EFFECT OF ORTHODONTIC TREATMENT ON THE FACIAL PROFILE

A Thesis

Presented to

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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Bodily exercise, when compulsory,
does no harm to the body; but knowledge
which is acquired under compulsion
obtains no hold on the mind.

PLATO'S REPUBLIC

Effect of orthodontic treatment on the facial profile

by

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ABSTRACT

Using computerized cephalometric techniques, the effect of orthodontic treatment on the facial profile was quantitatively assessed. Seventy-four orthodontic patients treated at the University of Manitoba constituted the test sample, while twenty-eight untreated subjects obtained from the Burlington Growth Centre, Faculty of Dentistry, University of Toronto, served as a control sample. Utilizing serial lateral cephalometric films of both samples, linear horizontal, linear vertical, angular and cross-sectional measurements were performed. A mixed factorial analysis of variance was used to examine the effect of extraction versus non-extraction type of treatment in Class I, Class II Division 1 and Class II Division 2 malocclusion groups over the three stages of treatment (pre-treatment, post-treatment and post-retention).

The statistical assessment of the data suggests the following conclusions:

(1) The effect of orthodontic treatment in the cross-sectional areas of the maxillary and the mandibular lips is minimal. The observed increase in the cross-sectional area of both lips resulted from the effect of

growth.

(2) The maxillary lip followed the maxillary incisal retraction in a ratio of 0.7:1. As a result of this response, the thickness of the maxillary lip increased as measured linearly. This increase, however, was not detected cross-sectionally.

(3) The mandibular lip responded to maxillary rather than to mandibular incisal retraction, supporting the concept that lower lip protrusion is related to the prominence of the upper incisors.

(4) The soft tissue cephalometric points epidermic "A" and epidermic "B", showed a close association with the underlying skeletal framework. The retraction ratio between hard and soft tissue "A" and "B" points was found to be 1:1.

(5) The vertical interincisal relationship was affected by the orthodontic treatment as a result of incisal intrusion and clock-wise mandibular rotation.

(6) The orthodontic treatment caused no changes in the interlabial relationship.

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INTRODUCTION

Aesthetics is defined as the study or philosophy of beauty and from classical times, has played an important role in human life. As a source of inspiration, aesthetics has influenced the artistic expression in all its forms.

During the Golden Century of Athens, the ideal beauty was synonymous with concepts such as harmony and symmetry, and as Plato asserted,"The qualities of measure and proportion invariably... constitute beauty and excellence." Aesthetics, during the same time, became the area of study of the physiognomics which were based on a concept that there is a close relationship between bodily, especially facial features, and psychosynthesis. This relationship was expressed, during the era of Aristotle, with the apothegm "ΟΙΑ Η ΜΟΡΦΗ ΤΟΙΑΔΕ ΚΑΙ Η ΨΥΧΗ" which, in free translation means that the face reflects the soul.

Facial aesthetics embodied in classical sculpture of ancient Hellas, strongly influenced many early orthodontists, most notably, Angle at the beginning of this century. When Angle (1907) gave the description of the ideal soft tissue profile, in a chapter on facial art, he referred to Apollo Belvedere which exhibits a soft tissue profile expressing balance, harmony and beauty.

In the past few decades, the influence of orthodontic treatment on skeletal and integumental profile has

been a subject of great interest. Numerous investigators, using different cephalometric approaches, have attempted to identify the interrelationships between profile changes and orthodontic treatment.

One of the main problems is that changes in the skeletal and soft tissue profile caused by treatment as well as those caused by growth, require to be identified. In addition, growth changes in the soft tissue profile are often not fully expressed on the completion of orthodontic therapy, depending on the sex and age of the patient. Consequently, the effects of growth and orthodontic treatment on the final morphology of the soft tissue facial profile may be difficult to discriminate. The lips in particular, have attracted considerable interest as they form one of the main components of the lower face. Many investigators, using cephalometry, have examined lip posture (Burstone, 1967) and the linear changes in vertical (Jacobs, 1978) and horizontal (Anderson et al, 1973, Roos, 1977, etc.) dimensions resulting from incisal retraction during and after orthodontic treatment. Unfortunately, there has been no study of cross-sectional changes in the area of the lips before, during and after orthodontic treatment, to examine what kind of effect the orthodontic treatment has on the lip volume and discern, if an interaction exists between form and function. Yet the absence of data on the separate effects of growth and orthodontic treatment inhibits our

understanding on the role of the soft tissues on the facial profile. The objectives of this investigation were:

1) To evaluate quantitatively the influence of both growth and orthodontic treatment on various regions of the facial profile.
2) To evaluate cross-sectional soft tissue lip changes relative to underlying skeletal elements before, during and after orthodontic treatment.
3) To describe the interrelationships between the hard and the soft tissue profile changes occurring before, during and after orthodontic treatment.

REVIEW OF THE LITERATURE

CHAPTER II

REVIEW OF THE LITERATURE

The interest of investigators in the growth and development of the human facial profile and the face generally, has led to the development of various techniques which allow the standardization of methods. As a result, it is possible to analyse quantitatively changes in the facial profile.

Early Studies of the Face and the Facial Profile Prior to the Advent of Cephalometric Radiography

In 1872 Von Ihering devised a plane for the evaluation of the facial profile. This plane, known today as the Frankfort horizontal plane, is defined as a line passing through the highest point at the margin of the external acoustic meatus and the lowest point at the orbital margin. The Frankfort horizontal plane has been traditionally used by many workers in this field as a reference plane to study changes of the facial profile.

Dreyfus (1922) developed an alternative reference plane of measuring profile changes, using a vertical line through nasion point perpendicular to the Frankfort horizontal. Four years later, Simon (1926) devised a photographic method termed "photostatics" to assess the soft tissue growth and other facial changes. In this technique the head is divided into three planes. One of these planes the orbital plane, which passes through the two infraorbital

foramina perpendicular to the Frankfort horizontal, has been used to measure the integumental profile.

While many methods were developed in order to assess facial growth and development, not much emphasis was placed on defining what characterizes a normal or abnormal facial profile.

Angle (1907) emphasized the importance of the soft tissue and considered the mouth as a very significant factor in making or marring the character of the face. He stated that the form and beauty of the mouth itself depended on the occlusal relationship of the teeth. Angle felt that a harmonious facial pattern could exist only with a full complement of teeth arranged in a normal occlusion and that the upper incisor, with its influence on both upper and lower lips, was the key to facial aesthetics.

Case (1921), like Angle, was one of the first orthodontists to be concerned with facial aesthetics. He made facial casts of patients to show the effect of malocclusion and subsequent orthodontic therapy on facial profile. Case considered that the facial outlines should be a guide in determining orthodontic treatment plans for all malocclusions. He demonstrated the futility of depending on normal occlusion for a complete diagnosis by showing three different profiles, each with a Class I malocclusion. Case therefore differed from Angle, the latter tending to disregard the profile in order to achieve a "normal"

occlusion. Indeed, Case considered that the orthodontists should be trained in observing profiles and advocated extractions in some cases of bimaxillary protrusion in order to retract the procumbent lips.

Wuerpel (1937) stated that faces can be beautiful even though they are proportioned differently. The important factor was considered to be balance: i.e., that one part of the facial pattern must not be overemphasized at the expense of another.

The different treatment philosophies of Angle and Case generated great interest among their colleagues and placed facial aesthetics at the center of attention of the orthodontic world. Neither worker employed the use of measurements, however, as each relied upon subjective training in the ability to observe facial changes.

Hellman (1939) was one of the first to use anthropometric methods to study growth changes in individuals. Using rulers and calipers, Hellman analyzed facial measurements on 1,693 subjects from three to twenty-two years of age and concluded that as the face grows, depth increases most, height increases less, and width changes least of all. The relative increase in height was greater in the posterior (ramus height) than in the anterior (total face height), while the relative increase in width and depth was greater inferiorly (mandibular angle and body of the mandible) than superiorly (bizygomatic width and auriculonasion depth).

Standardization of the anthropometric methods, using craniostats and calipers, helped orthodontists to measure and investigate the facial growth at the quantitative as well as the qualitative level. This was subsequently elaborated in the design of more sophisticated tools, such as the cephalometer, which increased the data concerning growth and development of the human face.

Hard Tissue Assessment of the Facial Profile

Numerous studies followed the development of the cephalometer, by Broadbent (1931) in the United States and Hofrath (1931) in Germany. This heralded the beginning of a new era in the study of facial growth and development. Studying the cephalometric films of a cross-sectional group of children, Broadbent (1937) reported that growth of the facial structures occurred in a rather constant, orderly manner. This observation differed from previous assumptions that facial growth is a complex erratic process.

Brodie (1941), in a longitudinal study of growth in children of unspecified ethnic origin, from three months to eight years of age, found that the morphogenetic pattern of the head and face is established early in life and tends to remain constant. In a later longitudinal study (1953), utilizing nineteen males, age eight to seventeen years, Brodie noted that the late stages of growth are accompanied by a continuation of forward and downward movement of the anterior nasal spine and pogonion. By contrast the dental

arch and its supporting bone tend to move more slowly and therefore "drop behind", decreasing the prominence of the dental arches. He found that a steady constant rate of growth occurs up to eight years of age, followed by a slowing down of growth until adolescence, at which time a definite growth spurt was seen.

Bjork (1947) studied a growing sample of three hundred and twenty-two boys, twelve years old, and a non-growing sample of two hundred eighty-one adult males, twenty-one and twenty-two years of age. He concluded that an increased prognathism of both jaws was characteristic of profile changes with age. He also noted that the increase was greater in the mandible which effectively straightened the facial profile in an anteroposterior dimension. The same conclusions were made by Bjork in a later longitudinal study (1951) of one hundred and fifty males at the age of twelve and again later at the age of twenty-one.

Lande (1952), in a longitudinal study of thirty-four males ages four to seventeen, concurred with Bjork that the mandible becomes more prognathic in relation to the remainder of the cranium during growth. This was found to be associated with a decrease in the inclination of the lower border of the mandible as well as a decrease in the angle of convexity. It is interesting, that the findings of both Bjork and Lande are supportive of Brodie's early work.

Tweed (1945) felt that a definite relationship existed between pleasing facial aesthetics and the orientation of the teeth. He attempted to correlate the angulation between the mandibular incisors and basal bone and what he considered to be balanced facial lines. Using cephalometrics as a tool, Tweed (1954) expanded this concept and stated that balanced facial aesthetics will be obtained when a Frankfort-mandibular incisor angle (FMIA) of sixty-five degrees is established.

Downs (1948, 1952, 1956), recognized the importance of the relationship between facial profile and the occlusion and incorporated a number of measurements indicative of the ideal position of the anterior teeth. He felt that excessive deviations from the means of measurements in his analysis usually express abnormalities or imbalance in particular areas of the facial profile.

Steiner (1953, 1959, 1960) presented angular and linear guidelines for the placement of the incisors as a function of the craniofacial skeleton. In the face which deviates from the normal, he suggested a series of "acceptable compromises" that could be utilized as treatment goals. These "compromises" were based on the maxillary-mandibular relation and provided for incisal placement that would provide an optimal soft tissue profile. Thus, Steiner's analyses and compromises enabled the orthodontist to plan a more realistic and aesthetic treatment goal based

on the nature of existing skeletal discrepancies.

Many other orthodontists have used cephalometric methods for the evaluation of lateral cephalograms. Wylie (1947), Margolis (1953), Bjork (1947), Tweed (1946, 1954), Ricketts (1957, 1960), Sassouni (1955, 1958, 1960), Enlow (1975), have all contributed valuable methods for cephalometric analysis.

Soft Tissue Assessment of the Facial Profile

In orthodontics, there is primarily a two faceted view of an orthodontic problem, namely, the hard and the soft tissue components. The majority of analyses provide an assessment of the skeletal and dental elements of hard tissue component in a sagittal view. This assessment indicates the changes necessary to reorient the structures to more harmonious relationships.

Even though there is close approximation of hard and soft tissue, it was realized that analyses of the hard tissue was not sufficient in itself and study of the soft tissue was essential in order to have a clear view of the orthodontic problem. To aid in diagnosis and treatment planning various analyses have been formulated.

Burstone (1958), evaluating the integumental profile, felt that much variation exists between individuals in the thickness, length and posture of soft tissue overlying the skeletal foundation of the facial profile. He studied the profiles of the Herron sample (a group of good

faces selected by a panel of three artists) and developed an integumental analysis. Burstone analyzed seven integumental landmark points and their interrelationships and compiled an integumental profile grid of acceptable young adult faces from which graphic comparison can be made. In a later study (1973), Burstone pointed out the existing variation in the form and length of the nose and he stated that it will be a mistake to use the nose as a major factor determining lip protrusion. Burstone proposed as a reference plane, for aesthetic evaluation of the soft tissue profile, the Sn-Pg plane, which he believes can be used advantageously in a non-growing individual since subnasale and pogonion areas are relatively unaffected by orthodontic treatment. He also found that in adolescent groups the soft tissue thickness from point A to subnasale is 4 mm greater than the thickness of the upper lip and chin and 3 mm greater than the thickness of the lower lip. All measurements represented harmonious interrelationship of the upper and lower lip in an aesthetically pleasing profile.

Ricketts (1957, 1961), believes that the nose is part of the profile and therefore should be included in the analysis of the soft tissue. He recommends as a plane of reference, for routine clinical use, the aesthetic or "E" plane which is made by a tangent line from the soft tissue chin to the tip of the nose. He found that in white adults the lower lip is located on the average about 4 mm posterior

(± 3 mm) to the "E" plane, slightly more in adult males due to sexual differences in chin and nose. Ricketts (1968) stated that in the evaluation of the soft tissue profile there is no single goal, but an acceptable range and in the normal mature caucasian, the lips are contained within the "E" plane, the outlines of the lips are smooth in contour, the upper lip is slightly posterior to the lower lip when related to that plane and the mouth can be closed without any visible strain. If the lower lip falls behind the upper lip, he feels that the profile is overtreated. Ricketts also pointed out the important role which the lower incisor plays in treatment planning as a result of its influence to upper incisor and lower lip and therefore to facial aesthetics. He recommended that the lower incisor should be placed 1 mm ahead of the A-Pg plane with acceptable range of -1 to +3 mm.

Steiner (1960), proposed for the evaluation of the soft tissue profile, a line tangent from the chin to the middle of the lower border of the nose. He said that the lips should fall on this line, while lips lying ahead are too full, and lips lying behind are too flat, relative to other parts of the profile. In this analysis, the lip position is more definitely defined than in Ricketts analysis and takes into consideration large or small nose, a large or small chin and harmonizes them with the lips. Both the Steiner and Ricketts analyses relate the three