information by allocating the subjects into various syndromes of malocclusion according to the main deviation from the ideal. This information would need to be extrapolated from other assessments according to the measurement of occlusal features. This is done on the basis that a given degree of deviation needs correction, an assumption which may not be justified. The aetiological factors, which are difficult to assess, need to be recorded as they have a bearing on the treatment. None of the available methods cater for this.

## CRITICISMS OF THE ANGLE CLASSIFICATION.

The Angle classification was devised as a prescription for treatment and not as an epidemiological tool and in this respect is used out of context (Jago 1974). Despite its shortcomings (Case, 1921; Bennett, 1912; Ackerman and Proffit, 1969), the universal recognition and widespread use of Angle's classification in the past has made it virtually the only method of assessing the prevalence of malocclusion in different populations (Houston, 1975).

In epidemiological terms, this classification is an indicator rather than an index of malocclusion as it does not quantify the features of the occlusal disharmony. Therefore it cannot be used to measure the severity of disharmony either in an individual or in a population.

Ackerman and Proffit (1969) state that the definitions within this classification are not reliable when assessing features qualitatively. They pointed out that the Angle classification does not distinguish between analogous and homologous malocclusions. Analogous malocclusions are conditions which present with similar appearances but aetiologically are different entities.

The validity of this classification as both a clinical and an epidemiological tool was found to be questionable. Studies have proven that both the inter-examiner (Ast et al., 1962) and the intra-examiner error was very high, especially with class II division 2 malocclusions (Gravely and Johnson, 1974). Furthermore Brash et al. (1956) quoting prevalences from various studies showed that normal occlusion ranged from 8.6% to 77.6%; Class I malocclusion from 26.2 to 65.9%; Class II division 1 from 4.8 to 21%; for Class II division 2 from 2.6% to 13.3% and for Class III malocclusions from 0.9% to 12.2%. They attributed these disparities to the differences in examination criteria rather than differences between communities themselves.

Gravely and Johnson (1974) proposed that unless epidemiological studies using the Angle classification are carried out by the same examiner, different communities cannot be compared with each other.

COMPARATIVE STUDIES.

Although a number of indices for the standardised scoring of malocclusion have been developed, few attempts to systematically compare the use of these measures in a clinical setting have been reported (Albino et al., 1978).

Carlos and Ast (1966) tested the HLD but their findings were inconclusive.

Byrne (1968) suggested that the HMAR is useful in the assessment of the severity of malocclusion in relation to the expenditure and for controlling the over-utilization of orthodontic services.

Hermanson and Grewe (1970) compared the Indian Health Malocclusion Survey (Glauser, 1966), the Malocclusion Severity Assessment (Salzmann, 1968), the Occlusal Evaluation Technique (Stringfellow, 1965), the OI (Summers, 1971) and the TPI (Grainger, 1967) and found that the latter two were more precise insofar as inter-examiner variability was concerned.

Carlos (1970) and Barmes (1970) emphasized the need for an index which would exhibit high interexaminer reliability, as well as being precise in description.

Popovich and Thompson (1975) in their assessment of the TPI, reported that there was more variation in the low and medium than in the high severity scores. This suggested that severity status had an influence on the consistency of the assessor. Draker (1960) mentioned this possibility although he used a categorical instead of a continuous scale. Further analysis showed that inter-examiner variation and severity were inversely related, that is, the less severe the malocclusion the greater was the variation (Freer et al., 1973).

Grewe and Hagan (1972) tested the TPI, the OI and the HMAR and concluded that the three systems had equal merit as far as precision and intra- and inter- examiner differences were concerned, but that the OI was superior in having the least amount of bias. Scivier and co-workers (1974) tested the TPI and described it as extremely promising.

Foster and Menezes (1976) compared seven indices and stated that they were adequate in the recording of occlusal features, though not so with the assessing of treatment priority. In this respect they felt that the TPI and the OI were the most useful.

Caveney (1976) reporting on the HMAR concluded that it provided a valid measurement of the severity of malocclusion.

Gray and Dermijian (1977) tested the HLD, TPI, OI and the HMAR systems. They observed that these indexes were all highly reproducible with an acceptable margin of error. The HLD system distinguished only the very worst cases and tends to group all the others into a common pool making it impractical for field use. The HMAR is highly reproducible and is sensitive over the entire range of occlusions although it does not correlate as well with the standard as the TPI or OI. They concluded that the HMAR is best suited for working in the field

Slakter and others (1980) on comparing the HMAR and TPI and concluded that the TPI would be of optimum value in the screening of the population as it has a higher interexaminer reliability. They felt that both systems could easily be learned by lay persons.

Steigmann and Weisberg (1985) incorporated the features, not needing precise measurement, of the OI and the TPI into the HMAR claiming that a highly sensitive method would be attainable.

It is obvious that there is as yet no universally acceptable system. Each proposed system has advantages for its particular purpose (Zietsman, 1979). Foster and Day (1974) and Helm (1975) maintain that all the scoring methods are in essence no less subjective than that of the individual assessments. Furthermore, the requirements for public health purposes are different to those required for clinical purposes (Greene, 1970).

## FDI METHOD FOR MEASURING OCCLUSAL TRAITS.

In 1970 the FDI Commission on Classification and Statistics for Oral Conditions (COCSTOC) recommended a method for measuring occlusal traits (MOT) (Baume et al., 1973), rather than attempting to develop either an index of malocclusion or an index of the need for treatment (Jago, 1974; Proshek et al., 1979).

The FDI noted that with current knowledge no objective way of measuring either the social or the psychological factors relating to the disharmonies of occlusal traits exists (Draker, 1960; Popovitch and Thompson, 1971; Freer et al., 1973; Cons et al., 1983). It is further suggested that this would not be achieved until methods for determining meaningful cutoff points have been established for combination of traits and individual traits, which separate individuals who require treatment from those who do not. At present any system of weighting individual measurements or scores has to be subjective and somewhat arbitrary.

Of the indices presented, only that of Björk et al. (1964) and the FDI (Baume et al., 1973) set out to measure and record occlusal features without attempting to determine the need for treatment. However there is an element of subjectivity in the method advocated by the former. The other indices summate the various scores in an attempt to determine the severity of malocclusion and thus establish treatment priority (Van Kirk and Pennell, 1959; Grainger, 1967; Salzmann, 1968; Summers, 1971) or determine the presence of a handicapping condition (Draker, 1960). Whilst examining the same features as the others, the indices of Björk and associates (1964) and the FDI also take into account the presence of supernumerary teeth. The latter is also the only method that indicates gingival trauma through excessive incisal overbite.

Comparisons among populations with regard to individual traits can be facilitated by the MOT, whereas that of combinations of traits which may be responsible for dentofacial appearance is not (Baume and Maréchaux, 1974). Proshek et al. (1979) advocate the use of factor analysis to identify the characteristics that occur jointly, forming trait combinations or occlusal patterns that can be used in the assessment of occlusal conditions. Grainger (1967) and Freer (1970) showed that distinct sets of attributes must first be established before valid separation of discrete subdivisions of differential anomalies is possible. On this basis the social acceptability of the trait combinations could then be determined (Haynes, 1974).

With the utilization of the concept of occlusion instead of malocclusion, it is felt that studies using this approach could form the basis for the development of a valid, reliable, quantitative method for assessing occlusal variation. Although, to date it would seem that a totally objective method is not quite possible (Freer, 1970).

From the available studies it is noteworthy that the percentage of malocclusion reported in epidemiological studies range from 1.0 to over 90%. This large variability is primarily due to lack of agreement in the definition of malocclusion. In those instances where the same features were used by the different investigators, the differences between the results underline the importance that subjectivity plays in the appraisal by the investigator as well as in the establishment of the aims of the study.

When comparing the various indices, it is clear that an objective assessment of malocclusion may as yet not be within the ambit of the science of orthodontics. Hence the methods of the FDI despite its shortcomings is currently the most suitable for assessing malocclusion within a given population.

# MATERIALS AND METHODS

This project investigated the prevalence of occlusal traits in a Western Cape sample. The materials and methods for this study shall be discussed under the following headings:

1. The Population Sample.
2. Subject selection.
3. Materials.
4. Experimental Procedure.
5. Measurements.
6. Statistical Analysis.

THE POPULATION SAMPLE.

South Africa has a heterogeneous population consisting of four large ethnic groups namely the Bantu, who are an indigenous Negroid group, Caucasians mainly of European origin, Coloureds of mixed origin, Asians (predominantly from the Indian subcontinent), and two small groups namely the Chinese and the Khoisan. The latter like the Bantu are aboriginal to the South African subcontinent (Tyack, 1970; Thomas, 1981).

The four major groups mentioned by government decree live in separate, clearly defined areas (1950 Group Areas Act). Based on this policy primary, secondary and to a large extent tertiary education, is controlled by "Own Affairs" Educational departments (Government Gazette, Volume 219 (8914), 28 Sept. 1983, pages 12, 70).

The sample in this study was drawn from the Coloured population group of the Western Cape, being representative of the majority of patients attending the Oral and Dental Hospital, University of the Western Cape.

The "Coloured" person, according to the Population Registration Act 30 of 1950, paragraph 1 (i), is somebody neither white nor black. This broad definition was refined by Proclamation 46 of 1959, later amended in 1961, and incorporated in the Population Registration Amendment Act 106 of 1969 (S. A. Institute of Race Relations, 1978) whereby the Coloured population was divided into the following subgroups: Cape Coloured, Malay, Griqua as one subgroup, the Chinese, Indians and "Other Asiatics" as another and thirdly, a residual category of "Other Coloureds" (Thomas, 1982).

Cloete (1977), thus, defines a "Coloured" as a person who is accepted as a product of mixed White, Bantu and/or Asian origin, as well as one who is accepted as of Malay or Griqua origins.

According to Wolfgang Thomas (1982) the heterogeneity of the "Coloured's" backgrounds and their varied socio-economic positions precluded their constituting a distinct group. This is further compounded by their uneven geographic distribution.

The subjects examined in this study belong to the so called Cape Coloured and Cape Malay groups. These groups are regarded as being an artifact of the South African socio-political environment rather than a cultural entity (Hall and Morris, 1983).

In this study the term Cape Coloured (including Cape Malay) is used to designate a group of people of mixed origin residing in the Cape Province rather than inferring a distinct group with certain unique characteristics.

The Coloured group in 1980 constituted about 9 per cent of the total South African population, 800,000 (32%) of which resided in the Greater Cape Town area.

As mentioned earlier, separate education is an established government policy and the children attend schools designated for their particular group. Therefore the children attending Coloured schools were selected.

SUBJECT SELECTION.

The subjects examined in this study were selected from schools in the magisterial district of Wynberg and Bellville. The sample comprised of 166 individuals, 14 years of age, of which 76 were male and 90 were female. The age being recorded as at the last birthday.

In the Western Cape there are seventy five high schools, serving the Coloured community, with the 14 year old population of approximately six thousand. The sample thus represents approximately 2.76 per cent of the total. The schools were ranked alphabetically and four schools were randomly chosen from this list. The children in this age group at these schools, in turn, were listed alphabetically and randomly chosen. The sizes of the various cohorts were tested for validity (Appendix I).

Children who had undergone or were undergoing orthodontic therapy were excluded from the sample. This information was ascertained from the dental history.

MATERIALS.

The instruments used were:

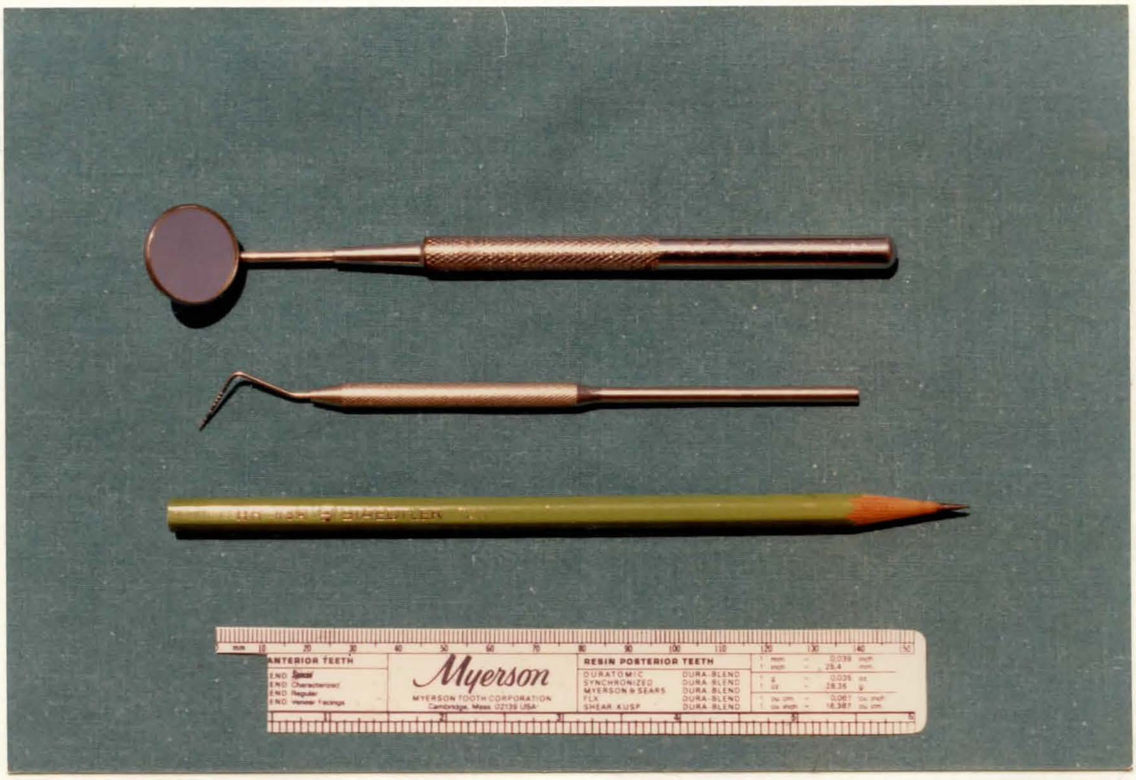
a) A plane mouth mirror,

b) a periodontal probe,

c) a sharp HB pencil,

d) a modified Meyerson plastic dental ruler,

e) the FDI COCSTOC - MOT examination form (Baume et al., 1973) (Appendix II).




**Examination instruments (Figure 1).**

EXPERIMENTAL PROCEDURE.

Clinical examination was carried out in a classroom with natural light. The subjects were stood against a wall facing the examiner. All examinations were performed by the author in a standing position. All the relevant data for each subject were recorded by an assistant onto the form designed by the FDI (Baume et al., 1973) (Appendix II).

**Measurements.**

The criteria for registration of occlusal features were those used by the World Health Organization. The following characteristics were examined and recorded:

1) Dentition status: missing permanent teeth, supernumerary teeth, malformation of incisors, ectopic eruption, retained primary teeth.

2) Space conditions: diastema, crowding, spacing.

3) Occlusion: maxillary overjet, mandibular overjet, anterior crossbite, overbite, anterior openbite, midline shift, anteroposterior relations of the first permanent molars (or premolars if aforementioned were absent), posterior openbite, lingual/buccal crossbite.


Method used to measure Overjet (Figure 2).

Method used to establish extent of Overbite (Figure 3a)

**Measurement of Overbite (Figure 3b).**

## STATISTICAL ANALYSIS.

Frequencies were computed for the qualitative data. Mean results and standard deviations were calculated for all the traits that could be measured quantitatively.

During the survey a random sample (approximately 10% of the children) was re-examined checking for intra-examiner variability. These frequencies were evaluated using the chi-squared and kappa tests (Appendix III).

# RESULTS

DENTITIONAL STATUS.

The numeric and percentage distribution of abnormalities and missing teeth due to extractions or trauma by number of teeth involved are shown in Table I and II respectively.

**Numerical Distribution of Dental Anomalies (Table I).**

| MAXILLA | CI | LI | C | 1PM | 2PM | 1M | 2M |
|---|---|---|---|---|---|---|---|
| Hypodontia | | 3 | 2 | | 3 | | |
| Extracted | 32 | 30 | 13 | 15 | 5 | 50 | 4 |
| Impacted | | | 3 | | 1 | | |
| Malformed | 1 | 10 | 2 | | | | |
| Transposed | | | 5 | 1 | | | |
| Unerupted | | | 11 | | | | |
| Retained Primary | 4 | 6 | 2 | 6 | 1 | 1 | 2 |
| MANDIBLE | CI | LI | C | 1PM | 2PM | 1M | 2M |
| Hypodontia | 3 | | | | 5 | | |
| Extracted | 2 | 1 | 1 | 2 | 22 | 94 | 1 |
| Impacted | | | 1 | | 2 | | |
| Malformed | | | | 1 | 1 | | |
| Transposed | | | | | | | |
| Unerupted | | | 1 | | 2 | | 3 |
| Retained Primary | | | | | | | |

In the population studied no cases of severe anomalies were found, likewise no cases of supernumerary teeth occurred.

The average number of permanent teeth lost was 1.64 teeth per child (Table I). The permanent teeth most frequently extracted were the mandibular and maxillary first molar

**Percentage Distribution of Dental Anomalies (Table II).**

| Abnormalities | Number of teeth | | | | | |
|---|---|---|---|---|---|---|
| | None | 1 | 2 | 3 | 4 | >=5 |
| Congenitally missing teeth | 92.73 | 4.24 | 3.03 | | | |
| Extractions | 41.57 | 18.07 | 19.28 | 3.61 | 7.83 | 9.64 |
| Impacted teeth | 96.36 | 3.03 | 0.61 | | | |
| Malformed teeth | 92.73 | 6.06 | 1.21 | | | |
| Transposed teeth | 96.36 | 3.03 | 0.61 | | | |
| Unerupted teeth | 93.33 | 2.42 | 4.24 | | | |

(34.6% and 18.4% respectively) followed by the maxillary central incisor (11.8%) and the maxillary lateral incisors (11.0%). The average number of residual primary teeth and erupted permanent teeth (exclusive of third molars) was 12.8 (range 3-14) in the maxilla and 12.4 (range 8-14) in the mandible. One individual had only three maxillary teeth present. The number of teeth in both jaws were, on average 26.4 (range 17-28).

Hypodontia (exclusive of third molars) was noted in 7.3% of the individuals. Mostly only one tooth was missing (4.2%), with 3% missing two teeth.

The number of impacted teeth were 3.6% of which only one subject had two impacted teeth.
Malformation of teeth was not a common feature (7.3%) with the maxillary lateral incisor being the tooth most affected (10 cases).

Transposition of the teeth was also uncommon, with the canines being the teeth mostly involved.

Only 0.1% of the sample presented with retained primary teeth. The teeth most frequently seen were the canines and second molars which possibly related to the anomalies associated with their succedaneous teeth.

SPACE CONDITIONS.

Distribution of Space Conditions. (Table III)

| Segment of arch | Normal | Crowded | Spaced | A |
|---|---|---|---|---|
| Upper right lateral | 54.55 | 11.52 | 4.85 | 29.09 |
| Upper incisal | 47.27 | 23.03 | 11.52 | 18.18 |
| Upper left lateral | 54.55 | 15.76 | 3.03 | 26.67 |
| Lower right lateral | 46.67 | 12.73 | 1.82 | 38.79 |
| Lower incisal | 63.03 | 24.85 | 9.09 | 3.03 |
| Lower left lateral | 44.85 | 10.91 | 2.42 | 41.82 |

A = segment not measurable.

Owing to the large number of teeth that had been extracted, many of the segments could not be recorded for space anomalies. Eighteen percent of the maxillary and 3.0% of the mandibular incisor segments, as well as 27.9% maxillary and 40.3% mandibular lateral segments had to be disregarded.

In the remainder there were relatively few spacing abnormalities (8.0% upper and 4.0% lower) in the lateral segments of both jaws. Crowding in these segments were represented by 27.0% the maxilla and 23.0% in the lower jaw. The incisal segments of both jaws showed similar percentages of crowding in the upper and lower jaws (23.0% and 24.0%

respectively); whereas, there was little difference in spacing of the incisal segments with 11.5 % in the upper and in the 9.1% lower.

It is clear from the table that crowding and spacing of the teeth were evenly distributed in both jaws. Crowding was equally common in both jaws, while spacing was somewhat more frequent in the maxilla. Crowding and spacing was most common in the incisor segment for both the maxilla and the mandible.

ANTERIOR IRREGULARITIES.

**Anterior Irregularities (Table IV).**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| Upper jaw | | | | | |
| 0 | 76.97 | 69.09 | 77.58 | 69.70 | 80.61 |
| 1 | 6.06 | 6.67 | 5.45 | 6.06 | 6.06 |
| 2-3 | 2.42 | 8.48 | 1.82 | 7.27 | 1.82 |
| 4-5 | | 0.61 | | | |
| 6-7 | 0.61 | | | | |
| Unrecordable | 15.76 | 15.15 | 15.15 | 15.15 | 11.52 |
| Lower jaw | | | | | |
| 0 | 84.85 | 79.39 | 82.42 | 82.42 | 96.36 |
| 1 | 9.09 | 14.55 | 12.73 | 11.52 | 1.82 |
| 2-3 | 3.03 | 3.03 | 1.21 | 2.42 | 1.21 |
| 4-5 | | | | | |
| 6-7 | | | | | |
| Unrecordable | 3.03 | 3.03 | 3.64 | 3.64 | 0.61 |

A = Area between the right cuspid and the right lateral incisor.

B = Area between the right lateral incisor and the right central incisor.

C = Area between the central incisors.

D = Area between the left lateral incisor and the left central incisor.

E = Area between the left cuspid and the left lateral incisor.

Table IV shows the percentage distribution of anterior irregularities or labio-lingual deviations of the teeth on the upper and lower anterior jaws. The letters A, B, C, D and E were assigned to areas between the anterior teeth for convenience.

It is interesting to note that in the upper arch this trait occurs most frequently in locations B (15.8%) and D (13.3%), the lowest frequency occurred between the central incisors (7.4%). In the lower arch this trait has an almost uniform distribution in the areas A to D, however, E showed a markedly reduced frequency (3.0%). Eighty percent of the population had no anterior irregularities recorded.

MIDLINE DIASTEMA.

**Frequency of Midline Diastema. (Table V)**

| Diastema in mm | Percent |
|---|---|
| None | 80.72 |
| 1 | 4.82 |
| 2 | 2.41 |
| >=3 | 1.20 |
| A | 10.84 |

Mean = 1.64 ± 0.93

A = not measurable, teeth missing or broken.

Eighty-one per cent of the subjects examined had no diastema, whereas 8.4% presented with one. Of the sample 4.8% had a diastema of 1mm; while only 1.2% had a diastema of 3mm or more. The mean measurement in millimetres for diastema was 1.64 ± 0.93.

MOLAR RELATIONSHIPS.

**Molar Relationships (Table VI).**

| | | LEFT | | | | |
|---|---|---|---|---|---|---|
| | | M+ | M | N | D | D+ |
| RIGHT | M+ | 1.23 | 1.23 | 1.23 | 0.62 | |
| | M | 1.23 | 0.47 | 3.09 | 0.62 | |
| | N | 0.62 | 3.70 | 32.08 | 12.96 | 4.94 |
| | D | 1.23 | 0.62 | 9.88 | 8.64 | 3.70 |
| | D+ | | 0.62 | 1.23 | 3.09 | 4.94 |

M+ = The mesiobuccal cusp of the upper first molar articulates with the distobuccal groove of the lower first molar or the interproximal space between the lower first and second molars.

M = An end to end relationship where the tip of the mesiobuccal cusp of the upper first molar articulates with the tip of the distobuccal cusp of the lower first molar.

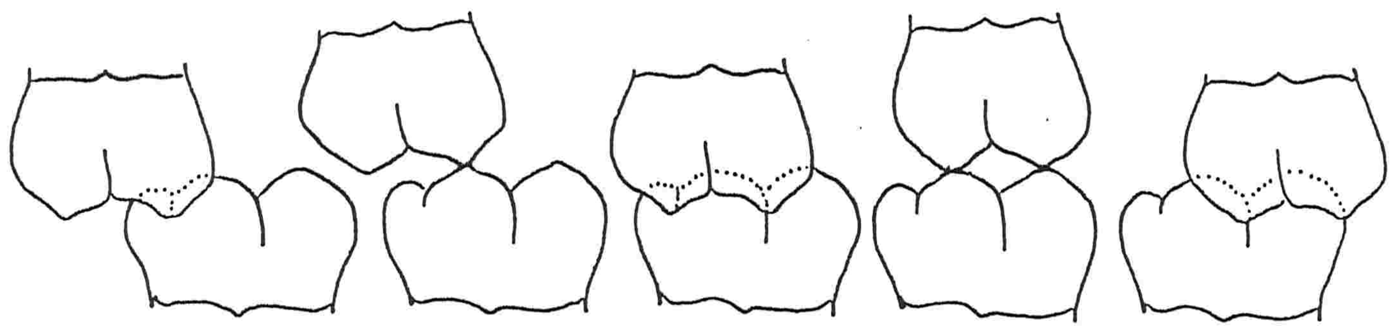
N = Normal molar relation where the mesiobuccal cusp of the upper first molar articulates with the buccal groove of the lower first molar.

D = An end to end relationship in which the tip of the mesiobuccal cusp of the upper first molar articulates with the tip of the mesiobuccal cusp of the lower first molar.

D+ = The distobuccal cusp of the upper first molar articulates with the buccal groove of the lower first.

MESIAL NORMAL DISTAL

M+ M N D D+



Schematic Representation of Molar Relationships (Figure 4).

Table VI gives the percentage distribution of molar relations in the total sample. The molar relations on the left and right sides are very similar.

The bilateral normal group (class I molar relationship) accounted for 32.1% of the subjects observed. The bilateral M+ group, the equivalent of the Angle class III molar relationship, displayed a very low frequency (1.2%), whereas the bilateral D+ (class II) were 4.9%.

The asymmetrical molar relationships are also presented in the table and are seen to account for approximately 40.3% of the sample examined.

POSTERIOR OPENBITES

.

**Distribution of Posterior Openbites. (Table VII)**

LOWER LEFT SIDE

| | Normal | Openbite | Absent* |
|---|---|---|---|
| Cuspid | 92.73 | 6.06 | 1.21 |
| 1st bicuspid | 91.52 | 6.06 | 2.42 |
| 2nd bicuspid | 89.70 | 5.45 | 4.85 |
| 1st molar | 61.21 | 2.42 | 36.36 |
| 2nd molar | 97.58 | 1.21 | 1.21 |

LOWER RIGHT SIDE

| | Normal | Openbite | Absent* |
|---|---|---|---|
| Cuspid | 90.30 | 8.48 | 1.21 |
| 1st bicuspid | 92.12 | 5.45 | 2.42 |
| 2nd bicuspid | 89.09 | 4.85 | 6.06 |
| 1st molar | 60.61 | 3.64 | 35.76 |
| 2nd molar | 97.58 | 1.21 | 1.21 |

* Not measurable; teeth broken or missing.

The percentage distribution of posterior openbite on the right and left sides is given in Table VII. Fewer than 4.5% of each of the posterior teeth were in open bite. However, the percentage not measurable because teeth were missing was very high for first permanent molars; 36.4% for lower left first molar; and 35.8% for lower right first molar. Thus accounting for the low frequency of molar openbites.

The cuspids on both sides displayed the highest number of openbites, 8.5% and 6.1% on the right and left sides respectively.

## POSTERIOR CROSSBITES.

**Distribution of Posterior Crossbites (Table VIII).**

LOWER LEFT

| | Normal | Buccal | Lingual | Absent* |
|---|---|---|---|---|
| Cuspid | 90.91 | 7.88 | | 1.21 |
| 1st bicuspid | 90.91 | 4.85 | 1.21 | 3.03 |
| 2nd bicuspid | 83.03 | 9.09 | 3.03 | 4.85 |
| 1st molar | 59.39 | 3.64 | 0.61 | 36.36 |
| 2nd molar | 98.18 | 0.61 | | 1.21 |

LOWER RIGHT

| | Normal | Buccal | Lingual | Absent* |
|---|---|---|---|---|
| Cuspid | 92.12 | 5.45 | 0.61 | 1.82 |
| 1st bicuspid | 91.52 | 4.24 | 1.82 | 2.42 |
| 2nd bicuspid | 83.64 | 6.06 | 4.24 | 6.06 |
| 1st molar | 62.42 | 1.82 | | 35.76 |
| 2nd molar | 97.58 | 1.21 | | 1.21 |

* Not measurable; teeth broken or missing.

The percentage distribution of posterior crossbite on the right and left sides is presented in Table VIII. Ninety-one and a half percent of the subjects had a normal buccolingual relationship in the posterior segments. Where crossbites were measurable the second bicuspid was the most frequent tooth found in both buccal and lingual crossbite on both the right and left sides.

**Frequency and Distribution of Overjet (Table IX).**

| mm | Right lateral incisor | Right central incisor | Left central incisor | Left lateral incisor |
|---|---|---|---|---|
| -3 | 1.40 | | | |
| -2 | 2.10 | 1.37 | 1.38 | 1.39 |
| -1 | 2.10 | 1.37 | 2.76 | 1.39 |
| 0 | 9.79 | 5.48 | 5.52 | 10.42 |
| 1 | 24.48 | 10.96 | 8.97 | 23.61 |
| 2 | 25.17 | 23.29 | 24.14 | 27.08 |
| 3 | 20.98 | 21.92 | 22.76 | 20.83 |
| 4 | 7.69 | 19.18 | 15.86 | 10.42 |
| 5 | 4.90 | 10.96 | 10.34 | 3.47 |
| 6 | 0.70 | 3.42 | 4.83 | 0.69 |
| 7 | 0.70 | 0.68 | 2.07 | 0.69 |
| 8 | | 0.68 | 0.69 | |
| 9 | | 0.68 | | |
| >=10 | | | 0.69 | |
| Mean | 1.85 ± 1.66 | 2.92 ± 1.73 | 2.94 ± 1.98 | 2.04 ± 1.51 |

Average.
Mean = 2.45 ± 1.55 mm
Median = 3.00

Negative overjet expressed by a minus sign.
A = Not measurable; teeth missing or broken.

OVERJET.

Table IX gives the percentage distribution of positive and negative overjet by incisor tooth type. The distribution of overjet is fairly symmetrical on the right and left. Negative overjet is represented in the Table by negative measurements. About 1.7% of the people were found with a negative overjet on central incisors. About 5.6% of lower right lateral incisors and 2.8% of lower left lateral incisors were found to have a negative overjet. Means, standard deviations and medians are given for each incisor using negative overjet as a negative measurement. The mean for overjet for each incisor ranged from 1.85 mm to 2.94 mm. Medians ranged from 2.49 mm to 2.8 mm. It is interesting to note that the average means for all the incisors, yield a positive overjet of about 2.45 ± 1.55 mm. Of the subjects 11.4% had overjet readings greater than four millimetres (these are values of one standard deviation or greater).

**Frequency and Distribution of Overbite (Table X).**

| mm | Right lateral incisor | Right central incisor | Left central incisor | Left lateral incisor |
|---|---|---|---|---|
| -5 | 0.69 | 0.68 | 0.68 | 0.69 |
| -4 | | | | |
| -3 | 1.39 | 1.35 | 2.05 | 2.07 |
| -2 | 0.69 | 1.35 | 0.68 | 0.69 |
| -1 | 4.17 | 2.03 | 2.74 | 4.83 |
| 0 | 9.03 | 10.14 | 8.90 | 14.48 |
| 1 | 25.69 | 13.51 | 15.07 | 20.00 |
| 2 | 28.47 | 28.38 | 28.08 | 24.14 |
| 3 | 14.58 | 16.22 | 17.12 | 16.55 |
| 4 | 10.42 | 14.86 | 13.70 | 11.03 |
| 5 | 3.47 | 8.78 | 8.90 | 4.14 |
| 6 | 0.69 | 2.70 | 1.37 | 0.69 |
| 7 | 0.69 | | 0 .68 | 0.69 |
| mean | 1.81 ± 1.71 | 2.26 ± 1.88 | 2.21 ± 1.90 | 1.76 ± 1.85 |

Average.
Mean = 2.01 ± 1.73
Median = 2.00

Negative overbite expressed by a minus sign.
A = Not measurable; teeth missing or broken.

OVERBITE.

Table X gives the percentage distribution of incisal overbite and openbite. There appears to be bilateral symmetry for both openbite and overbite. Means, standard deviations and medians were calculated for each incisor using a negative sign for openbite and a positive sign for overbite. The mean ranged from 1.81 mm to 2.26 mm. The median was 2.00 mm. It is seen that a positive overbite of 2.01 mm was the mean with a standard deviation of 1.73 mm. Of the subjects examined 6.7% had openbites and 8.4% had a bite deeper than 5 mm.

MIDLINE DEVIATIONS.

**Frequency of Midline Deviations (Table XI).**

| mm | Right | Left |
|---|---|---|
| 1 | 9.09 | 12.12 |
| 2 | 7.27 | 6.06 |
| 3 | 3.03 | 3.64 |
| 4 | 1.82 | 1.82 |
| 5 | | 1.21 |
| 6 | | |
| 7 | | |
| 8 | | 0.61 |
| Coincident | | 41.31 |
| A | | 12.20 |

Mean = 0.15 (to the right)

sd = 1.73

A = Not measurable; teeth missing or broken.

Table XI shows the percentage distribution of midline deviations in millimeters. It gives midline deviations to the right and left sides. About 41.0% of the population showed no deviation of the midline. However, 21.2% showed some deviation to the right and 25.5% showed a deviation to the left. Twenty-one percent of the population had a midline deviation to either side of one millimeter and 25.5% had a midline deviation to right or left of two millimeters or more. The mean is a deviation to the right side of 0.15 millimetres.

SOFT TISSUE IMPINGEMENT.

**Soft Tissue Impingement (Table XII).**

| | | LEFT | | |
|---|---|---|---|---|
| | | Labial | Normal | Lingual |
| RIGHT | Labial | 0.61 | | |
| | Normal | | 88.84 | |
| | Palatal | | | 0.61 |

Unrecordable = 9.94.

Table XII gives the percentage distribution of soft tissue impingement in the right and left incisal segment, 98% of the population showed no soft tissue impingement. Only 0.6% had a labial impingement on the right and left. Palatal impingements accounted for 0.6%.

# DISCUSSION

Although numerous studies on the prevalence of malocclusion have been reported in the literature, most cannot be compared with this study because of the diversity of evaluation criteria used. Even when relatively simple indices like the DMF and the PI are used great examiner variability is a consequence. Indices that rely on subjective evaluation, as is the case with many occlusal indices compound this problem. Comparisons will be made with some of the studies where there has been similarity in methods used, although it must be borne in mind that these are at best tenuous.

**Status of the dentition.**

Much of the recorded data would have been excluded had the high frequency of extracted teeth been taken into account, as advocated by Björk et al. (1964).

The frequency of extracted teeth was higher than the values found in the White American (Pelton and Elsasser, 1953; Cons et al., 1978), the Finnish (Myllarniemi, 1970), Polynesian (Baume, 1974) the and Nigerian children (Garner and Butt, 1985). The permanent first molar was found to be the tooth most frequently extracted, with the frequency of extracted mandibular molars being twice as high as that of the maxillary molars. These findings were in keeping with those of Ingervall (1974) and Myllarniemi (1970) being two and a half and three times respectively. The study by de Muñiz et al. (1986) on an Argentinian sample, revealed a frequency of mandibular first molar extractions as being five times that of the maxillary first molar.

The frequency of anterior extractions in this study was exceptionally high; six times higher than reported by Ingervall and Hedegaard (1975). This high rate of tooth loss was probably related to educational and socioeconomic factors that determine the type of treatment received (Helöe and Haugejorden, 1981; de Muñiz et al., 1986). The frequencies and locations of extractions in this study indicates that the basic preventative and conservative needs for the population have yet to be met.

The occurrence of hypodontia was not as high as that of the Finnish subjects (Ingervall and Hedegaard, 1975) but comparable to other Scandinavian studies (Helm, 1968; Thilander and Myrberg, 1973). There was, however, concurrence in the distribution of the affected teeth, with the highest frequency being for mandibular and maxillary second premolars followed by the maxillary lateral incisors.

The frequency of malformed maxillary lateral incisors compared well with that of hypodontia of the same tooth, since these two types of anomalies are often postulated to be associated with one another (Granhen, 1956).

The interpretation of these findings in the absence of radiographs and, in some cases, comprehensive dental histories, should be made with circumspection. There was no way of knowing whether teeth were congenitally absent, impacted or unerupted due to the lack of adequate records. Cases with doubtful diagnoses were recorded as teeth missing due to extraction or trauma. Also, since the population studied was 14 years of age supernumerary teeth, if present, may have been extracted prior to the survey for aesthetic or other reasons. Hence the frequencies listed under congenitally absent, impacted and supernumerary teeth may have been under-reported. Also the number of teeth missing due to extractions or trauma may have been over-reported. These limitations were recognised and accepted by COCSTOC when devising this method for accessing occlusal traits (Baume et al., 1973).

Space conditions.

Owing to the high frequency of extractions many of the segments could not be recorded. It was very likely that this factor could have had an influence on the occurrence of spacing anomalies that were recorded.

The frequency of crowding was lower than that reported in England, Finland and Denmark (Foster and Day, 1974; Ingervall and Hedegaard, 1975; Helm, 1982; Laine and Hausen, 1983), but higher than New York State and Argentina (Cons et al., 1978; de Muñiz et al., 1986). However these frequencies were similar to those reported in Nigeria and other non-Western societies (Isiekwe, 1983; Corruccini, 1984).

The frequency of spacing in this study was lower than for Polynesians (Baume, 1974), Swedish inductees (Ingervall, 1974), American children (Cons et al., 1978) and those reported in Finnish communities (Ingervall and Hedegaard, 1975; Laine and Hausen, 1983) but higher than that reported by de Muñiz et al. (1986). It could be tentatively postulated that space anomalies are an acceptable variation of normal occlusion and not necessarily a malocclusion (Hemley, 1971).

The number of dentitions without any spaced condition (that is both crowding and spacing) was fifty-two percent, which was slightly higher than the observations of Steigmann and Weissberg (1985) in a Middle Eastern population.

**Maxillary midline diastema.**

The reported frequencies of maxillary midline diastema, for both the same and different racial groups, vary greatly in the literature. The frequency of diastema, in this study, compared well with that of Caucasian samples (Taylor, 1939; Keene, 1964; Horowitz and Doyle, 1970), but were appreciably lower than others (Gardiner, 1967; Richardson et al., 1973). The presentation was higher than in British children (Weyman, 1969) and for each group in the mixed sample of Lavelle (1970). The Negroid samples in other surveys show frequencies more than twice that seen in the Western Cape sample (Jacobson, 1967; Horowitz and Doyle, 1970; Richardson et al., 1973).

**Anterior relations.**

The measurement of overbite and overjet has been attempted by numerous investigators, resulting in the establishing of a number of systems using different criteria (Björk, 1953; Draker, 1960; Hallett and Burke, 1961; Björk et al., 1964; Grainger, 1967; Summers, 1971; Haynes, 1972; FDI, 1973; Todd, 1975; Heikenheimo, 1978; Akpata and Jackson, 1979).

For the evaluation of increased overjet numerous measurements have been suggested namely 3 mm by Walther (1960) and Isiekwe (1983), over 3 mm (Tulley, 1973; Foster and Day, 1974; Isiekwe, 1983), 5 mm or more (Haynes, 1972; Tavares et al., 1982; Corruccini et al., 1983), 6 mm or more (Björk et al., 1964; Ingervall and Hedegaard, 1975; Magnusson, 1976; Cons et al., 1978) and as over 6 mm (Lavelle, 1976; Horowitz and Doyle, 1970).

Likewise the assessment of excessive overbite varies greatly. One-third overlap as proposed by Gardiner (1956) and Poulton and Aronson (1961), greater than half (Miller and Hobson, 1961; Houston, 1976) more than two-thirds overlap (Jackson, 1962; Haynes, 1972 and 1974), over 3 mm by Johnson et al. (1978), 5 mm or more (Björk et al., 1964; Helm, 1968; Pedersen et al., 1978) and over 5 mm by Lavelle (1976).

In most studies the results were subjective as normal overjet and overbite was defined before the study was conducted rather than determined from the results of the study. The mean overjet of 2.45 mm reported in this study was very similar to that of Nigerian and English children (Akpata and Jackson, 1979) but slightly lower than the study of Haynes (1974, 1975a, 1975b, 1977) and Kinaan (1986). The frequency of increased overjet was the same as that reported by Cons et al. (1978) and lower than both groups in the survey of Horowitz and Doyle (1970). Reverse overjet (anterior crossbite) was similar to Foster and Day (1974) and de Muñiz et al. (1986) but higher than that reported by

Cons et al. (1978) and the York group of Akpata and Jackson (1979). To the contrary, the Nigerian group of Akpata and Jackson (1979) and that of Isiekwe (1983) showed a higher incidence than this study.

Other researchers report a higher incidence of deepbite than observed in this study (Horowitz and Doyle, 1970; Luffingham and Campbell, 1974; Cons et al., 1978; Kinaan, 1986).

An increased incidence of openbite has been reported (Worms et al., 1971; Akpata and Jackson, 1979; Isiekwe, 1983. However, both groups of Cons and co-workers (1979) show an incidence less than half of that of the Western Cape group.

**Posterior relations.**

In the posterior segments the frequencies of crossbite and openbite were found to be lower than those reported in the USA (Horowitz, 1970; Cons et al., 1978), the Philippines (Lombardi and Bailit, 1972) and Finland (Ingervall and Hedegaard, 1975).

The frequency of distal molar occlusion was similar to that found in the United States of America (Horowitz and Doyle, 1970; Cons et al., 1978). Mesial molar occlusal was more frequent than in the latter group of studies including the Finnish group (Ingervall and Hedegaard, 1975), but less than in Nigeria (Isiekwe, 1983).

Asymmetrical molar relations were higher than that of most studies (Horowitz and Doyle, 1970; Cons et al., 1978; de Muñitz et al., 1986). Smith and Bailit (1977) reported a very high frequency of these type of molar relations. This observation could be due to the evaluation criteria used. The vast number of asymmetries highlights a major shortcoming of the Angle classification. This classification only accommodates asymmetries where one of the sides have a class I relationship.

**Midline deviations.**

Less than fifty percent of the subjects examined had coincident maxillary and mandibular midlines. This was in keeping with studies elsewhere (Horowitz and Doyle, 1970; Cons et al., 1978) and might suggest deviations of the midline are the norm and not the exception.

The frequency of teeth lost caused many secondary malpositions of the teeth in the dental arches, a feature that is common after extraction of the first molar. On the other hand, loss of teeth had probably had little influence on the frequency of crossbite (Ingervall and Hedegaard, 1975) and on the relative frequency of molar relations (Cons et al., 1978).

**Treatment priority.**

In this study an assessment of treatment priority was not made because of its highly subjective nature. Notwithstanding, Helm (1977) and others (Steigmann et al., 1983) stated that the subjective estimation of treatment need, based on professional experience, seems to be the only approach we have at our disposal, to the problem of assigning treatment priorities. This is calculated on the basis of a clinical estimation of the adverse effects of the occlusal traits on aesthetic and oral function.

A systematic orthodontic examination permits not only the planning and timing of treatment of malocclusion but also facilitates the use of preventive and interceptive measures to minimize the severity of the problem (Helm, 1977). Careful planning based on feasibility studies is essential for the creation of appropriate solutions. Specific aspects such as assistance plans, distribution of dental professionals and the adaptation of available human and material resources will require further studies.

# CONCLUSION

The findings of this study indicate that ideal occlusion as described by Angle (1899) is very rare. A record of the distribution of the occlusal traits can be utilised to determine the expected variations from ideal occlusion. Thus a definition of normal occlusion, in statistical terms, can be developed by taking the mean for the individual traits with consideration for standard deviation and confidence ranges.

Thus for the population examined a **"normal occlusion"** should have:

1. No developmental anomalies.
2. No crowding or spacing in the lateral segments of the arch, and anterior irregularities between any of the anterior teeth no greater than 1 mm or anterior diastema greater than 0.1mm.
3. Normal molar relationships.
4. No posterior open bites or crossbites.
5. Anterior overjet less than 4.0 mm, with no mandibular overjet.
6. No overbite greater than 3.74 mm, or anterior openbite.
7. Midline deviations not more than 0.15 mm to the right or left.
8. No soft tissue impingements.

# APPENDIX I

**Sample Sizes Required Under Simple One-Stage Cluster Sampling.**

$$m = \frac{z^2 \; V^2}{\epsilon^2}$$

where

$$Vx^2 = \frac{\sigma x^2}{Xb^2}$$

$$Vr^2 = \frac{\left[ \frac{\sigma x^2}{Xb^2} + \frac{\sigma y^2}{Yb^2} - \frac{2\;(\sigma xy)}{XbYb} \right]}{r^2}$$

$$\sigma xy = \frac{\Sigma(X - Xb)(Y - Yb)}{M}$$

M is the number of clusters in the population.

z is the reliability coefficient at the 95% confidence level.

$\epsilon$ represents the specifications of the estimate in terms of the maximum relative difference allowed between it and the unknown population parameter.

# APPENDIX II

**MEASUREMENT OF OCCLUSAL TRAITS**

**RECORDING FORM**

Name.....................................................................

Date of Birth | | | | | | | Sex | |

**A. Dental Measurements**

| | CODE |
|---|---|
| 1. Anomalies of Development | |
| a. Congenitally Absent Teeth | C |
| b. Supernumerary Teeth | S |
| c. Malformed Teeth | M |
| d. Impacted Teeth | I |
| e. Transposed Teeth | T |
| 2. Missing Teeth Due to Extraction or Trauma | X |
| 3. Retained Primary Teeth | R |

| CODE | TOOTH |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**B. Intra-arch Measurements**

| | |
|---|---|
| 1. Crowding (insufficient arch space) | C |
| 2. Spacing (excessive arch space) | S |
| Normal | N |
| Non-recordable segment | A |

| | RIGHT LATERAL | INCISAL | LEFT LATERAL |
|---|---|---|---|
| UPPER | | | |
| LOWER | | | |

3. Anterior Irregularities

Score only the largest irregularity for each arch to the nearest whole millimetre

| | 2 | 1 | 1 | 2 |
|---|---|---|---|---|
| UPPER | | | | |
| LOWER | | | | |

4. Upper Midline Diastema

If non-recordable, enter "A" in Box

| | +mm

**C. Inter-arch Measurements**

1. Lateral Segments

| | CODES | RIGHT 47 | 46 | 45 | 44 | 43 | LEFT 33 | 34 | 35 | 36 | 37 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Anteroposterior - Molar Relation | D+, D, N, M, M+ | | | | | | | | | | |
| b. Vertical - Posterior Openbite | N, O | | | | | | | | | | |
| c. Transverse - Posterior Crossbite | B, N, L | | | | | | | | | | |

If a tooth is ABSENT, measurement is unrecordable A

2. Incisal Segments

| | | RIGHT 2 | 1 | LEFT 1 | 2 |
|---|---|---|---|---|---|
| a. Anteroposterior - Overjet | ±mm. | | | | |
| b. Vertical - Overbite | ±mm. | | | | |
| c. Transverse - Midline Deviation | ±mm., side | | | | |
| d. Soft Tissue Impingement | L, P | | | | |
| | | | | | |

If a tooth is ABSENT, measurement is unrecordable A

# APPENDIX III

1. **Kappa Index**

Measuring the agreement relative to what could have been expected by chance.

| | | Observation A | | |
|---|---|---|---|---|
| | | normal | abnormal | totals |
| Observation B | normal | a | b | a + b |
| | abnormal | c | d | c + d |
| | totals | a + c | b + d | |

$$k = \frac{2(ad - bc)\ n}{(a+b)(b+d)+(a+c)(c+d)}$$

where

a, b, c and d are the frequencies observed.

n = total number of observations.

2. **Chi-squared Test.**

$$Chi^2 = \Sigma \frac{(O - E)^2}{E}$$

where

O = observed values.

E = expected values.

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