Nonextraction and Extraction Facial Profiles Compared by Trained Dentists and Lay Evaluators

by

Dr. Dan A. Stuart

A thesis submitted to the Faculty of Graduate Studies of the
University of Manitoba in partial fulfillment of the requirements
For the degree of

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University of Manitoba
Department of Preventive Dental Science
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Dedication

This thesis is dedicated to my wife, Kelly Stuart. Only she and I know just what it took to bring my stepdaughter, Danielle, and our daughter, Kayleigh, through graduate school with us.

Your support in my life, Kelly, is what every man hopes to have. For that, I am truly grateful.

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So many times the Clinic Staff are forgotten in the acknowledgements. At U of M we have the luxury of having dental assistants take all of our records – this allowed me to concentrate on treating patients rather than taking countless records. Thank you for giving me the time to concentrate on my passion of being chairside and truly enjoying the provision of care to my patients as an Orthodontist.

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Mom and Dad! Without your support and encouragement over the years none of this would be possible. Thank you for making me what I am today – a very happy man with eternal gratitude and respect for his parents for giving him the courage to "step out of the comfort zone." It will be great to return to Nova Scotia and be close to home again.

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Abstract

Premolar extraction effects on the soft tissue profile remain a source of debate in the orthodontic profession. The "before and "after" facial profiles of 20 patients treated by four first premolar extraction and 20 by nonextraction were evaluated by 40 trained dentists and 40 lay evaluators. The purpose of this study was to determine any preference between the change in extraction or nonextraction profiles at the end of orthodontic treatment with fixed appliances. Age, facial contour angle and Ricketts' E-line measurements were compared in both groups in an attempt to quantify soft tissue facial changes. Trained dentists and lay evaluators preferred the changes in the extraction profiles over nonextraction profiles immediately after orthodontic treatment ($p<.0001$). Trained dentists and lay evaluators preferred competent lips to incompetent lips in both extraction and nonextraction profiles ($p<.0001$). With respect to profile change, extraction of four premolars does not seem to have a significant effect on subjective evaluation of post-extraction facial esthetics immediately after treatment. This finding is supported by several other similar studies.

Chapter 1

Introduction

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Chapter 1

Introduction

1.1 The Basis of the Controversy in Extraction versus Non-Extraction Orthodontic Treatment

The debate on whether to embrace a non-extraction or extraction approach continues to shape the orthodontic profession. The recent popularity of non-extraction treatment plans to promote "arch development" has resulted in a reduction of treatment plans to support premolar extraction even in crowded arches (Weintraub et al., 1989; O'Connor, 1993). This approach, propagated by the teachings of Edward Angle in the early 20th century, concentrated on the importance of facial esthetics and the appearance of the soft tissues that emphasized a non-extraction approach to ensure facial harmony (ie. the mouth is the most potent factor of the facial character (Angle, 1907). However, a paradigm shift in this philosophy of the orthodontic profession occurred with the teachings of Tweed (Tweed, 1944; Tweed, 1945; Tweed, 1952; Tweed, 1953) who clearly advocated the extraction of premolar teeth. Tweed's teachings influenced many North American orthodontists and teaching institutions so greatly, that the prevalence of first premolar extractions rose to 50% of the patients treated at The University of North Carolina in 1963 compared to only 10% just ten years earlier (Proffit, 1994).

1.2 The Concern of Facial Esthetics

Premolar extraction has led the profession to recognize the "orthodontic look" or "dished in" profile (Drobocky and Smith, 1989). The focus began to shift back to facial esthetics in the 1980's, when some practitioners claimed that non-extraction techniques, utilizing two-phase treatment, removable appliances, air-rotor stripping and arch development as the only way to achieve acceptable facial esthetics (Stoner, 1984; Witzig and Sphal, 1987; Bowbeer, 1986; Broadbent, 1990). The central decision not to extract teeth is the retrusive lips and poor profile changes caused by four first premolar extractions and orthodontic treatment (Witzig and Sphal, 1986). Presently, the orthodontic profession is just beginning to address the concerns of all practitioners – should we treat early and possibly reduce the frequency of extractions or wait until the permanent dentition erupts, extract teeth and achieve a more acceptable outcome? A recent symposium on early treatment and follow-up publications (Boley, 2002; Gianelly, 2002; Johnston, 2002; Little, 2002; McNamara, 2002; Proffit amd Tulloch, 2002) attempted to address those questions which are pertinent to this day.

1.3 Facial Profile and Orthodontics

Orthodontists have long been interested in the facial profile changes caused by orthodontic treatment (Tweed, 1946; Burstone, 1958; Burstone, 1967; Holdaway, 1984; Kocadereli, 2002). Although numerous studies have determined that premolar extractions do not produce poor facial balance (Drobocky and Smith, 1989; Paquette at

al, 1992; Luppanapornlarp and Johnston, 1993; Young and Smith, 1993; Bowman and Johnston, 2000) "key" references cited in a recent journal article (Boley,2002) in defence of serial extraction are based on tracings of profiles (Paquete et al., 1992; Bowman and Johnston, 2000) and cephalometric analysis (Drobocky and Smith, 1989; Luppanapornlarp and Johnston, 1993; Young and Smith, 1993). Photographs of facial profiles are more representative of before and after orthodontic treatment results as this is what both lay persons and clinicians evaluate at the end of treatment; however it has been suggested that hair style, make-up, facial expression and age may unnecessarily influence the evaluators (Bishara and Jakobsen, 1997).

This begs the question whether lay persons (untrained in dentistry) have a different opinion of what facial profiles are preferred after orthodontic treatment relative to a "dentally trained" group? Studies have shown differences between these two groups, in that laypersons tend to be less critical of changes in profiles than dentists (Kerr and O'Donnell, 1990; Bishara and Jakobsen, 1997) but an extensive search of the English literature did not produce any previous studies where "dentally trained" individuals as well as "lay" individuals had evaluated using "before" and "after" treatment profiles on the same set of photographs.

To address the principal issues contained in the literature review, the current study was designed to test the following null hypotheses:

1) There is no difference in the changes between the post-orthodontic treatment profiles of non-extraction cases vs. first four premolar extraction cases as judged by trained dentists and lay evaluators.

2) There is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of profiles with incompetent vs. competent lips.

3) There is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of profiles with incompetent or competent lips.

4) There is no difference in the soft tissue profiles of the extraction and non-extraction group before and after treatment.

Chapter 2

Review of the Literature

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Chapter 2

Review of the Literature

2.1 Early Evaluation of Facial Profile

Measurements of the human face have been performed since the Greek era. The Greeks were likely influenced by the Egyptians who first recorded body proportions to create the "art" of human figures (Vegter and Hage, 2000). Aristotle's *Physiognomica* describes the science of reading a person's character from their bodily features (Heinemann, 1963); in particular Aristotle's *Historia Animalium* associates the descriptions of facial features reflecting the quality of the person associated with such features (Aristoteles, 1949). The evaluation of facial proportion in relation to profile was offered by Leonardo Da Vinci in the fifteenth century. Da Vinci described a well-proportioned face in equal thirds: from chin to nostrils, nostrils to eyebrows and from eyebrow to hairline. Da Vinci also added that the height of the ear should equal the length of the nose (McMurrich, 1930). The father of modern rhinoplasty, Jacques Joseph, presented drawings of ideal nasal shapes, based on the length from the base of the nose and the inferior edge of the chin in the early 20^{th} century illustrating the importance of vertical face height on the overall esthetics of the face (Joseph, 1931).

During the early 20^{th} century the orthodontic community was treating patients mostly by non-extraction treatment based on the tenets of Dr. Edward Angle, the father of modern orthodontics. Angle professed that extraction destroyed the possibility of ideal occlusion

or ideal esthetics, and thus required the presence of all the teeth. He considered form and beauty of the mouth was directly related to the occlusal relationship of the teeth, and the mouth played a very significant role in making a face esthetically pleasing or not. Extractions had been used in the late 19th century in orthodontic treatment to alleviate crowding, but according to Angle's "new school" and modern orthodontic treatment of non-extraction, stabilization of the new tooth positions would be provided through function. The soft tissue would shape in a harmonious manner; if the teeth were in harmony so would be the face (Angle, 1907).

A group opposed Dr. Angle and his followers, who were sometimes referred to as the "rational school" of orthodontic treatment under the leadership of Calvin Case. They believed that new bone could not grow to support the new positions of the expanded dentition. Because of this proposed lack of support of bone, Case and his followers proposed that extractions were indeed necessary to treat some malocclusions, and criticized Angle because of the excess dental protrusion following expansion and its negative effects on facial esthetics (Case, 1964).

2.2 Cephalometric Evaluation of Facial Profile

The cephalostat, introduced in 1931 by B. Holly Broadbent, Sr, allowed the orthodontist to visualize the hard and soft tissue profile of the face (Broadbent, 1931). Cephalometics, literally the measurement of the head, brought about a new way to evaluate facial esthetics by relating hard and soft tissues to patient profiles. Many cephalometric

analyses began to develop with this new diagnostic tool. Prior to 1950, there was little mention of soft tissue evaluation in cephalometrics.

Reidel was one of the first investigators to study facial profiles and orthodontics. He examined the lateral cephalograms of thirty subjects and reported that the position of the teeth on their apical bases in conjunction with the relationship of the maxilla and mandible and relative convexity, all influence the soft tissue profile (Reidel, 1950). Steiner suggested that facial profile was in balance if the upper and lower lips each touched a line extending from the middle of the lower border of the nose to the most anterior portion of the chin (S-Line) in a 12-year old subject (Fig 2.1). If the lips were ahead of this line, it was considered unesthetic because the lips are too protrusive. Alternatively, if they are behind this line, they were considered too retruded (Steiner, 1960).

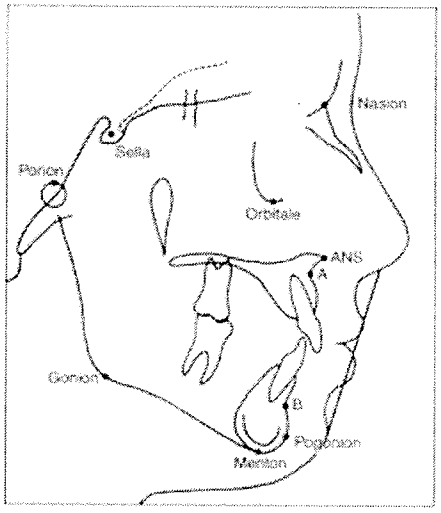


Figure 2.1 S-Line is a line extending from the middle of the lower border of the nose to the most anterior portion of the chin

Ricketts (1960) used a line tangent to the tip of the nose and the chin known as the Esthetic Line or E-Line. The lower lip should be 2mm behind this line on average, with both lips contained within this line in adult Caucasians (Fig 2.2).

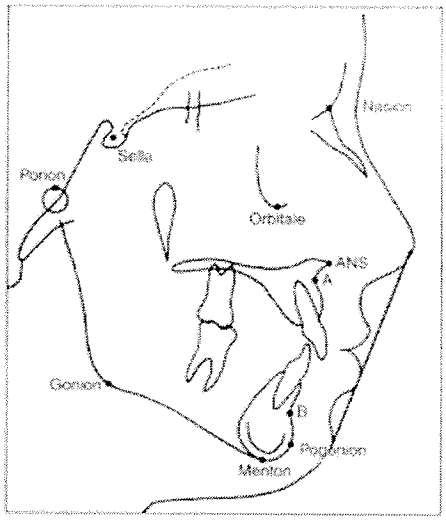


Figure 2.2: E-Line is a line tangent to the tip of the nose and the chin

Holdaway incorporated hard and soft tissue landmarks in the development of a soft tissue analysis. The "H" angle, proposed in 1963, essentially measured the angle formed between Nasion – Pogonion and a line drawn tangent to the upper lip and the tip of the soft tissue chin. He contended that this value should be between 7 and 9 degrees, if the angle formed by subspinale-nasion-supramenton (ANB) value was 3 degrees. If ANB is greater than 3 degrees or smaller than 1 degree, the "H" angle value (Fig 2.3) could then be increased or decreased respectively (Holdaway,1956; Jacobsen and Caufield, 1985).

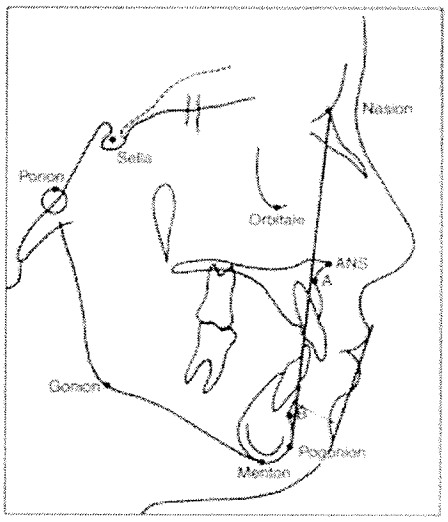


Figure 2.3: "H" Angle is formed between nasion – pogonion and a line drawn tangent to the upper lip and the tip of the soft tissue chin.

Merrifield also used hard and soft tissue landmarks to describe an ideal soft tissue profile. His modification of the H line, used by Holdaway, was to measure an angle formed by Frankfort Horizontal and a line tangent to the soft tissue chin and the most anterior point of either the lower or upper lip, whichever was most protruded. He considered the upper lip should be tangent to the profile line; the lower lip should then be tangent or slightly behind this line. In adults, the normal "Z" angle should be 80 degrees; in patients 11 to 15 years of age the normal Z angle is 78 degrees (Fig 2.4). Both of these values are valid with a normal Frankfort –mandibular plane angle (FMA), lower incisor to mandibular plane angle (IMPA), Frankfort to maxillary incisor angle (FMIA) and ANB angles for both groups (Merrifield, 1966).

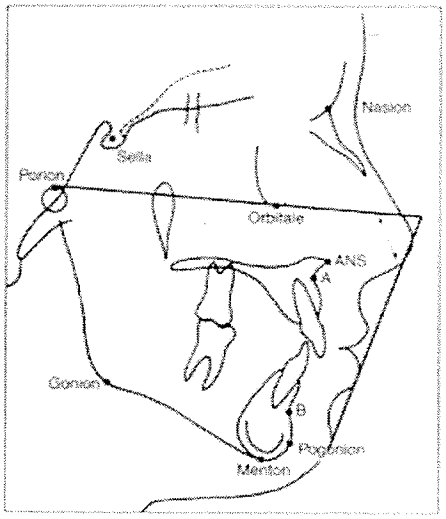


Figure 2.4: "Z" Angle is an angle formed by Frankfort Horizontal and a line tangent to the soft tissue chin and the most anterior point of either the lower or upper lip, whichever was most protruded.

Evaluation of lip protrusion independent of the size of the nose has also been utilized to measure esthetics. Linear measurement of the upper and lower lips from a line Subnasale-Soft Tissue Pogonion, where the ideal measurement is the upper lip 3.5mm ± 1.4mm ahead of the line and the lower lip 2.2 ± 1.6mm forward of the line is known as the B-Line or Burstone line (Fig 2.5). The measurements are perpendicular to Sn-Pg and extend to labrale superius and labrale inferius, respectively (Burstone, 1967).

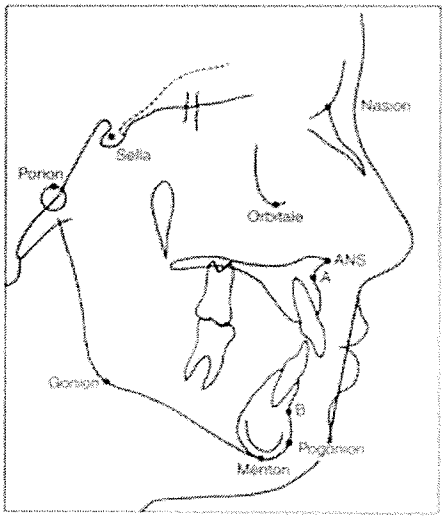


Figure 2.5 Burstone Line is from subnasale to soft tissue pogonion. Linear measurement of the upper and lower lips from a line Subnasale- Soft Tissue Pogonion, where the measurements are perpendicular to Sn-Pg and extend to labrale superius and labrale inferius, respectively.

The Burstone line has been demonstrated to be a more sensitive measurement than Rickett's E-line, Steiner's S-Line and Holdaway's H-Line in identifying esthetic and unesthetic faces in a sample of 110 students selected from a pool of 1000 students for attractiveness of lip protrusion (Hsu, 1993).

Burstone pointed out that investigation of the soft tissue profile was "relatively meager" in the early orthodontic literature (Burstone, 1958) and proposed two main reasons for this omission. First, orthodontic treatment was concerned with the manipulation of hard tissues. Second, there had been an assumption that if the teeth are arranged according to a given standard, the soft tissue will automatically produce facial harmony (Angle, 1907). Burstone examined a group of 40 ideal faces chosen by three artists from the Herron Institute of Art in Indianapolis and concluded that the ideal hard tissue cephalometric values of each individual was not correlated with facial profile. The ideal hard tissue

values did not allow for variations in soft tissue thickness. Burstone's early observations demonstrated the lack of correlation between treating patients to ideal skeletal norms and creating a pleasing soft tissue profile. Years later, Burstone would further strengthen this conclusion by treating patients to an ideal dental norm by placing the lower incisor 1mm ahead of Subspinale-Pogonion (A-Pog) and concluding that the soft tissue position of the lips varies greatly in spite of achieving a hard-tissue treatment goal (Park and Burstone, 1986). This is in agreement with others who have also recognized that the soft tissue drape can vary significantly from one person to another and that a pleasing profile is not necessarily dependent on the underlying hard tissue structures (Zylinski at al, 1992; Nanda and Ghosh, 1995). In the evaluation of facial profile, nasal structure is also a factor that must be considered by the clinician.

The nasolabial angle, is formed by the intersecting of two lines originating at subnasale and extending to the most anterior tip of the columella with a line from subnasale to labrale superiorus (Fig 2.6). This angle has a wide range with means of approximately 102.4° ± 8.2° for males and 102.2° ± 7.7° for females (McNamara et al, 1992). This measurement has been used as an evaluation of esthetics in the sense that values over 120° are considered to be unesthetic; more importantly the goal of the orthodontist is to avoid the creation of an obtuse nasolabial angle with the over-retraction of maxillary incisors (Witzig and Sphal, 1986; Drobocky and Smith, 1989)

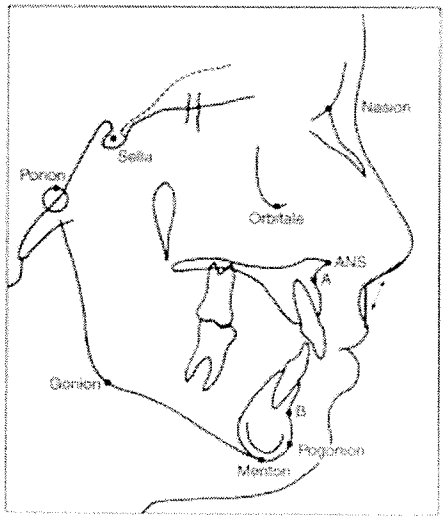


Figure 2.6 Nasolabial Angle is formed by the intersecting of two lines originating at subnasale and extending to the most anterior tip of the columella with a line from subnasale to labrale superiorus

Evaluation of the facial profile cannot be limited only to the lower one third of the face with specific focus on the lips, nose and soft tissue chin. Another highly relevant analysis to assess the relative convexity or concavity of the face is the Facial Contour Angle (Burstone, 1959; McCollum, 2001). The angle is formed by the intersection of tangents at soft tissue pogonion and glabella which intersect at subnasale (Fig 2.7). The upper facial contour plane is from glabella to subnasale while the lower facial contour plane is from subasale to pogonion; the acute angle between these two planes is the Facial Contour Angle with a normal of -11° ±° (Burstone, 1959).

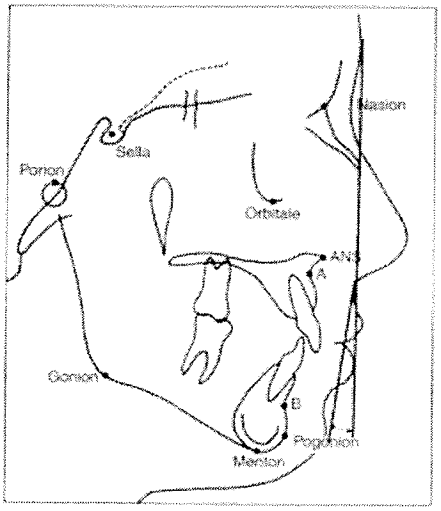


Figure 2.7: Facial Contour Angle is formed by the intersection of tangents at soft tissue pogonion and glabella which intersect at subnasale.

In a study of 545 dental professionals rating constructed profiles, it was concluded that more protrusive profiles were preferred and that more lip protrusion was found acceptable for both male and female faces if either a large nose or large chin was present (Czarnecki et at, 1993). When the selected profiles were analyed, the "ideal" Facial Contour angle for men varied between -10° and -14° with a mean of -12°; female "ideals" ranged from -14° to -16° with a mean of -15° (McCollum, 2001). Racial differences are evident with female Caucasians being reported as slightly flatter (mean -11°) when compared to African American females with a mean facial contour angle of –13.9° (Sutter and Turley, 1998).

Recently, soft tissue analysis of the facial profile has become increasingly complex with the identification of soft tissue landmarks with radiopaque markers to allow the evaluation of facial structures such as the cheek bone, orbital rim, alar base, subpupillary area, and the neck-throat point (Arnett, 1993). Multiple measurements are now possible

with the use of a computer to digitally analyze facial profile and identifying over 40 measurements from a true vertical line on the cephalometric radiograph (Arnett and McLaughlin, 2004).

2.3 Facial Profile Changes as a Result of Orthodontic Treatment

Orthodontic treatment by means of the extraction of teeth has been criticized in the literature (Stoner, 1984; Bowbeer, 1986; Witzig and Sphal, 1987; Broadbent, 1990) and has been the focus of many studies to examine the effect of extraction treatment on facial profile.

The general belief that premolar extraction frequently causes "dished in" profiles has been refuted by scientific studies (Paquette at al, 1992; Luppanapornolarp and Johnston, 1993; Young and Smith, 1993; Staggers, 1994; Bishara and Jakobsen, 1997; Boley et al, 1998; James, 1998; Bishara et al, 1997; Bowman and Johnston, 2000). Luppanapornolarp and Johnston (1993) compared 29 non-extraction patients and 32 "clear-cut" extraction patients, an average of 15 years after orthodontic treatment. While extraction therapy produced a significantly greater reduction in hard and soft tissue convexity by 2-3mm initially, the extraction patients were actually more protrusive at recall. A similar study comparing 33 borderline extraction patients and 30 nonextraction patients reported opposite findings in that the extraction group had flatter profiles (on average 2mm less procumbent lips) but they were no less pleased with the treatment

result when asked to rate silhouettes of their own profiles before and after treatment (Paquette et al, 1992).

Extraction treatment can cause soft tissue profile changes that must be managed carefully by the orthodontist. Drobocky and Smith (1989) evaluated 160 subjects who were treated with the extraction of four first premolars; a mean increase in the nasolabial angle of 5.2° was reported along with a mean lip retraction of 3.5mm measured to Rickett's E-line. Their conclusion was that "extraction of four first premolars generally did not result in a 'dished in' profile." Approximately 10-15% of the 160 patients treated with the removal of four first premolars were defined as "excessively flat" after treatment. However, the authors concluded that the generalizations of the negative effects of extraction treatment of first premolars are false and that "the great majority of patients exhibit controlled amounts of profile change that produce improvements in facial esthetics."

In order to critically evaluate the facial changes in extraction and non-extraction patients, Boley et al (1998) tested the perceptions of 192 experienced general dentists and orthodontists in the evaluation of 25 non-extraction and 25 four premolar extraction profiles. The dentists and orthodontists could not tell the difference between the two groups. It was concluded that "the avoidance of extracting premolars based on a fear of a significant detrimental effect on the face is unjustified when the case has been properly diagnosed and treated". Bishara and Jacobsen (1997) also compared extraction and non-extraction patients by using profile silhouettes of 44 extraction and 47 nonextraction Class II division 1 patients. They were also compared to "normal" untreated Class I

matched photographs for age and sex from 10 female and 10 male patients who participated in the Iowa Growth Study. Lay people were asked to assess the profiles of these patients. It was concluded that treatment profiles of "normal" Class I patients were preferred over "before" treatment profiles of Class II division 1 patients. Immediately after treatment the profile changes in the extraction group were rated more favorably than the nonextraction group; the final evaluation after two years post treatment concluded that the profile of neither group was rated more favorably than the other. An important note was that both groups were perceived more favorably at the two year mark than at initial observation.

Extraction effects on soft tissue profile with the extraction of four first premolars using a variety of treatment approaches have also been measured. Young and Smith (1993) examined 198 orthodontic patients treated nonextraction by various methods including the Tweed technique, Begg technique, straightwire appliances, and a two-phase treatment group using functional appliances followed by full fixed edgewise appliances. They compared the non-extraction patients to a group of 160 patients treated by first four bicuspid extraction in a previous study (Drobocky and Smith, 1989) and showed that non-extraction and extraction patients had the same percentage of undesirable facial changes (approximately 15%). After comparison of the lateral cephalometic films of the two groups, the authors concluded, "...it is simplistic and incorrect to blame undesirable facial esthetics after orthodontic treatment on the extraction of premolars (Young and Smith, 1993). In another study, Z-Angle and E-line measurements were used to quantify differences between 170 consecutively treated patients (108 treated with premolar

extraction and 62 treated without premolar extraction). The author concluded that both groups completed treatment in normal ranges of profile measurement values. In addition, the lips were slightly more retrusive in the non-extraction group at the end of treatment, and "the extraction group began with greater facial imbalance and had the greatest improvement in facial esthetics" (James, 1998).

In an effort to eliminate the bias of the orthodontist and make conclusions based on cephalometric numbers alone, Bowman and Johnston (2000) recently investigated the esthetic effects of extraction and non-extraction by comparing the before and after profile tracings of 70 extraction and 50 non-extraction Class I and Class II patients. They asked 58 laypersons and 42 dentists to assess pre and post treatment profiles. With similar profiles at the beginning of treatment, the extraction group had an average 1.8mm "flatter" profile. However, the flatter faces were preferred by both groups, with the dentists preferring the flatter faces more than the laypersons. When lips were shown to be more protrusive (more than 2-3 mm behind the E-Line), both panels saw extraction as being beneficial. The conclusion reached in the study was that "extraction treatment can produce improved facial esthetics for many patients who present with some combination of crowding and protrusion" (Bowman and Johnston, 2000).

Vertical dimensions of the face have also been demonstrated to have a significant role in the assessment of soft tissue facial profile. De Smit and Dermaut (1984) tested 249 adults (110 with limited orthodontic training and 139 untrained) to judge 27 artificially constructed profile silhouettes. Differences in orthodontic training had no effect on

esthetic preferences of the two groups and class I profiles were most appreciated. "Open types" or long –faced profiles were least appreciated with a warning from the author to "avoid the creation of long-face features." Clinically, the author states that, "...in vertical normal and open profiles, it could be more appropriate to maintain the skeletal Class II deviation in order to avoid a lengthening of the facial height". An increase in facial height during the course of orthodontic treatment not only affects the lower face height, but it has also been significantly correlated to an increase in the nasolabial angle (Lo and Hunter, 1982). This is in agreement with Talass et al. (1987) who showed that orthodontic treatment increased the nasolabial angle an average of 10.5° in an orthodontically treated group of 80 females. Mandibular rotation during orthodontic treatment was also found to be one of the more significant variables in predicting the response of upper and lower lips to treatment (Rains and Nanda, 1982) thus influencing the final position of the lips in facial profile.

The effects of orthodontic treatment on the position of the lips has been an area of great interest to orthodontists. Early research by Bloom (1961) attempted to establish a linear correlation of upper and lower incisor retraction to the lips. Bloom compared the pretreatment and post treatments cephalograms of 60 American white patients (30 males and 30 females) with a mean age of 11-6 (range 8 to 16 years) pretreatment. Twenty five percent of the patients were treated by 4 premolar extraction and the rest treated non-extraction. He concluded that the linear change of the upper incisor to the upper and lower lip was .87 and .82 respectively. The lower lip was found to have a linear change of the lower incisor to lower lip of .93.

Rudee (1964) evaluated pre and post-treatment cephalograms of 85 patients (50 females and 35 males) who ranged in age from 6-4 to 22-6. He concluded that the mean ratio of upper incisor retraction to upper lip retraction was 2.9:1. More importantly, Rudee noted the large range of –3:1 to 6:1. Due to the influence of growth on lip position of patients Hershey (1972) limited his patient sample to females over 16 years of age (20.3 ± 3.2 years) at the start of orthodontic treatment. His sample consisted of 20 Class I, 15 Class II and one Class III patient of which 32 had four first premolars extracted and four were treated non-extraction. In the evaluation of pre and post cephalometric films he concluded "Lip position is not highly correlated with incisor tooth movement".

Racial Background

Racial background is an important factor in lip position in response to orthodontic treatment. A study with a sample of 10 boys and 6 girls (aged 11- to 16-2) of African-American background consisting of 7 bimaxillary dentoalveolar protrusions, 4 Class I arch-length discrepancies, 4 Class II division 1 and one Class III all treated with extraction therapy, assessed lip posture as the result of tooth movement (Garner, 1974). Through comparison of pre and post treatment cephalometric radiographs the author concluded that, "...boys and girls who undergo mechanotherapy of orthodontic treatment do exhibit changes in lip posture as a result of this tooth movement. The extent of the lip change is not always predictable." Garner commented, "As a rule of thumb, a 2:1 ratio for the maxillary incisor to labrale superius change might be expected in girls if the lip tonus is normal, thickness, and length are typical, and no growth occurs. It appears that

there is no sure answer." The recognition of differences in lip response in incisor retraction was simply stated by Oliver (1982) where, "thin upper lips showed significant correlations between upper incisor retraction while thick lips did not." This observation was based on based a cephalometric study of 40 white Class II division 1 patients aged 12 to 15 years at the onset of orthodontic treatment.

Lip incompetence and response to incisor retraction is also of great interest to the orthodontist. Jacobs (1978) treated 20 Class II division 1 patients (11 males and 9 females) to examine this relationship. Jacobs concluded that the interlabial gap closes at 1mm for every 2mm of horizontal retraction if neither extrusion or intrusion of the incisors occur. If incisors are intruded the closure of the interlabial gap tends to increase and decreases if incisors are extruded during retraction.

Soft tissue analysis in the treatment planning of orthodontic patients requires clinical experience. Holdaway (1983) offered his conclusions based on years of observation and treatment of patients from his private practice. He stated that:

"..in general, for adolescents the normal or usual lip thickness of the soft tissue at point A is altered by tooth movement, headgear, etc., the soft tissue will follow this point and remain the same thickness. When there is taper in the maxillary lip immediately anterior to the incisor, as in protrusive dentures, the tissue will thicken as the incisors are moved lingually until the tissue approaches the thickness at point A (within 1mm of the thickness at point A). When the taper has been eliminated, further lingual movement of the incisor will now cause the lip to follow in a one-to-one ratio. These concepts are predicable in adolescents when the lip thickness at point A is within the normal range. Some exceptions are as follows: even if there is a lip taper, if the thickness at point A is very thin (for example 9 to 10mm), the lip may follow the incisor immediately and still retain the taper. If the tissue at point A is very thick (for example 18 to 20mm), the lip may not follow incisor movement at all. Adult tissue reaction is similar to the first...

..exception. Even though there may be lip taper, the lips will usually follow the teeth immediately."

In an effort to remove the effects of growth on lip changes during orthodontic treatment Talass et al. (1987) evaluated 80 female Class II division 1 orthodontically treated patients with a control group of 53 age matched female patients from the Burlington Growth Center. The changes in anteroposterior position of the upper lip as a result of growth were minimal. However, a significant retraction of the upper lip (average of 3.7mm) took place when orthodontic treatment was performed. A low degree of predictability of upper lip response and upper incisor retraction was also noted.

The desire to quantify the mean ratio of maxillary incisor retraction to maxillary lip retraction has been a goal in the literature. Rudee (1964) found a ratio of 2.93:1, Roos (1977) found a ratio of 2.5:1, and Perkins and Staley (1993) found a ratio of 2.24:1. In a more recent study, 32 adult Japanese patients were treated with extraction of four first premolars. It was concluded that the ratio of upper incisor retraction to horizontal movement of the upper lip was 2.38 (±1.67):1 (Kasai, 1998). An opposing view is that only mandibular incisor retraction can correlate with upper and lower lip change for both white and African American and Indonesian patients (Assuncao et al., 1994; Caplan and Shivapuja, 1997; Kusnoto and Kusnoto, 2001). Rudee (1964), an early researcher in lip response associated with tooth movement, concluded from his results that although there is a positive statistical significance between correlated incisor and lip movement, it is,

" tempered with the knowledge that the range of possible results is broad enough to thwart precision."

Recent research has attempted to quantify facial changes in three dimensions with the use of optical surface scans. In a recent study (Ishmail et al, 2002) the entire face was scanned in three dimensions rather than an assessment of a two-dimensional profile. Twenty-four patients aged 9 to 11 years were treated in a prospective study. Twelve patients were treated orthodontically by extraction and 12 by non-extraction therapy. In measurements of the cephalometric profile alone, the only significant ($p < .05$) difference detected between the two groups was an increase in nasolabial angle in the extraction group and an increase in lower lip thickness in the non-extraction group. The 3-D optical surface scans of the face before and after orthodontic treatment indicated that not only did the concavity of the labiomental fold increase in extraction patients, but this group also showed a gradual flattening of the lower part of the cheeks over the course of treatment. This was in contrast to the nonextraction group who showed a slight increase in convexity of the cheeks during orthodontic treatment. The authors concluded that 3-D surface scans offer more data analysis than a lateral cephalogram alone.

2.4 The Role of Growth on the Profile

The orthodontist has a critical role in the evaluation of a patient's profile. Decisions that are made in early adolescence by the orthodontist could determine how a patient may look for the rest of his or her life. Perhaps it has been stated best that, "anterior teeth that were retracted during the adolescence period to correct protrusion, even though the teeth had looked good initially, may appear over-retracted 20 years later. The experience in the 1950's and 1960's of high extraction rates and profile flattening resulted in many unesthetic outcomes. For these patients, the loss of lip thickness with aging makes the lack of lip support from the teeth even more obvious" (Sarver et al, 2003)

Clinicians have recently been warned in the literature to pay attention to the effects of extraction and non-extraction (Bishara et al, 1997) in order to avoid accentuating characteristics of an undesirable profile. This statement is based on the evaluation of 91 Class II division 1 patients (46 treated non-extraction/ 45 patients treated with extraction of four first premolars) where lateral cephalograms 2 years post treatment revealed that the extraction group had more retrusive lips compared to the creation of more protrusive lips in the non-extraction group. The conclusions were that, "current findings suggest that the extraction/ non-extraction decision, if based on sound diagnostic criteria, does not have a systematic detrimental effect on the facial profile" (Bishara et al, 1997). Bishara continued his investigation with a follow-up paper the next year that looked at the long-term effect of growth on soft tissue profiles from 5 to 45 years of age on 20 males and 15 females who had never been treated orthodontically, but who had lateral cephalograms taken between 5 and 45 years of age as part of the Iowa Growth Study (Bishara et al.,

1998). Bishara emphasized the fact that patients are still growing significantly when many orthodontic treatment decisions are made. This might influence the extraction/ non-extraction decision based on his conclusions that: (1) the timing of the greatest changes in the soft tissue profile occurred earlier in females than males (10-15 years and 15- 25 years, respectively). (2) The angle of soft tissue convexity that excludes the nose, has a very small average change between the ages of 5 and 45 years of age. (3) The Holdaway soft tissue angle progressively decreased between 5 and 45 years of age, and 4) the upper and lower lips became significantly more retruded in relation to the E-line between 15 and 25 years of age and this tendency continued until 45 years of age. (Bishara et al., 1998).

The position of the lips is very relevant to the assessment of facial profile by the clinician. Vig and Cohen (1979) studied the vertical growth of the lips and found that the length of the lips increases with age with the lower lip growing more than the upper lip. Clinically, this can translate to a facial profile of an 8-year-old boy, judged to have incompetent lips and possibly requiring extractions, changing as growth ensues and the lips increase in length such that his lips are competent at age 15 (Sarver et al, 2003). In another study, further investigation into the maturation of the lips by age clearly demonstrated the sex differences between boys and girls: Mandibular lip height tended to plateau at about age 16 in boys and girls, while maxillary lip height reached a plateau around age 14 for females and 18 for males. Even more importantly, it was demonstrated that maxillary lip thickness will plateau at age 14 in females and begins to decrease in

thickness shortly thereafter. The maximum lip thickness is also reached early in boys at age 16 (Mamandras, 1988).

Growth of the nose has a great influence on the profile and can greatly influence the outcome of cephalometric measurements of the soft tissue profile, especially the E-line (Jacobsen and Caufield, 1985). Furthermore, a clear difference in both the amount and patterns of nasal growth between boys and girls have been demonstrated where males tend to have a much greater increase during adolescence in nose length where girls may not. The formation of a dorsal hump in correlation with the presence of a class II malocclusion has also been demonstrated and is also more pronounced in boys (Chaconas, 1969).

It is clear that profile assessment is made up of individual differences in skeletal, dental, and soft tissue components (Ackerman and Proffit, 1997). Growth must also be taken into account. The challenge is to begin with the end in mind, and understand how to get there.

Chapter 3

Materials and Methods

Contents

Chapter 3

Materials and Methods

Prior to the gathering of any data, the thesis proposal for this project was submitted to the Health Ethics Review Board at The University of Manitoba. Approval was given confirming that this study was designed in accordance with the guidelines set out by the Health Ethics Review Board (Appendix 7) and permission gained to undertake the study.

3.1 Three Null Hypotheses are tested in this Study:

1. There is no difference in the change between the post-orthodontic treatment profiles of non-extraction cases vs. first four premolar extraction cases as judged by trained dentists and lay evaluators.

2. There is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of profiles with incompetent vs. competent lips.

3. There is no difference in post-orthodontic treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of profiles with incompetent or competent lips.

4. There is no difference between the soft tissue profiles of the extraction and non-extraction groups both before and after treatment.

3.2 Research Design

Consultation with an experienced Professor of Biostatistics* was the first step in the design of this study. In order to satisfy power considerations, a sample size of 40 patients

(20 treated by extraction and 20 treated by non-extraction) was advised. Also recommended was that the sample of 40 patients should be rated by 40 lay evaluators and 40 trained dentists.

*Dr.Tom Hassard, Director, Biostatistics Unit, Faculty of Medicine, University of Manitoba.

3.3 Sample Selection

Forty patients were selected from the University of Manitoba Graduate Orthodontic Program "C" records. These records are records of patients that have been treated by former residents of the program and have had initial, immediate post treatment and two-year retention records completed. Twenty patients treated by extraction of four first premolars and 20 patients treated by a non-extraction method were selected by the principal investigator. The charts were reviewed in alphabetical order. The first chart to meet the selection criteria was selected until forty patient records of 20 extraction and 20 non-extraction had been gathered. The criteria for the selection of the patients were:

1. No syndromic patients
2. No cleft palate patients
3. No patients that had been treated by orthognathic or cosmetic surgery
4. No beards, moustaches or facial hair of any type to obstruct the soft tissue profile.
5. All patients must have been treated with fixed orthodontic appliances.

The two facial profile slides were taken from each chart. The first facial profile slide was taken at "A" Records at the initial assessment. The second facial profile slide was taken immediately after treatment at "B" Records on the day of removal of the fixed orthodontic appliances. The slides were then taken to the Information Services and Technology office at The University of Manitoba and converted to digital images (JPEG) using a Minolta SC100 slide scanner. The software used to create the digital images was Adobe 6.0. The periocular area was blacked out using Adobe Photoshop 1.1 Business Edition to conceal the identity of the subjects (see fig 3.1). The slides were then organized into a Powerpoint® presentation of forty slides with each slide showing a "before treatment" facial profile photo on the left and an "after treatment" facial profile photo on the right.

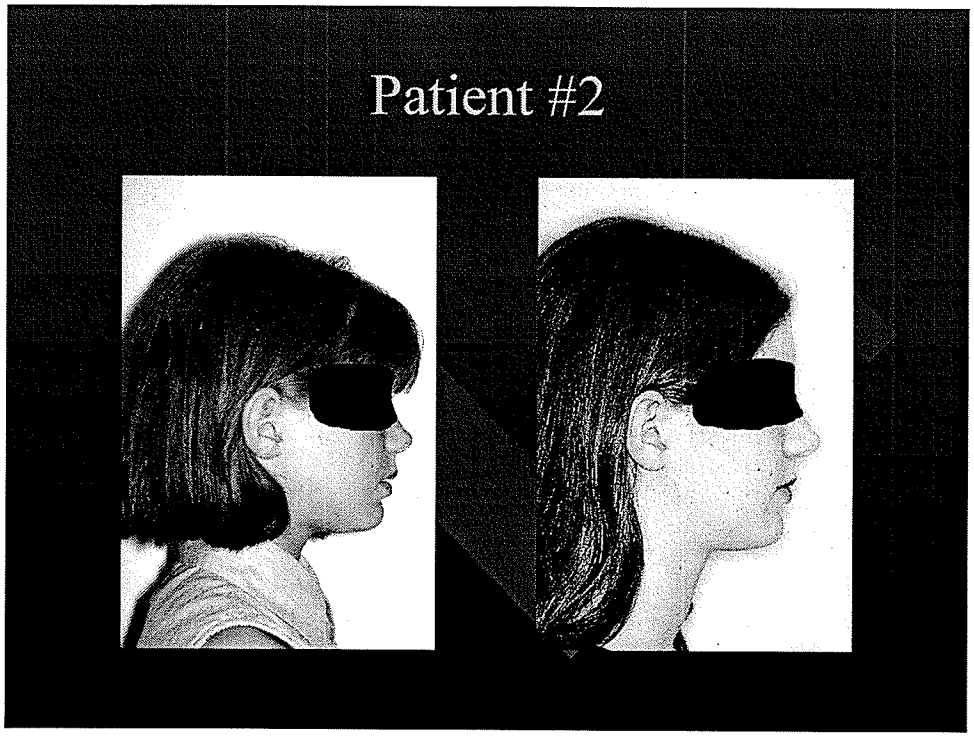


Figure 3.1: Sample of Powerpoint Slide

The Powerpoint© presentation and a binder containing the color printout of the Powerpoint© show were used for the collection of data by lay evaluators and trained dentists respectively.

Data collection from the lay evaluators took place in the Alpha Omega classroom in the Dentistry Building, University of Manitoba. Lay evaluators were the first year dental students in the fall of 2002 as well as untrained first year hygienists (ie. none had formal training in orthodontics). The lay evaluators were given a Research Participant Information and Consent Form (Appendix 4) prior to evaluating the profiles. The participants were then given a Data Collection handout (Appendix 5) and instructed to rate the profiles of 40 patients following orthodontic treatment. It was explained that some of the patients had been treated by extracting four first premolars and some had been treated without extractions. Participants were asked to rate the "after treatment" profiles compared to the "before treatment" profiles in accordance with a 5-point Likert scale that was provided on the handout with the labels of: 1)Worse 2) Slightly Worse 3) Same 4) Slightly Better or 5) Better. The raters were asked to circle the number that they felt best described the after treatment profile. It was explained that before treatment profiles were on the left, the after treatment profiles are on the right and that the patients were in no particular order.

Lay evaluators watched the Powerpoint© show with an exposure time of 30 seconds for each slide and recorded their responses on the Data Collection forms. At the end of

twenty minutes, Data Forms and Research Participant Information and Consent Forms were collected by the principal investigator.

Trained dentists were asked to participate on an individual basis. Trained dentists (20% (N=8) were certified orthodontists; another 15% (N=6) were second or third year orthodontic residents, the remainder were general dentists, periodontists, periodontic residents, an oral surgeon and an oral pathologist) were given the same Research Participant Information and Consent Form (Appendix 4) and Data Collection Form (Appendix 5). They evaluated the profiles using a color printout of the Powerpoint show© in a 1.5" three-ring binder (see sample of Powerpoint® show printout - fig 3.1). They were asked to limit the viewing of each page to 30 seconds. Data Forms and Research Participant Information and Consent Forms were collected by the principal investigator.

3.4 Distribution of Molar Classification: Extraction vs. Nonextraction Groups

Forty patients were selected from the University of Manitoba Graduate Orthodontic Program. "C" records consisted of 20 extraction and 20 nonextraction patients. The two groups were comprised of males and females with Class I, Class II and Class III malocclusions with the following distribution in each group:

The extraction group of 20 consisted of 15 female and 5 male patients. There were 9 Class I patients (5 female and 4 male); 9 Class II patients (8 female and 1 male); and 2 Class III patients (2 female).

The nonextraction group of 20 consisted of 9 female and 11 male patients. There were 8 Class I patients (2 female and 6 male); 10 Class II patients (6 female and 4 male); and 2 Class III patients (1 female and 1 male) (see Table 4.1 below):

40 PATIENTS					
24 FEMALE 16 MALE					
EXTRACTION 15 Female 5 Male			NONEXTRACTION 9 Female 11 Male		
Class I (9)	Class II (9)	Class III (2)	Class I (8)	Class II (10)	Class III (2)
5 Female 4 Male	8 Female 1 Male	2 Female 0 Male	2 Female 6 Male	6 Female 4 Male	1 Female 1 Male

Table 3.1: Extraction and Nonextraction Sample Characteristics of Sex and Dental Classification (Angle Molar Classification)

3.5 Age of Extraction vs. Nonextraction Groups

Before Treatment

The extraction group was significantly older than the nonextraction group at the beginning of treatment ($p < 0.0238$) (Appendix 1a). The extraction group's mean age was 16.32 ± 7 years while the non-extraction group's mean was 13.26 ± 3.8 years before orthodontic treatment.

After Treatment

The extraction and nonextraction groups were treated an average of 2.8 and 2.5 years, respectively. The difference in treatment times was not statistically significant ($p > 0.1552$). The ages at the completion of orthodontic treatment were 15.77 ± 3.87 for the

nonextraction group and 19.10 ± 7.29 for the extraction group. They were still statistically different groups with respect to age at the end of treatment ($p < 0.0155$) (Appendix 1b).

3.6 Facial Contour Angle of Extraction vs. Nonextraction Facial Profiles

Before Treatment

The extraction group differed from the non-extraction group significantly before treatment with respect to the facial contour angle ($p< .0136$) (Appendix 2a). The mean facial contour angle of the extraction group before orthodontic treatment was $-16.25° \pm 4.5$ compared to the nonextraction group with a mean facial contour angle of $-12.55° \pm 3.9$ before treatment.

After Treatment

The extraction group decreased in facial contour angle significantly during treatment ($p <.0001$) while the non-extraction group did not ($p> 0.85$) (Appendix 2b). The facial contour angles of the extraction and nonextraction groups after orthodontic treatment were $-14.28° \pm 4.6$ and $12.42° \pm 4.3$ respectively (Table 4.2). These two groups are not different statistically ($p> 0.29$) after treatment (Appendix 2c).

Changes in the Facial Contour Angle can be presented graphically by dividing each of the extraction and nonextraction groups into four groups or "Quantiles". Note that center bar reflects 25th to 75th Quantiles with the 50% Median expressed as a horizontal line. 95% of subject values expressed as vertical bars extending from middle Quantile values. An asterisk (*) denotes outlying subject(s). The changes in Facial Contour Angle (degrees) is shown for the extraction and nonextractions groups in Figure 4.1 below. By examination of the graph, it is evident that the change in Facial Contour Angle during orthodontic treatment was larger for the extraction group compared to the nonextraction group.

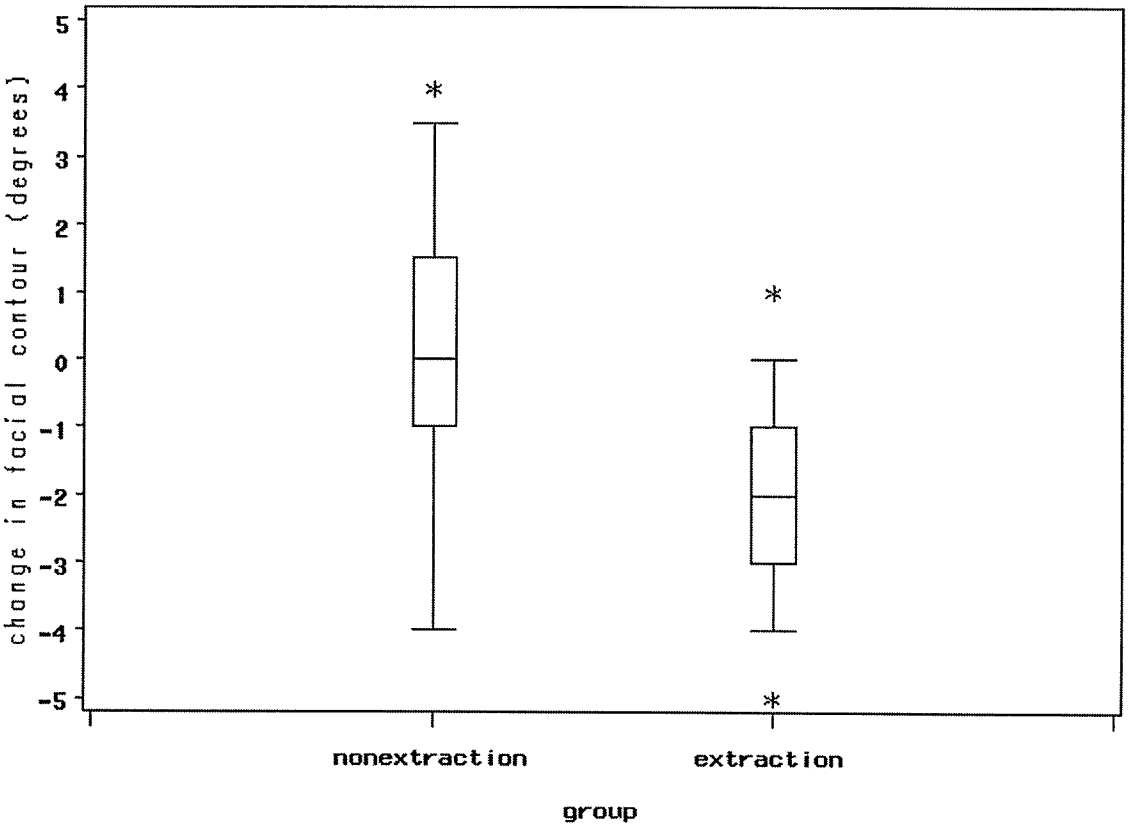


Figure 4.1: A Comparison of Extraction and Nonextraction Groups: Changes in Facial Contour Angle During Orthodontic Treatment as Expressed by Quantile

3.7 Rickett's E-line Values of Extraction vs. Nonextraction Facial Profiles

Before Treatment

The extraction and nonextraction groups were not found to be statistically different prior to treatment ($p > 0.21$) (Appendix 3a). Rickett's E-line values for the extraction group were 1.45mm ± 2.7 and -0.4mm ± 3.9 for the non-extraction group prior to orthodontic treatment.

After Treatment

The extraction group had an E-line value of -1.53mm ± 3.0 after treatment. The nonextraction group had an E-Line value of -1.5mm ± 2.8 after treatment. These two groups are not statistically different after treatment ($p>0.69$) (Appendix 3b). Despite the fact that that extraction and nonextraction groups were not statistically different before or after orthodontic treatment when compared with one another as stated previously, a significant decrease in the value of the E-Line measurement was detected between the two groups ($p < .0120$) (Appendix 3c); the change for the extraction group being significant ($p<.0001$) while no significant change ($p>0.11$) in the E-line value occurred in the nonextraction group (Appendix 3c).

Changes in the Ricketts' E-Line value can be presented graphically by dividing each of the extraction and nonextraction groups into four groups or "Quantiles". Note that center bar reflects 25th to 75th Quantiles with the 50% Median expressed as a horizontal line. 95% of subject values expressed as vertical bars extending from middle Quantile values. An asterisk (*) denotes outlying subject(s). The changes in Ricketts' E-Line Value (millimeters) is shown for the extraction and nonextractions groups in Figure 4.2 below. By examination of the graph, it is evident that the change in Ricketts' E-Line value during orthodontic treatment was larger for the extraction group compared to the nonextraction group.

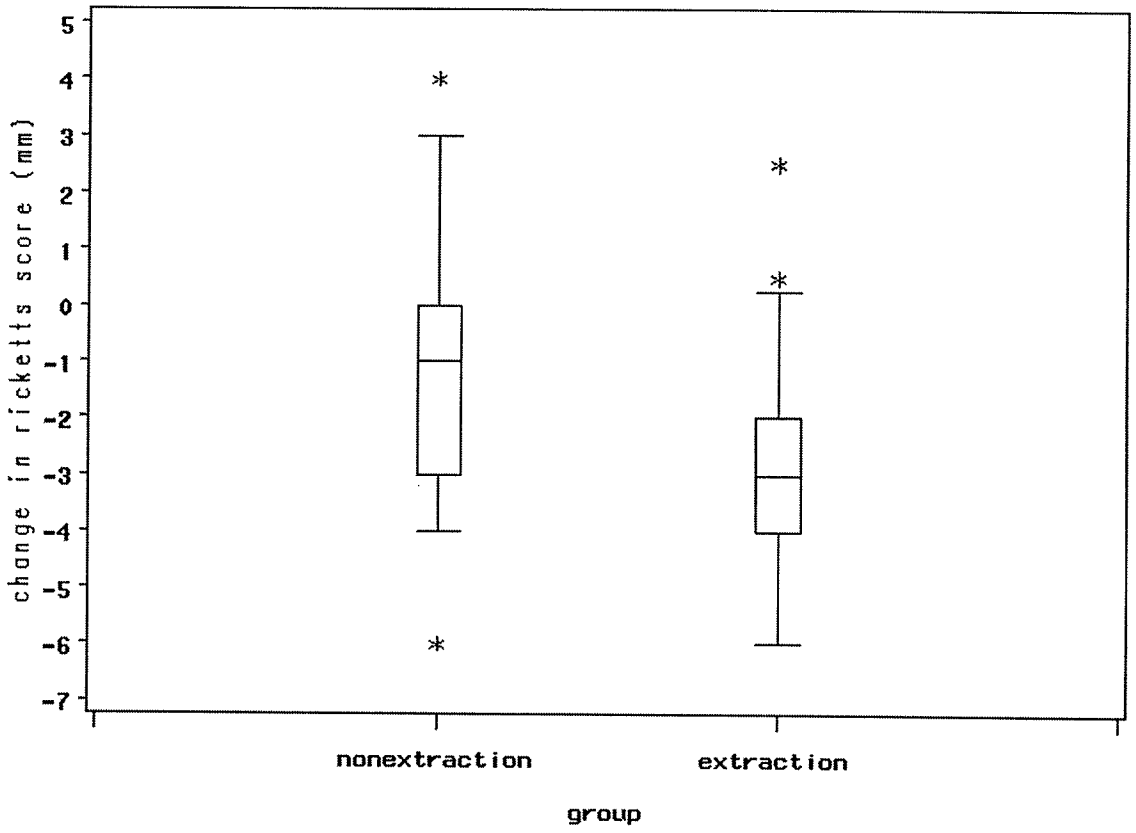


Figure 4.2: A Comparison of Extraction and Nonextraction Groups: Changes in Ricketts' E-Line Values During Orthodontic Treatment as Expressed by Quantile

3.8 The Likert Scale

The Likert Scale, named after U.S psychologist Rensis Likert (1903-1981), is a scale showing respondents' agreement or disagreement. It is a scale measuring the degree to which people agree or disagree with a statement, usually on a 3-, 5- or 7-point scale (Encarta World English Dictionary, 2003). The Likert Scale is a commonly used research tool in academic literature (Tindill et al., 1993; Seidel et al., 1999; Orlowski and Christensen, 2002). The Likert scale used in this study in the same method as described in Koochek (2001). For a more detailed explanation of the use of the Likert Scale see Bowers (1976).

3.9 Statistical Analysis

All data was entered into Excel© spreadsheets. Likert scale results from the data collected from the rating of facial profiles were entered. Numbers from 1 to 5 represented: 1) worse, 2) slightly worse, 3) same, 4) slightly better and 5) better. Forty lay evaluators and 40 trained dentists rated 40 patients (20 extraction and 20 nonextraction) for a total of 3200 responses. Since the results of the profile analyses did not follow a normal distribution (see figs 4.2, 4.3, 4.5). The Non-parametric data was subjected to Wilcoxon Signed Rank Sum Tests (Hassard, 1991) to determine if there was a difference between the post-orthodontic treatment profiles of non-extraction cases vs. first four premolar extraction cases as judged by trained dentists and lay evaluators. The difference in perception of these profiles by dentally trained individuals vs. lay evaluators

when they evaluate the post orthodontic treatment profiles of the two groups was also tested by the same method.

Eight patients (4 extraction and 4 nonextraction) out of the sample of 40 had incompetent lips at the end of treatment (see Table 4.3). This group was also subjected to Wilcoxon Signed Rank Sum Tests (Hassard, 1991) to determine if there was a difference in the profile rating of treatment outcomes with incompetent lips.

Statistical analyses of age of the patient, facial contour angle and Rickett's E-line to determine means, standard deviation, range for both extraction and non-extraction groups before and immediately after treatment were completed using Wilcoxon Signed Rank Sum Tests (Hassard, 1991). In order to determine the differences between the soft tissue profiles of the extraction and non-extraction group both before and after treatment the groups were compared by Rickett's E-line values and Facial Contour Angle values using the Wilcoxon Signed Rank Sum Tests (Hassard, 1991) as well.

Facial contour angles and Rickett's E-line values were measured manually on the lateral cephalometric films by the principal investigator to the nearest ½ degree and ½ mm respectively. Ten random measurements were performed by the principal investigator two weeks later to test for error in measurement. No errors were recorded.

Chapter 4

Results

Contents

Chapter 4

Results

Whereas sections 4.3 and 4.4 showed that there were significant changes in the facial profiles of patients (for Facial Contour Angle and Ricketts' E-Line) with premolar extraction on completion of orthodontic treatment, the aim of this study was to determine how these differences were perceived by dentally trained observers and lay observers in comparison to the nonextraction group which did not change significantly during orthodontic treatment based on the same measurements.

4.1 Facial Profile Preference of Extraction vs. Nonextraction Facial Profiles

Statistical results described in the following Tables use the Wilcoxon Signed Rank Sum Tests (Hassard, 1991). Please refer to "Appendix Guideline for the Interpretation of Statistical Tables" (page 97) for a detailed interpretation of these tables.

The comparison of extraction and nonextraction facial profiles in this study has resulted in the preference of extraction profiles by both trained dentists ($p < .0001$) (Table 4.1) and laypersons ($p < .0001$) (Table 4.2) at the completion of orthodontic treatment.

Extract	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1*	800	709535.50	640400.0	8951.546	886.92
0	800	571264.50	640400.0	8951.546	714.08

*1 means extracted

TABLE 4.1: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Extract

Trained dentists preferred extraction profiles more than non-extraction profiles $p < .0001$

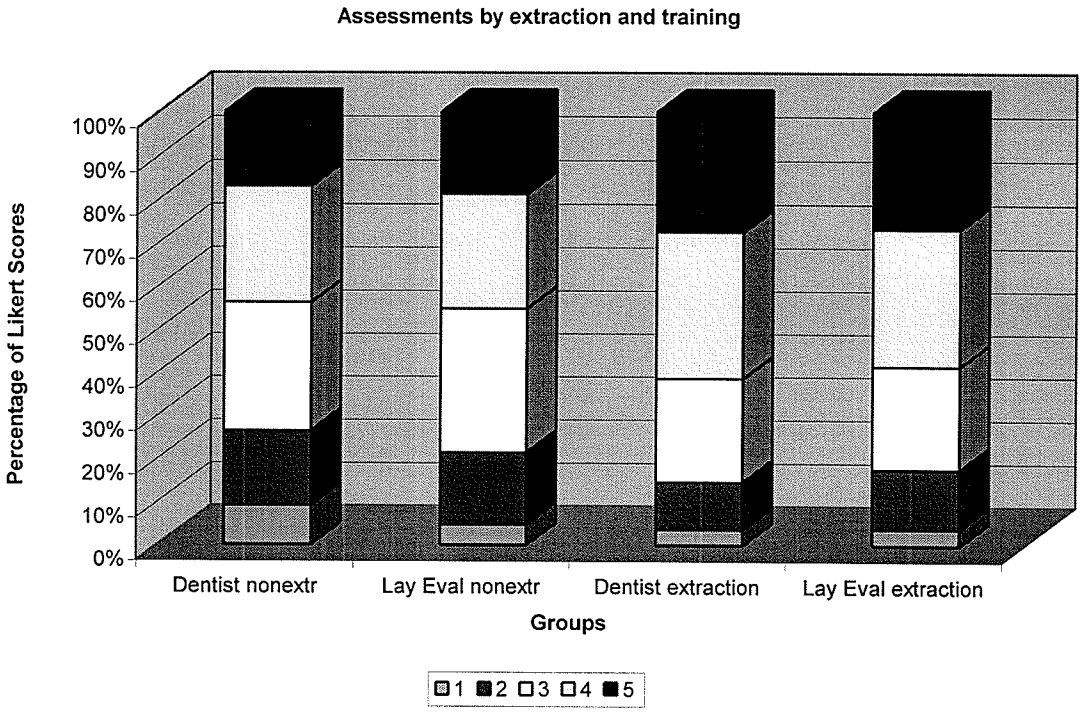
Extract	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1*	800	684396.0	640400.0	8942.159	885.50
0	800	596404.0	640400.0	8942.159	745.51

*1 means extracted

TABLE 4.2: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Extract

Lay Evaluators preferred extraction profiles more than non-extraction profiles $p < .0001$

In Figure 4.3 below, the rating of the nonextraction group by trained dentists and lay evaluators is shown in the two columns on the left. The rating of the extraction group by trained dentists and lay evaluators is shown in the two columns shown on the right. The rating of the "after" treatment profiles is shown by the percentage of Likert Scores that were rated by each group (ratings were 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better). Upon examination of the graph it is very apparent that the extraction group had a significantly ($p < .0001$) greater percentage of Likert Scores of slightly better (4) or better (5) in comparison to the nonextraction group.



(Likert Scale: 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better)

Figure 4.3: Trained Dentists and Lay Evaluators: Distribution Of Likert Scores (%) for Extraction and Nonextraction Facial Profiles

4.2 Competent and Incompetent Lip Preference of Extraction vs. Nonextraction Facial Profiles

Characteristics of the Incompetent Lip Group

Eight subjects (4 extraction and 4 non-extraction) had incompetent lips at the end of treatment (20%) while the other 32 subjects (80%) finished treatment with competent lips (Table 4.3). The average measurement of lip incompetence in the group at the end of treatment was 6.6mm with 6 of 8 subjects having lip incompetence of 5mm or more (Table 4.3 below):

Sex	Extraction or Non-extraction Treatment	Age at Initial "A" Records/ Lip Incompetence (mm) shown in parentheses*	Age at End of Treatment "B" Records/ Lip Incompetence (mm) shown in parentheses*	Length of Treatment*
F	extraction	15-1 (6)	18-7 (0.5)	3-6
F	non-extraction	14-0 (0)	16-0 (2)	2-0
M	non-extraction	12-6 (5)	15-0 (5)	2-6
M	non-extraction	14-4 (7)	15-7 (8)	1-3
F	non-extraction	16-10 (7)	20-2 (16)	3-5
F	extraction	13-0 (8)	15-6 (8)	2-6
F	extraction	13-5 (5)	17-4 (7)	3-11
F	extraction	13-2 (7)	16-2 (6)	3-0

*All ages and times are shown in years- months; measurement of Lip Incompetence (mm) is shown as taken from the cephalometric films, "zero" value means lips were competent.

TABLE 4.3: Summary of Profiles with Incompetent Lips: Extraction and Nonextraction Patients and Ages during Orthodontic Treatment

4.2 (a) Evaluation of Competent Lips vs. Incompetent Lips by Trained Dentists

Trained dentists significantly preferred competent lips more than incompetent lips in both extraction profiles ($p<.0001$) (Table 4.4) and nonextraction profiles ($p<.0001$) (Table 4.5).

Incompetent Lips	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1	160	44573.0	64080.0	2514.823	278.58
0	640	275827.0	256320.0	2514.823	430.98

*1 means incompetent lips

TABLE 4.4: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Incompetent Lips in Extraction Profiles

Trained dentists preferred competent lips more than incompetent lips in extraction profiles $p< .0001$

Incompetent Lips	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
0	640	280974.50	256320.0	2539.125	439.02
1	160	39425.50	64080.0	2539.125	246.41

*1 means incompetent lips

TABLE 4.5: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Incompetent Lips in Non-Extraction Profiles

Trained dentists preferred competent lips more than incompetent lips in non-extraction profiles $p< .0001$

4.2 (b) Evaluation of Competent Lips vs. Incompetent Lips by Lay Evaluators

Lay evaluators significantly preferred competent lips more than incompetent lips in extraction profiles ($p<.0001$) (Table 4.6) and nonextraction profiles ($p<.0001$) (Table 4.7).

Incompetent Lips	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1	160	48273.0	64080.0	2524.609	301.71
0	640	272127.0	256320.0	2524.603	425.20

*1 means incompetent lips

TABLE 4.6: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Incompetent Lips in Extraction Profiles

Lay Evaluators preferred competent lips more than incompetent lips in extraction profiles $p< .0001$

Incompetent Lips	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
0	640	277135.0	256320.0	2525.250	433.02
1	160	43265.0	64080.0	2525.250	270.41

TABLE 4.7: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Incompetent Lips in Non-Extraction Profiles

Lay Evaluators preferred competent lips more than incompetent lips in non-extraction profiles $p< .0001$

4.2 (c) Trained Dentists vs. Lay Evaluators in the Evaluation of Extraction Profiles with Competent Lips

There is no significant difference ($p< 0.14$) between trained dentists and lay evaluators in the evaluation of extraction profiles with competent lips (Table 4.8).

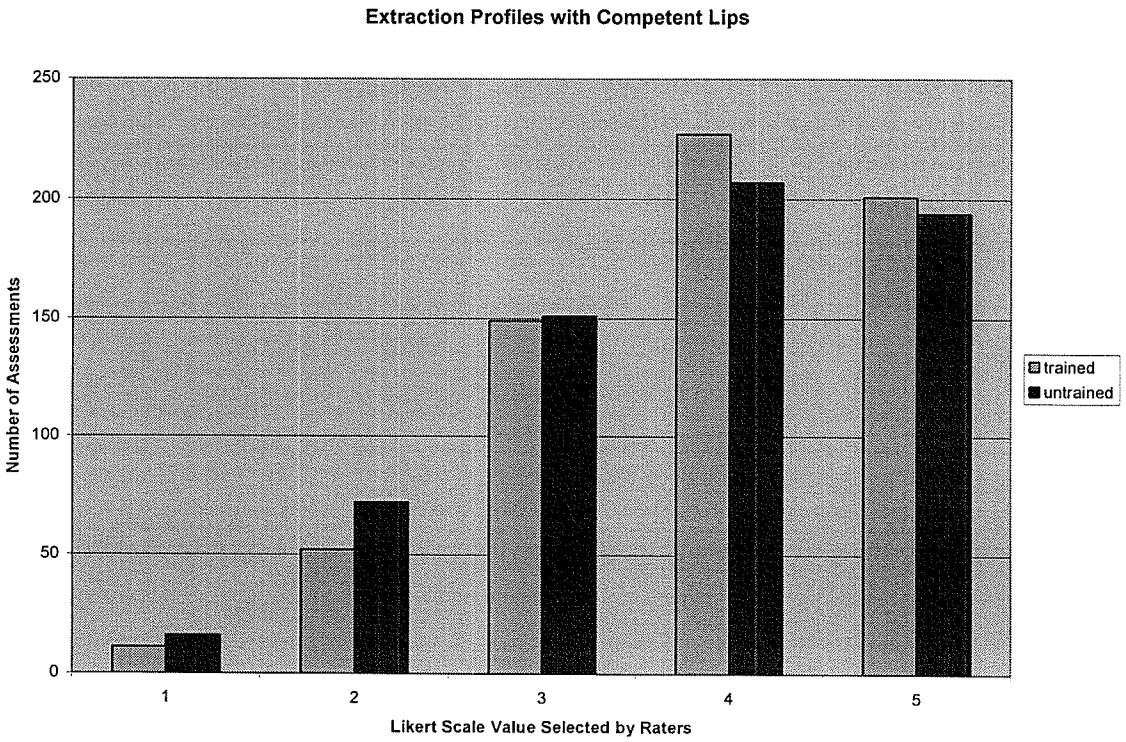
Evaluator	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1	640	419261.0	409920.0	6335.781	655.10
0	640	400579.0	409920.0	6335.781	625.90

*1 means trained dentist

TABLE 4.8: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Dentist

There is no significant difference ($p> 0.14$) between trained dentists and lay evaluators in the evaluation of profiles treated by extraction with competent lips (See Fig 4.4).

In the graph (Figure 4.4) below, extraction profiles with competent lips have been rated by trained dentists (blue) and lay evaluators (red). Forty trained dentists and 40 lay evaluators rated the post treatment profiles of 36 extraction patients with competent lips for a total of 2880 observations (shown on the Y-axis). Profile ratings were based on a Likert Scale of 1 to 5 (X-axis). The Likert Scale ratings were 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better. There is no significant difference ($p > 0.14$) between trained dentists and lay evaluators in the evaluation of profiles treated by extraction with competent lips - which is evident upon examination of the graph.



(Likert Scale: 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better)

Figure 4.4: Trained Dentists and Lay Evaluators in the Assessment of Extraction Profiles with Competent Lips: Number of Assessments vs. Likert Scores

4.2 (d) Dentists vs. Lay Evaluators in the Evaluation of Nonextraction Profiles with Competent Lips.

No statistically significant difference was found ($p > 0.34$) between trained dentists and lay evaluators in the evaluation of or nonextraction profiles with competent lips (Table 4.9).

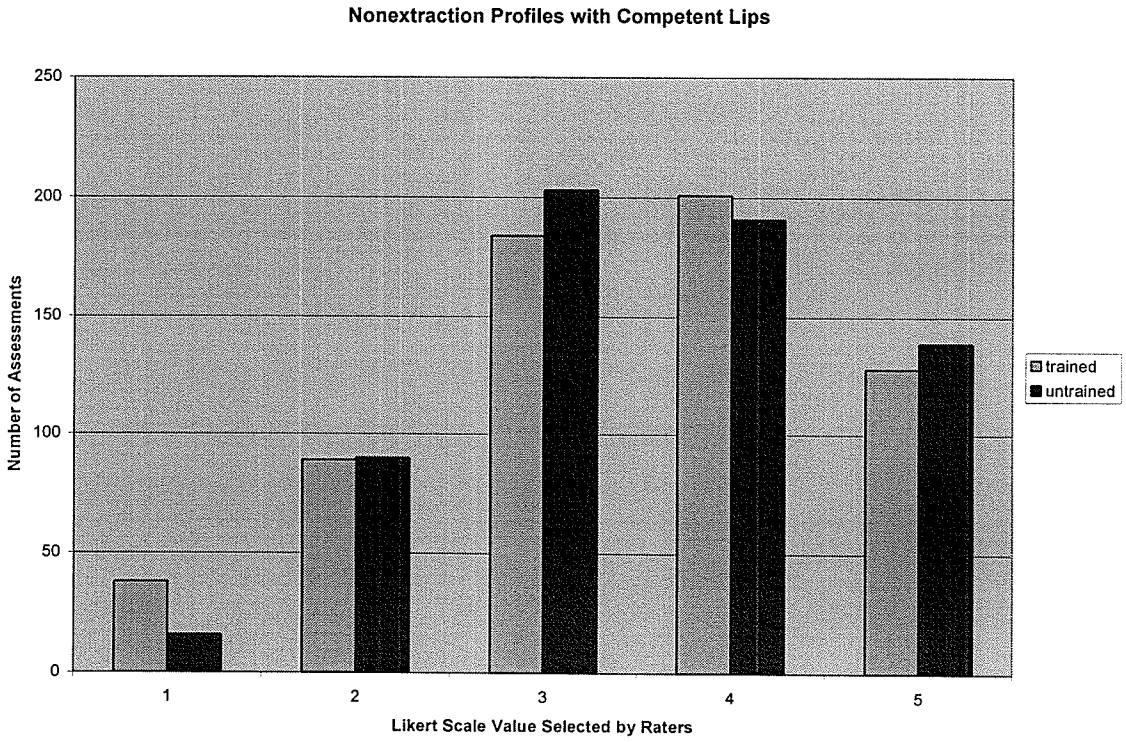
Evaluators	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1	640	403791.0	409920.0	6382.690	630.92
0	640	416049.0	409920.0	6382.690	650.08

*1 means trained dentist

TABLE 4.9: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Dentist

There is no significant difference ($p > 0.34$) between trained dentists and lay evaluators in the evaluation of profiles treated by non-extraction with competent lips.

In the graph (Figure 4.5) below, nonextraction profiles with competent lips have been rated by trained dentists (blue) and lay evaluators (red). Forty trained dentists and 40 lay evaluators rated the post treatment profiles of 36 nonextraction patients with competent lips for a total of 2880 observations (shown on the Y-axis). Profile ratings were based on a Likert Scale of 1 to 5 (X-axis). The Likert Scale ratings were 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better. There is no significant difference ($p > 0.34$) between trained dentists and lay evaluators in the evaluation of profiles treated by non-extraction with competent lips – this is evident upon examination of the graph.



(Likert Scale: 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better)

Figure 4.5: Trained Dentists and Lay Evaluators in the Assessment of Nonextraction Profiles with Competent Lips: Number of Assessments vs. Likert Scores

4.2 (e) Dentists vs. Lay Evaluators in the Evaluation of Extraction Profiles with Incompetent Lips.

There was no significant difference ($p > 0.68$) between trained dentists and lay evaluators in the evaluation of extraction profiles with incompetent lips (Table 4.10).

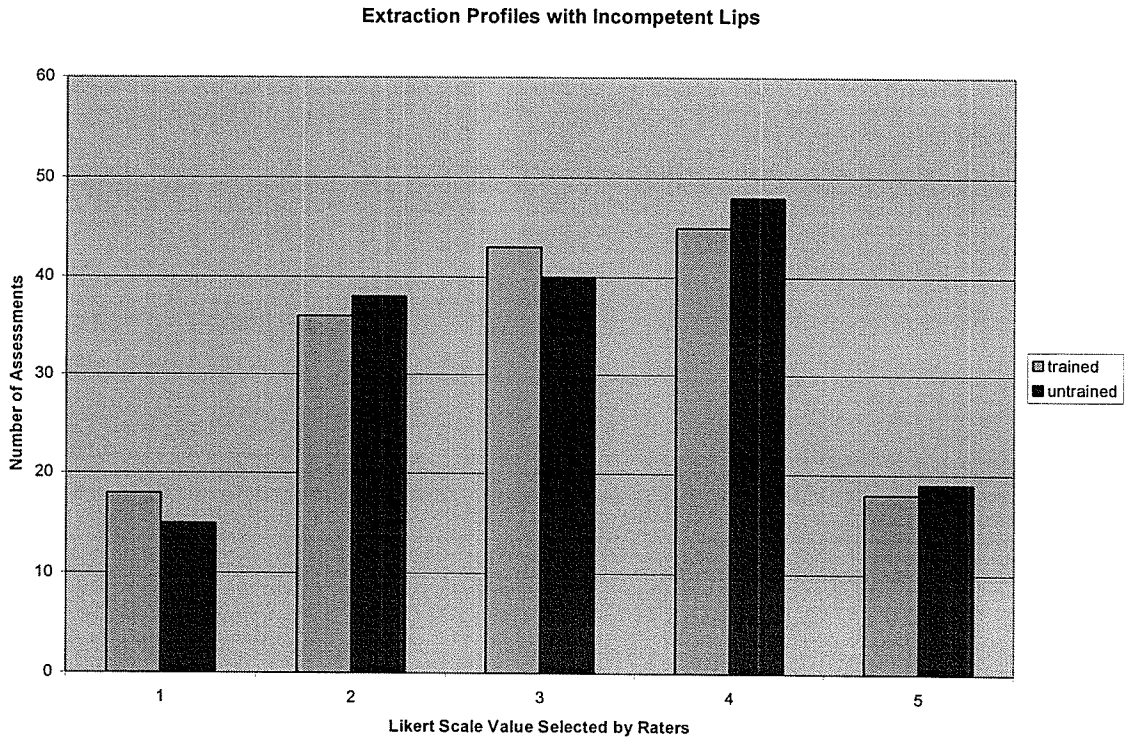
Evaluators	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1	160	25352.0	25680.0	803.597	158.45
0	160	26008.0	25680.0	803.597	162.55

*1 means trained dentist

TABLE 4.10: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Dentist

There is no significant difference ($p > 0.68$) between trained dentists and lay evaluators in the evaluation of extraction profiles with incompetent lips.

In the graph (Figure 4.6) below, extraction profiles with incompetent lips have been rated by trained dentists (blue) and lay evaluators (red). Forty trained dentists and 40 lay evaluators rated the post treatment profiles of 4 extraction patients with incompetent lips for a total of 320 observations (shown on the Y-axis). Profile ratings were based on a Likert Scale of 1 to 5 (X-axis). The Likert Scale ratings were 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better. There is no significant difference ($p > 0.68$) between trained dentists and lay evaluators in the evaluation of profiles treated by extraction with incompetent lips – this is evident upon examination of the graph.



(Likert Scale: 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better)

Figure 4.6: Trained Dentists and Lay Evaluators in the Assessment of Extraction Profiles with Incompetent Lips: Number of Assessments vs. Likert Scores

4.2 (f) Dentists vs. Lay Evaluators in the Evaluation of Nonextraction Profiles with Incompetent Lips.

There was a significant difference between trained dentists and lay evaluators in the evaluation of nonextraction profiles with incompetent lips p=.016 (Table 4.11).

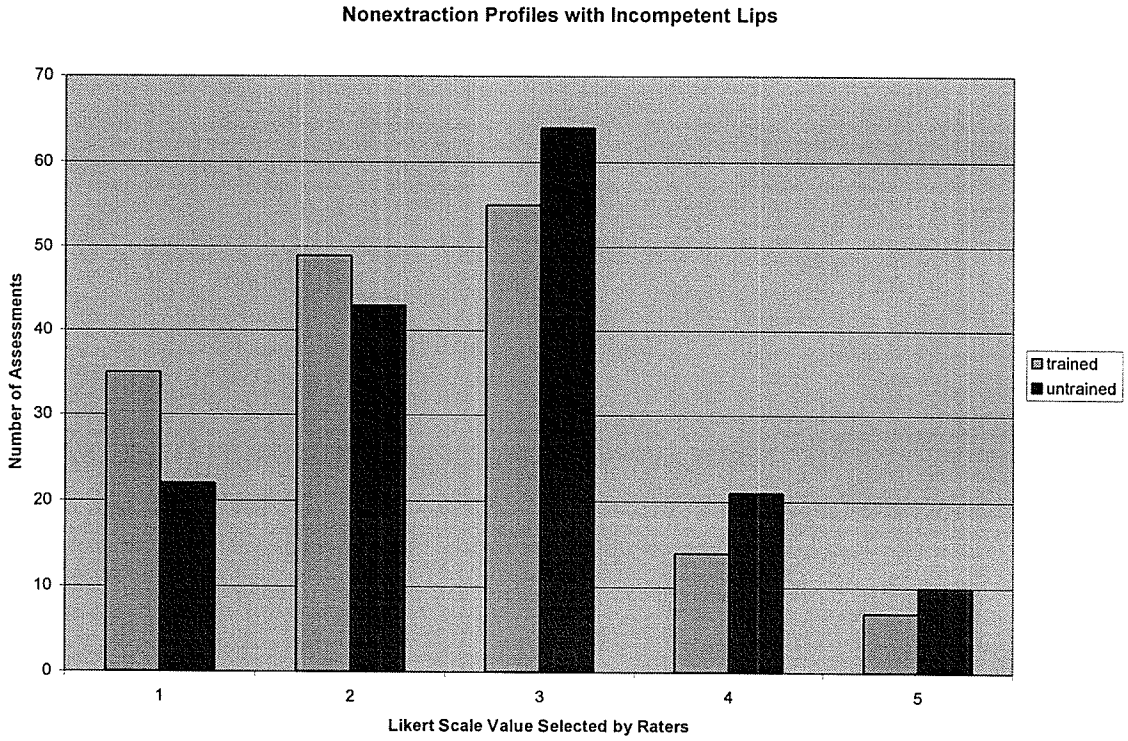
Dentist	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1	160	23769.50	25680.0	792.746	148.56
0	160	27590.50	25680.0	792.746	172.44

*1 means trained dentist

TABLE 4.11: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Dentist

Lay evaluators prefer profiles with incompetent lips more than trained dentists in the evaluation of profiles treated by non-extraction with incompetent lips p= .016

In the graph (Figure 4.7) below, nonextraction profiles with incompetent lips have been rated by trained dentists (blue) and lay evaluators (red). Forty trained dentists and 40 lay evaluators rated the post treatment profiles of 4 nonextraction patients with incompetent lips for a total of 320 observations (shown on the Y-axis). Profile ratings were based on a Likert Scale of 1 to 5 (X-axis). The Likert Scale ratings were 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better. There was a significant difference (p= .016) between trained dentists and lay evaluators in the evaluation of profiles treated by nonextraction with incompetent lips – upon examination of the graph, it is evident that the lay evaluators scored the profiles with a rating of 4 (slightly better) or 5 (better) more frequently than the trained dentists.



(Likert Scale: 1= worse, 2= slightly worse, 3= same, 4= slightly better and 5= better)

Figure 4.7: Trained Dentists and Lay Evaluators in the Assessment of Nonextraction Profiles with Incompetent Lips: Number of Assessments vs. Likert Scores

4.3 Summary of Results and Null Hypotheses

The current study was designed to test the following null hypotheses:

1) There is no difference in the changes between the post-orthodontic treatment profiles of non-extraction cases vs. first four premolar extraction cases as judged by trained dentists and lay evaluators.

2) There is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of profiles with incompetent vs. competent lips.

3) There is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of profiles with incompetent or competent lips.

4) There is no difference in the soft tissue profiles of the extraction and non-extraction group before and after treatment.

Hypothesis #1

Trained Dentists preferred extraction profiles more than non-extraction profiles ($p<.0001$) (Table 2.1)

Lay Evaluators preferred extraction profiles more than non-extraction profiles ($p< .0001$) (Table 2.2)

The null hypothesis that there is no difference in the changes between the post-orthodontic treatment profiles of non-extraction cases vs. first four premolar extraction cases as judged by trained dentists and lay evaluators is rejected ($p<.0001$).

Hypothesis #2

Trained dentists significantly preferred competent lips more than incompetent lips in both extraction profiles ($p<.0001$) (Table 4.4) and nonextraction profiles ($p<.0001$) (Table 4.5).

Lay evaluators significantly preferred competent lips more than incompetent lips in extraction profiles ($p<.0001$) (Table 4.6) and nonextraction profiles ($p<.0001$) (Table 4.7).

The null hypothesis that there is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of profiles with incompetent vs. competent lips is rejected ($p<.0001$).

Hypothesis #3

There is no significant difference ($p> 0.14$) between trained dentists and lay evaluators in the evaluation of extraction profiles with competent lips (Table 4.8).

There is no significant difference ($p> 0.34$) between trained dentists and lay evaluators in the evaluation of or nonextraction profiles with competent lips (Table 4.9).

There is no significant difference ($p> 0.68$) between trained dentists and lay evaluators in the evaluation of extraction profiles with incompetent lips (Table 4.10).

There was a significant difference between trained dentists and lay evaluators in the evaluation of nonextraction profiles with incompetent lips $p=.016$ (Table 4.11).

The null hypothesis that there is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of extraction profiles with competent and incompetent lips or nonextraction profiles with competent lips is accepted ($p>0.14$).

The null hypothesis that there is no difference in post treatment profile rating by dentally trained individuals vs. lay evaluators in the evaluation of nonextraction profiles with incompetent lips is rejected (p = .016).

Hypothesis #4

The Ricketts' E-Line values for the extraction and nonextraction groups were not found to be statistically different prior to treatment (p >0.21) (Appendix 3a).

The facial contour angle of the extraction group and the non-extraction group were significantly different statistically before treatment (p< .0136) (Appendix 2a).

The Ricketts' E-Line values for the extraction and nonextraction groups were not found to be statistically different after treatment (p>0.69) (Appendix 3b).

The facial contour angles of the extraction and nonextraction groups after orthodontic treatment not different statistically (p> 0.29) after treatment (Appendix 2c).

"Before" Treatment Summary

The null hypothesis that there is no difference in the soft tissue profiles of the extraction and non-extraction groups " before" treatment cannot be rejected based on Ricketts' E- line value (p > 0.21) (Appendix 3a) and is accepted.

However, the null hypothesis that there is no difference in the soft tissue profiles of the extraction and non-extraction groups "before" treatment is rejected (p<.0136), *if based on the fact that the facial contour angle of the extraction group and the non-extraction group were significantly different statistically before treatment (p< .0136) (Appendix 2a).*

"After" Treatment Summary

The null hypothesis that there is no difference in the soft tissue profiles of the extraction and non-extraction groups "after" treatment is accepted based on the results that the facial contour angles of the extraction and nonextraction groups after orthodontic treatment not different statistically (p>0.29) after treatment (Appendix 2c) and the Ricketts' E-Line value for the extraction and nonextraction groups were not found to be statistically different after treatment (p> 0.69) (Appendix 3b).

Chapter 5

Discussion

Contents

Chapter 5

Discussion

5.1 Interpretation of the Results Relative to the Literature

5.1 (a) Extraction vs. Nonextraction Facial Profiles

The comparison of extraction and nonextraction facial profiles in this study has resulted in the preference of the change in extraction profiles by both trained dentists and laypersons at the end of treatment. (Table 4.11; Table 4.12; Figure 4.3) The results disagree with literature (non peer-reviewed) that is critical of the extraction of premolar teeth (Stoner, 1984; Bowbeer, 1986; Witzig and Sphal, 1987; Broadbent, 1990) and the belief that premolar extraction causes "dished in" or compromised profiles. This is in agreement with the peer-reviewed literature on the subject (Paquette at al, 1992; Luppanapornolarp and Johnston, 1993; Young and Smith, 1993; Staggers, 1994; Bishara and Jakobsen, 1997; Boley et al, 1998; James, 1998; Bishara et al, 1997; Bowman and Johnston, 2000). Examination of the literature that is critical of the extraction of premolar teeth (Stoner, 1984; Bowbeer, 1986; Witzig and Sphal, 1987; Broadbent, 1990) however, reveals that this body of evidence is based on opinion or limited case reports and should be seen in this light.

5.1 (b) Why were the extraction profiles preferred?

A possible reason why both trained dentists and laypersons preferred the post treatment profiles of the extraction group is that the magnitude of change following orthodontic treatment was greater in the extraction group compared to the nonextraction group. It also happened that the perception of change in the extraction group over the course of orthodontic treatment approached accepted norms found in the scientific literature (Jacobsen and Caufield, 1985). In this study facial contour angle and Rickett's E-line values were measured before and after orthodontic treatment for the extraction and nonextraction groups in an effort to measure facial change that would be observed by the raters as a predictor for facial profile preference, using established "norms" in the literature as a guide.

5.1 (c) Facial Contour Angle on Profile Assessment

The extraction group differed from the non-extraction group significantly before treatment with respect to the facial contour angle. The mean facial contour angle of the extraction group before orthodontic treatment was $-16.25° \pm 4.5$ compared to the nonextraction group with a mean facial contour angle of $-12.55° \pm 3.9$ before treatment. These two groups are statistically different before treatment $p < .0136$ (Table 4.5). Furthermore, the nonextraction group falls into the preferred norms for facial contour angle ($-11° \pm 4°$) based on 40 acceptable faces chosen by a group of three artists at the Herron Institute of Art in Indianapolis (Burstone, 1959). Other "ideal" facial contour

angles (based on 84 constructed androgynous silhouettes rated by 545 dental professionals) reported for men are between -10° and -14° with a mean of -12° and female "ideals" range from -14° to -16° with a mean of -15° (McCollum, 2001). Other "norms" reported for female Caucasians are -11° and –13.9° in African American females based on a study of 60 Caucasian and 60 African American females (Sutter and Turley, 1998). The extraction group is clearly more convex prior to treatment. More interesting are the values of the facial contour angles immediately after orthodontic treatment.

The facial contour angles of the extraction and nonextraction groups after orthodontic treatment were –14.28° ± 4.6 and -12.42° ± 4.3 respectively. These two groups are not different statistically ($p>.05$) after treatment (Table 4.6). In fact, the extraction group decreased in facial contour angle significantly during treatment ($p <.0001$) (Table 4.7) and was no longer statistically different from the nonextraction group. Is there an explanation for this result?

5.1 (d) Impact of Age on Profile Assessment

Post treatment profiles were compared with pretreatment profiles during a period of active growth for most of the patients, particularly males. Differences in the magnitude of growth between the two groups is very likely since the extraction and nonextraction groups were significantly different in age ($p<.0238$)(Table 4.3). The average active treatment time of the extraction and nonextraction groups were 2.8 and 2.5 years,

respectively, and were statistically different groups at the end of treatment ($p < .0155$)(Table 4.4) for the simple reason that the average treatment time of the extraction group was longer than the nonextraction group. However, the extraction group mean age was 16.3 ± 7 years while the non-extraction group mean was 13.26 ± 3.8 years before orthodontic treatment. The change in the facial contour angle actually occurred in the significantly older group of extraction patients. Most studies attempt to keep an extraction and non-extraction group the same age when making comparisons (Finnoy et al, 1987; Bishara et al, 1994; Kocadereli, 2002) and certainly age and sex match controls in a study to reduce the effects of growth at different ages (Talass et al, 1987, Bishara and Jacobsen, 1997). The comparison of two groups of different ages in the early literature has been criticized as the effects of growth and treatment are often together rather than discrete variables (Hershey, 1972). If the extraction group had been significantly younger than the nonextraction group when pubertal growth was most rapid, it could perhaps be concluded that the extraction group had more "growth" and therefore changed the most and became more highly favored. In fact, the opposite happened. Why? One reason could be that the rate of change of facial convexity occurs mostly between the ages of 15 to 25 years in males and over a longer period of time (10 to 25 years) in females (Bishara, 1998) thus favoring the older extraction group to improve in facial convexity more than the nonextraction group.

Other factors than facial convexity could have influenced the perception of an improved facial profile such as hairstyle, makeup or facial expression (Bishara and Jakobsen, 1997) or increased vertical dimension (De Smit and Dermault, 1984). Regardless, the

results of this study support the generally held opinion in the literature, namely that soft tissue convexity is reduced by premolar extraction where non-extraction treatment has little effect (Luppanapornolarp and Johnston, 1993; Bowman and Johnston, 2000). This is likely since the extraction groups tend to have greater pretreatment facial imbalances than nonextraction groups resulting in the perception of greater improvements in facial balance of the extraction group (James, 1998). Bishara (1995) who concluded that the angle of convexity had a significantly greater decrease in the extraction group (N=44) compared to the non-extraction group (N=47) of 91 Class II division 1 patients. Significant differences in the reduction in convexity (Nasion, A-Point and Pogonion hard tissue points) have also been demonstrated between a Class II extraction group compared to both Class II and Class I nonextraction groups (Bishara et al., 1994). Bishara (1994) concluded that orthodontic treatment using orthopedic extraoral forces as well as light Class II elastics could "normalize" the skeletal relationship and has been observed in the earlier literature (West, 1957; Moore, 1959).

5.2 Rickett's E-line

Rickett's E-line values were 1.45mm ± 2.7 for the extraction group and -0.4mm ± 3.9 for the non-extraction group prior to orthodontic treatment. These two groups were not found to be statistically different prior to treatment (Table 4.8). After treatment, both extraction and nonextraction groups experienced a decrease in the value of the E-Line measurement; the change for the extraction group being greater and significant (Table 4.9). At the end of treatment, both groups were very close to the "norms" of 2mm behind this line on

average, with the observation by Ricketts (1960) that the lower lip may be expected to be on the E-Plane in an 11-14 year old group while adults can exhibit a lower lip a full 4mm behind the E-plane. Ricketts attributed this observed value primarily to both thinning of the lips and growth of the nose and chin later in life. The extraction group had a mean value of -1.53mm ± 3.0 after treatment. The nonextraction group had an E-Line value of -1.5mm ± 2.8 after treatment. The E-line value changed significantly ($p<.0001$) for the extraction group during orthodontic treatment (Table 4.9) but not enough to make the extraction and nonextraction groups statistically different (Table 4.1) because the standard deviation is so high. The individual variation mean within one group is greater than between the two groups.

To summarize, in the extraction group the facial contour angle and the E-line value both changed significantly during treatment to approach a more "normal" value post-treatment. These measurements are only part of the overall assessment of facial profile, but based on this study, changes accomplished by treatment and/or growth that approximate accepted normal values is perceived to improve facial profile by both trained dentists and lay evaluators.

5.3 Competent Lips vs. Incompetent Lips

Trained dentists and lay evaluators significantly ($p<.0001$) preferred competent lips more than incompetent lips in extraction and non-extraction profiles (Tables 4.14-4.17). Eight subjects (4 extraction and 4 non-extraction) had incompetent lips at the end of treatment

while the other 72 subjects finished treatment with competent lips (Table 4.13). The average measurement of lip incompetence in the group was 6.6mm. The preference of a lip competent group over a lip incompetent group of this magnitude is in agreement with the literature as the average interlabial gap at rest has been reported to be 1.8mm ± 1.2 in centric occlusion and 3.7mm ± 1.6 with the mandible at rest (Burstone, 1967). These values are also supported by Proffit (2000) who states that an interlabial gap at rest of 5mm or more is generally not esthetically pleasing.

The ratings of extraction vs. nonextraction profiles with incompetent lips by dentists and lay evaluators should be interpreted with caution. Lay evaluators prefer (p=.016) nonextraction profiles with incompetent lips more than trained dentists (Table 4.21). The results, although statistically significant, are based on a small sample size of 4 patients in each group.

5.4 Comment

Bisahra and Jakobsen (1997) reported in their systematic review of the literature that 29 studies had been completed which investigated the facial profile before and after treatment. Laypersons were used to assess profiles in only two of the studies (De Laat, 1974; Barrer and Ghafari, 1985). De Laat (1974) used silhouettes of the facial profile where all patients had their premolars extracted. Barrer and Ghafari (1985) used 100 dental students to rate 48 silhouettes of the facial profile representing patients all treated by nonextraction. Bishara's study (1997), using laypersons to compare extraction and

nonextraction effects on facial profile found that extraction profiles were also favored immediately after treatment. To date, after an extensive search of the English literature, no study other than the present one has offered the assessment of extraction and nonextraction facial profile photographs by both dentists and laypersons, where both preference of extraction or nonextraction profiles and preference of competent or incompetent lips in orthodontically treated patients was examined.

Chapter 6

Limitations of the Present Study

Chapter 6

Limitations of the Present Study

This study was limited in that it was designed to only determine the preference of the extraction or non-extraction facial profiles immediately after orthodontic treatment. Continued facial growth may also have an influence with respect to the preference of extraction or nonextraction profiles.

Due to the design of the study, all participants that rated the profiles remained unidentified. It may be valuable in future studies to track the gender of the raters in order to determine if this affects preference of facial profiles. This could be applicable in the present study as the extraction group was heavily weighted with female patients (15 out of 20) while the nonextraction group was more evenly distributed with 11 males and 9 females.

This study was limited by the Ethics Committee at the University of Manitoba. The Health Research Ethics Board ruled that the use of the internet to collect data through the use of a secure website would not be permissible. This limited the amount of data that could be collected by limiting the number of raters. As well, it eliminated the potential for a national discussion in the sense that rater response may have varied by region, educational background, or nationality if the study was extended to other countries.

Chapter 7

Suggested Modifications of Future Studies

Chapter 7

Suggested Modifications of Future Studies

In a future study, an attempt should be made to determine the gender of the participants asked to rate the profiles for the reasons mentioned in section 6 above.

Orthodontic records (especially photographs) require standardization with Frankfort horizontal parallel to the horizontal plane of the photograph being evaluated. Patient profile photographs should also be modified to a relatively constant distance from the camera lens to reduce magnification differences between patients.

A future study should attempt to match the extraction and nonextraction groups for age and sex in an effort to limit the effects of growth. Perhaps the only ideal way to achieve this would be to select both groups as non-growing patients, but at the end of the day the majority of the patients in the orthodontic office are still growing – and so should our knowledge of growth and its effects during orthodontic treatment.

A long-term study is needed to determine whether these preferences persist with age. It would be of great interest to evaluate whether the impact of soft tissue growth or thinning of soft tissue with age on facial profile would effect the rating by both lay evaluators and trained dentists.

A study to determine the impact of such extraneous factors such as hair color, makeup or style of hair on rater's assessment of facial profiles would be interesting.

One of the most interesting studies would be to do exactly what this thesis had first intended to do – use the internet in the creation of a national web page to gather vast amounts of data to address the great debate "Extraction vs. Nonextraction" and examine the subject based on scientific studies, opinion or anecdotal reports in the orthodontic treatment of our patients. With a web-based design, the amount of data collected from raters could be greatly increased. Regional preferences for the "ideal" profile could also be assessed.

Chapter 8

Conclusions and Recommendations

Chapter 8

Conclusions

From the findings of this study, the following conclusions can be made:

1. Trained dentists and lay evaluators prefer the change in extraction profiles over nonextraction profiles immediately after orthodontic treatment ($p<.0001$)

2. Trained dentists and lay evaluators preferred competent lips to incompetent lips in both extraction and nonextraction profiles ($p<.0001$)

3. The facial contour angle decreased only in the extraction group in this study ($p<.0001$) while the facial contour angle did not change significantly for the nonextraction group.

4. With respect to profile change, extraction of four first premolars does not seem to have as significant effect on subjective evaluation of post-extraction facial esthetics. This finding is supported by several other similar studies.

Recommendations

1. Orthodontists should not be reluctant to extract four premolars in moderately crowded cases if based on a sound diagnosis that includes a soft tissue profile evaluation.

2. Further studies are needed to assess the rating of facial profiles over time. That is, it would be ideal to determine how the extraction and nonextraction groups would be judged by trained dentists and lay evaluators 10 to 15 years post treatment.

REFERENCES

1. Ackerman JL, Proffit WR. Soft tissue limitations in orthodontics: Treatment planning guidelines. Angle Orthod 1997; 67: 327-336.

2. Angle EH. Malocclusion of the Teeth. 7th ed. Philadelphia: SS White Dental Mfg Co. 1907.

3. Arnett GW and Bergman RT. Facial keys to orthodontic diagnosis and treatment planning: Part II. Am J Orthod Dentofac Orthop 1993; 103:395-411.

4. Arnett GW and McLaughlin RP. Facial and Dental Planning for Orthodontists and Oral Surgeons. Edinburgh: Mosby. 2004.

5. Artistoteles. The Works of Aristotle – Volume IV: Historia Animalium. Oxford: Clarendon Press, 1949.

6. Assuncao ZLV, Capelli J, Almeida MA, Bailey LJ. Incisor retraction and profile changes in adult patients. Int J Adult Orthognath Surg 1994; 9: 31-6.

7. Barrer JG, Ghafari J. Silhouette profiles in the assessment of facila esthetics: a comparison of cases treated with various orthodontic appliances. Am J Orthod 1985; 87: 385-91.

8. Beattie JR, Paquette DE, Johnston LE. The functional impact of extraction and non-extraction treatments: A long-term comparison in patients with "borderline," equally susceptible class II malocclusions. Am J Orthod Dentofac Orthop 1994; 105: 444-9.

9. Bishara SE, Abbas RZ, Cummins DM, Jakobsen JR. Effects of orthodontic treatment on the growth of individuals with Class II division 1 malocclusion. Angle Orthod 1994; 64: 221-230.

10. Bishara SE, Cummins DM, Zaher AR. Treatment and posttreatment changes in patients with Class II, Div 1 malocclusion after extraction and non-extraction treatment. Am J Orthod Dentofac Orthop 1997; 111: 18-27.

11. Bishara SE and Jakobsen JR. Profile changes in patients treated with and without extractions: assessments by lay people. Am J Orthod Dentofac Orthop 1997; 112: 639-44.

12. Bishara SE, Jakobsen JR, Hession TJ, Treder JE. Soft tissue profile changes from 5 to 45 years of age. Am J Orthod Dentofac Orthop 1998; 114: 698-706.

13. Bloom LA. Perooral profile changes in orthodontic treatment. Am J Orthod 1961; 47:371-9.

14. Boley JC.Serial extraction revisited: 30 years in retrospect. Am J Orthod Dentofac Orthop. 2002; 121: 575-577.

15. Boley JC, Pontier JP, Smith S, Fulbright M. Facial changes in extraction and non-extraction patients. Angle Orthod 1998; 68: 539-546.

16. Broadbent JM. Facing malocclusion: achieving harmony and balance. Dent Today. 1990; 9: 41-45.

17. Broadbent BH. A new x-ray technique and its application to orthodontia. Angle Orthod. 1931; 1: 45.

18. Brodie AG. On the growth pattern of the human head from the third month to the eighteeth year of life. Am J Anat 1941; 68: 209-62.

19. Bowbeer GRN. Saving the face and the TMJ, part 2. Funct Orthod. 1986; 3:9-24.

20. Bowers DG. Systems of Organization: Management of the Human Resource. Ann Arbor: University of Michigan Press, 1976.

21. Bowman J, Johnston L. The esthetic impact of extraction and non-extraction treatments on Caucasian patients. Angle Orthod 2000; 70: 3-10.

22. Burstone CJ. The integumental profile. Am J Orthod. 1958; 44:1-25.

23. Burstone CJ. Integumental contour and extension patterns. Angle Orthod 1959; 29: 93-104.

24. Burstone CJ. Lip posture and its significance to treatment planning. Am J Orthod. 1967; 53:262-284.

25. Caplan MJ, Shivapuja PK. the effect of premolar extractions on the soft tissue profile in adult African American females. Angle Orthod 1997; 129-36.

26. Case CS. The question of extraction in orthodontia. Am J Orthod 1964; 50: 660-91.

27. Chaconas SJ. A statistical evaluation of nasal growth. Am J Orthod 1969; 56:403-414.

28. Czarnecki ST, Nanda RS and Currier GF. Perceptions of a balanced facial profile. Am J Orthod Dentofac Orthop 1993; 104:180-7.

29. De Smit A, Dermault L. Soft-tissue profile preference. Am J Orthod. 1984; 86:67-73.

30. De Laat BC. Orthodontics and the facial profile [Academische Proefschript.] Amsterdam: Vrije Universieit Te Amsterdam, Academische Pers; 1974.

31. Drobocky OB, Smith RJ. Changes in facial profile during orthodontic treatment with extraction of four first premolars. Am J Orthod. Dentofac, Orthop. 1989; 95: 220-230.

32. Encarta World English Dictionary: Encarta Reference Library 2003. Microsoft Corporation.

33. Finnoy JP, Wisth PJ, Boe OE. Changes in soft tissue profile during and after orthodontic treatment. Eur J Orthod. 1987; 68-78.

34. Garner LD. Soft tissue changes concurrent with orthodontic tooth movement. Am J Orthod 1974; 66:367-77.

35. Gianelly AA. Treatment of crowding in the mixed dentition. Am J Orthod Dentofac Orthop. 2002; 121: 569-572.

36. Hassard TH. Understanding Biostatistics. St Louis: Mosby Year Book. 1991. p 263.

37. Heinemann W. Aristotle – Minor Works: Physiognomics. Cambridge, Mass.: Harvard University Press, 1963. 83-137.

38. Hershey HG. Incisor tooth retraction and subsequent profile change in preadolescent female patients. Am J Orthod 1972; 45-54.

39. Holdaway RA. A soft-tissue cephalometric analysis and its use in treatment planning. Part I. Am J Orthod 1983; 84:1-28.

40. Holdaway RA. A soft-tissue Cephalometric analysis and its use in treatment planning. Part II. Am J Orthod 1984; 85:279-293.

41. Holdaway R. Presentation, Jarabak Society meeting, February, 1963.

42. Hsu BS. Comparisons of the five analytic reference lines of the horizontal lip position: their consistency and sensitivity.Am J Orthod Dentofac Orthop 1993;104:355-60.

43. Ismail SFH, Moss JP, Henessey R. Three-dimensional assessment of the effects of extraction and non-extraction orthodontic treatment on the face. Am J Orthod Dentofac Orthop 2002; 121: 244-56.

44. Jacobs JD. Vertical lip changes from maxillary incisor retraction. Am J Orthod 1978; 74:396-404.

45. Jacobsen A and Caufield P. Introduction to Cephalometry. Philadelphia: Lea and Febiger. 1985.

46. James RD. A comparative study of facial profiles in extraction and non-extraction treatment. Am J Orthod Dentofac Orthop 1998; 114:265-76.

47. Johnston LE. Answers in search of questions. Am J Orthod Dentofac Orthop. 2002; 121: 552-553.

48. Joseph J. Nasenplastik und Sonstige Geichtplastik. Leipzig, Germany: Curt Kabitzsch, 1931. 4-26.

49. Kasai K. Soft tissue adaptability to hard tissues in facial profiles. Am J Orthod Dentofac Orthop 1998; 113: 674-84.

50. Kerr WJS, O'Donnell JM. Panel perception of facial attractiveness. Br J Orthod. 1990; 17: 299-304.

51. Kocadereli I. Changes in soft tissue profile after orthodontic treatment with and without extractions. Am J Orthod Dentofac Orthop. 2002; 122: 67-72.

52. Koochek AR, Yeh MS, Rolfe B Richmond S. The relationship between Index of Complexity, Outcome and Need, and patients' perception of malocclusion: a study in general dental practice. Br Dent J 2001; 191: 325-9.

53. Kusnoto J, Kusnoto H. The effect of anterior tooth retraction on lip position of orthodontically treated adult Indonesians. Am J Orthod Dentofac Orthop 2001; 120: 304-7.

54. Little RM. Stability and relapse: early treatment of arch length deficiency. Am J Orthod Dentofac Orthop. 2002; 121: 578-581.

55. Lo FD, Hunter WS. Changes in nasolabial angle related to maxillary incisor retraction. Am J Orthod 1982; 82:384-391.

56. Luppanapornlarp S, Johnston LE. The effects of premolar extraction: a long-term comparison of outcomes in "clear cut" extraction and non-extraction class II patients. Angle Orthod 1993; 63:257-272.

57. Mamandras AH. Linear changes of the maxillary and mandibular lips. Am J Orthod 1988; 94: 405-410.

58. McCollum TG. TOMAC: An orthognathic treatment planning system. Part 1: soft tissue analysis. J Clin Orthod 2001; 35(6):356-64.

59. McMurrich JP. Leonardo Da Vinci: The Anatomist. Baltimore: Williams and Wilkins, 1930. 104-110.

60. McNamara JA, Brust EW and Riolo ML. Soft tissue evaluations of individuals with ideal occlusions and a well-balanced face. In Esthetics and the Treatment of Facial Form, Monograph 28, Craniofacial growth series. Ann Arbour: University of Michigan Press. 1992; 137.

61. McNamara JA. Early intervention in the transverse dimension: is it worth the effort? Am J Orthod Dentofac Orthop. 2002; 121: 572-574.

62. Merrifield LL. The profile line as an aid in critically evaluating facial esthetics. Am J Orthod 1966; 52: 804-822.

63. Moore AW. Orthodontic treatment factors in class II malocclusion. Am J Orthod 1959; 45: 323-352.

64. Nanda RS and Ghosh J. Facial soft tissue harmony and growth in orthodontic treatment. Semin Orthod 1995; 1: 65-81.

65. O'Connor BMP. Contemporary trends in orthodontic practice: a national survey. Am J Ortho Dentofac Orthop 1993; 103: 163-170.

66. Oliver BM. The influence of lip thickness and strain on upper lip response to incisor retraction. Am J Orthod 1982; 82: 141-9.

67. Orlowski JP, Christensen JA. The potentially coercive nature of some clinical research trial acronyms. Chest 2002; 121: 2023-8.

68. Paquette DE, Beattie JR, Johnston LE. A long-term comparison of nonextraction and premolar extraction edgewise therapy in "borderline" class II patients. Am J Orthod Dentofac Orthop. 1992; 102:1-14.

69. Park Y and Burstone CJ. Soft tissue profile: fallacies of hard-tissue standards in treatmnt planning. Am J Orthod 1986; 90: 52-56.

70. Perkins RA, Staley RN. Changes in lip vermillion height during orthodontic treatment. Am J Orthod Dentofac Orthop 1993; 103: 147-54.

71. Proffit WR. Contemporary Orthodontics 3rd Ed. St Louis: Mosby, 2000. 162.

72. Proffit WR, Tulloch JFC. Preadolescent class II problems: treat now or wait? Am J Orthod Dentofac Orthop. 2002; 121: 560-563.

73. Proffit WR. Forty-year review of extraction frequencies at a university orthodontic clinic. Angle Orthod. 1994; 64(6): 407-414.

74. Rains MD, Nanda R. Soft-tissue changes associated with maxillary incisor retraction. Am J Orthod 1982; 81: 481-8.

75. Reidel R. Esthetics and its relation to orthodontic therapy. Angle Orthod 1950; 20: 168-178.

76. Ricketts RM. A foundation for cephalometric communication, Am J Orthod 1960; 46: 330-57.

77. Roos N. Soft tissue profile changes in Class II treatment. Am J Ortho 1977; 72: 165-75.

78. Rudee DA. Proportional profile changes concurrent with orthodontic treatment. Am J Orthod 1964; 50: 421-34.

79. Sarver DM, Proffit WR, Ackerman JL. "Evaluation of facial soft tissues" Chapter 4. In Proffit WR, White RP, Sarver DM: Contemporary Treatment of Dentofacial Deformity, St Louis, 2003, Mosby. p. 98 CORRECT REF FORMAT

80. Siedel JS, Henderson D, Tittle S, Jaffe DM, Spaite D, Dean JM, Gausche M, Lewis RJ, Cooper A, Zartisky A, Espisito T, Maederis D. Priorities for research in emergency medical services for children: results of a conference. Ann Emerg Med 1999; 33: 214-7.

81. Staggers JA. Vertical changes following first premolar extractions. Am J Dentofac Orthop 1994; 105:19-24.

82. Steiner CC. The use of cephalometrics as an aid to planning and assessing orthodontic treatment. Am J Orthod 1960; 46: 721.

83. Stoner CC. An Interview: AAFO's man of the year 1984, Dr. John Witzig. Funct Orthod. 1984; 1: 9-15.

84. Sutter RE and Turley PK. Soft tissue evaluation of contemporary Caucasian and African American female facial profiles. Angle Orthod 1998; 68: 487-496.

85. Talass MF, Talass L, Baker RC. Soft tissue changes resulting from retraction of maxillary incisors. Am J Orthod Dentofac Orthop 1987; 91: 385-94.

86. Tindall BS, al-Asaaf AF, Gentling SJ. Total quality improvement: a study of Veterans Affairs Medical Center directors and QA coordinators. Am J Med Qual 1993; 8: 45-52.

87. Tweed CH. Indications for the extraction of teeth in orthodontic procedure. Am J Orthod. 1944; 30: 405-428.

88. Tweed CH. A philosophy of orthodontic treatment. Am J Orthod. 1945; 31: 74-103.

89. Tweed CH. Why I extract teeth in the treatment of certain types of malocclusion. Alpha Omegan 1952; 46:93-104.

90. Tweed CH. Evolutionary Trends in orthodontics, past, present, and future. Am J Orthod. 1953; 39:81-108.

91. Tweed CH. The Frankfort-mandibular incisor angle (FMIA) in orthodontic diagnosis, treatment planning and prognosis. Angle Orthod. 1954; 24:121-169.

92. Tweed CH. The Frankfort mandibular plane angle in orthodontic diagnosis, classification, treatment planning and prognosis. Am J Orthod 1946; 32:175-230

93. Vetger F, Hage JJ. Clinical anthropometry and canons of the face in historical perspective. Plast Reconstr Surg 2000; 106: 1090- 1096.

94. Vig PS, Cohen AM. Vertical growth of the lips: a serial Cephalometric study. Am J Orthod 1979; 75:405-415.

95. Weintraub JA, Vig PS, Brown C, Kowalski CJ. The prevalence of orthodontic extractions. Am J Orthod Dentofac Orthop. 1989; 96: 462-466.

96. West EE. Analyses of early Class II, division 1 treatment. Am J Orthod 1957; 43: 769-777.

97. Witzig JW, Sphal TJ. The Clinical Management of Basic Maxillofacial Orthopedic Appliances. Vol 1, Mechanics. Littleton, Mass: PSG Publishing, 1987: 10-13.

98. Witzig JW and Sphal TJ. The clinical management of basic maxillofacial orthopedic appliances. Littleton, Massachusetts: PSG Publishing. 1986.

99. Young T, Smith R. Effects of orthodontics on facial profile: a comparison of changes during non-extraction and four premolar extraction treatment. Am J Orthod Dentofac Orthop 1993; 103: 452-458.

100. Zylinski CG, Nanda RS, Kapila S. Analysis of soft tissue facial profile in white males. Am J Orthod Dentofac Orthop 1992; 101: 514-518.

Appendix Guideline for the Interpretation of Statistical Tables

Evaluator	N	Sum of Scores	Expected Under Ho	Std Dev Under Ho	Mean Score
1	160	23769.50	25680.0	792.746	148.56
0	160	27590.50	25680.0	792.746	172.44

*1 means trained dentist

TABLE 4.11: Wilcoxon Scores (Rank Sums) for Variable Scale Classified by Variable Dentist

Lay evaluators prefer profiles with incompetent lips more than trained dentists in the evaluation of profiles treated by non-extraction with incompetent lips p= .016

INTERPRETATION OF THE ABOVE DATA

"Evaluator" defined as "1" or "0" where the observations of trained dentists and lay evaluators were compared. "1" means the trained dentist group.

"N" is the number of observations. In all cases, there are 80 evaluators (40 trained dentists and 40 lay evaluators). The sample size varies depending on the groups compared. In this case, 4 nonextraction profiles with incompetent lips are being compared to determine if there is a preference between the trained dentists or lay evaluators. The trained dentists had 160 observations (40 trained dentists X 4 patients with incompetent lips treated by nonextraction.

"Sum of Scores" is the sum of the ranking values applied to the data based on each responses from observers in the category based on the Likert Score they selected to rate the "after" treatment profile. *THIS IS THE VALUE THAT IS COMPARED TO A "Z TABLE" OR "T TABLE" TO DETERMINE THE LEVEL OF SIGNIFICANCE OF THE RESULT. In this case, p=0.016.*

"Expected Under Ho" describes what the ranks should be if they are equal.

"Std Dev Under Ho" describes the distribution of the sample

"Mean Score" is derived from the "Sum of Scores" to provide that Statistician a summary of the differences (if any) between the two groups.

APPENDIX 1: Age of Patient Comparing Extraction vs. Nonextraction Groups

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	493.50	410.0	36.951	24.68
non-ext	20	326.50	410.0	36.951	16.33

APPENDIX 1a: Wilcoxon Scores (Rank Sums) for Variable Age "Before" Treatment Classified by Variable Extraction

There is a significant difference in age between the extraction and nonextraction groups before orthodontic treatment $p < 0.0238$.

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	499.50	410.0	36.959	24.98
non-ext	20	320.50	410.0	36.959	16.03

Appendix 1b: Wilcoxon Scores (Rank Sums) for Variable Age "After" Treatment Classified by Variable Extraction

There is a significant difference in age between the extraction and nonextraction groups after orthodontic treatment $p < 0.0155$

APPENDIX 2: Facial Contour Angle of Extraction vs. Nonextraction Groups

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	501.0	410.0	36.887	25.05
non-ext	20	319.0	410.0	36.887	15.95

APPENDIX 2a: Wilcoxon Scores (Rank Sums) for Variable Facial Contour Angle "Before" Treatment Classified by Variable Extraction

There is a significant difference in facial contour angle between the extraction and nonextraction groups before orthodontic treatment $p < 0.0136$

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	301.0	400.0	35.292	15.05
non-ext	19	479.0	380.0	35.292	25.21

APPENDIX 2b: Wilcoxon Scores (Rank Sums) for Variable Change in Facial Contour Angle
Classified by Variable Extraction

There is a significant difference in change of facial contour angle between the extraction and nonextraction groups during orthodontic treatment $p < .005$

Note that a Signed Rank Test on the above data for the nonextraction group concluded that the change in Facial Contour Angle was not significant ($p< 0.85$) during orthodontic treatment. A Signed Rank Test for the extraction group concluded that the change in Facial Contour Angle was significant during orthodontic treatment $p< .0001$

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	437.50	400.0	35.455	21.88
non-ext	20	342.50	380.0	35.455	18.03

APPENDIX 2c: Wilcoxon Scores (Rank Sums) for Variable Facial Contour Angle "After" Treatment Classified by Variable Extraction

There is no difference in facial contour angle ($p> 0.29$) between the extraction and nonextraction groups after orthodontic treatment.

APPENDIX 3: Ricketts' E-Line of Extraction vs. Nonextraction Groups

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	456.0	410.0	36.756	22.80
non-ext	20	364.0	410.0	36.756	18.20

APPENDIX 3a: Wilcoxon Scores (Rank Sums) for Variable Ricketts' E-Line "Before" Treatment classified by Variable Extraction

There is no statistical difference ($p > 0.21$) in Ricketts' E-Line value between the extraction and nonextraction groups before orthodontic treatment.

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	386.0	400.0	35.294	19.30
non-ext	19	394.0	380.0	35.294	20.74

APPENDIX 3b: Wilcoxon Scores (Rank Sums) for Variable Ricketts' E-Line "After" Treatment Classified by Variable Extraction

There is no statistical difference ($p > 0.69$) in Ricketts' E-Line value between the extraction and nonextraction groups after orthodontic treatment.

Extraction	N	Sum of Under Ho	Expected Under Ho	Std Dev Score	Mean
ext	20	311.0	400.0	35.424	15.55
non-ext	19	469.0	380.0	35.424	24.68

APPENDIX 3c: Wilcoxon Scores (Rank Sums) for Variable Change in Ricketts' E-Line Values Classified by Variable Extraction

There is a significant difference in change in Ricketts' E-Line values between the extraction and nonextraction groups during orthodontic treatment ($p < .0120$).

A Signed Rank Test for the nonextraction group concluded that the change in Ricketts' E-Line values was not significant during orthodontic treatment. ($p > .11$.)
A Signed Rank Test for the extraction group concluded that change in Ricketts' E-Line values was significant during orthodontic treatment ($p < .0001$).

APPENDIX 4: Research Participant Information and Consent Form

Research Participant Information and Consent Form
(Version 1.2 –Nov 1, 2002)

"The Evaluation of Post-Orthodontic Soft Tissue Profiles:
Non-Extraction and First Four Bicuspid Extraction Profiles Compared by Dentally Trained and Untrained Individuals"

Dan Stuart, DDS- Principal Investigator
Resident, Graduate Orthodontic Program
University of Manitoba
780 Bannatyne Avenue
Winnipeg, Manitoba
R3E 0W2
(204) 789-3545

You are being asked to participate in a research study. Please take your time to review this consent form and decide whether or not you wish to participate in this study.

Purpose - The purpose of this study is to examine:

1) The differences between the post-orthodontic treatment profiles of non-extraction cases vs. first four bicuspid extraction cases.

2) The differences in perception of these profiles by dentally untrained individuals vs. untrained individuals. Untrained individuals will be the first year hygiene and dentistry students at The University of Manitoba in the fall of 2002.

Participant initials:

Study Procedures

Please rate the profiles of 40 patients following orthodontic treatment. Some of the patients have been treated by extracting four first premolars. Some have been treated with no extractions. The before treatment and after treatment profiles will be shown for approximately thirty seconds.

Please rate the after treatment profiles compared to the before treatment profiles in accordance with the scale below. *Please circle the number that you feel best describes the after treatment profile.* Before treatment profiles are on the left and after treatment profiles are on the right. The patients are in no particular order.

Risks

If you are a student of Dentistry or Dental Hygiene your participation in this study or lack thereof will in no way influence your evaluation as a student.

Benefits

You will receive no payment or reimbursement for any expenses related to taking part in this study.

Confidentiality

Information gathered in this research study may be published or presented in public forums, however your name and other identifying information will not be used or revealed.

The University of Manitoba Health Research Ethics Committee may review records related to the study for quality assurance purposes.

Decision to Participate or Withdraw

You decision to participate in this study is voluntary. You may refuse to participate or you may withdraw at any time.

Questions

If you have any questions during or after the study please contact Dr. Dan Stuart by phone at (204) 789-3545 ext 1 or by e-mail at danstuart96@hotmail.com.

APPENDIX 5: Data Collection Form

Data Collection

Dan Stuart, DDS - Master's Thesis 2004

Have you read and do you understand the enclosed consent form and agree to participate in this study? yes or no (please circle)

Are you a:
1) trained dentist or specialist OR 2) Untrained dental student/ hygienist
(Please circle 1 or 2)

Please rate the profiles of 40 patients following orthodontic treatment. Some of the patients have been treated by extracting four first premolars. Some have been treated with no extractions. The before treatment and after treatment profiles will be shown for thirty seconds. Please rate the after treatment profiles compared to the before treatment profiles in accordance with the scale below. *Please circle the number that you feel best describes the after treatment profile.* Before treatment profiles are on the left and after treatment profiles are on the right. The patients are in no particular order.

PATIENT #1

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #2

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #3

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #4

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #5

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #6

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #7

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #8

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #9

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #10

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #11

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #12

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #13

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #14

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #15

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #16

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #17

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #18

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #19

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #20

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #21

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #22

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #23

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #24

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #25

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #26

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #27

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #28

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #29

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #30

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #31

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #32

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #33

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #34

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #35

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #36

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #37

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #38

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #39

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

PATIENT #40

1	2	3	4	5
Worse	slightly worse	same	slightly better	better

COMMENTS (optional):

APPENDIX 6:
Extraction and Nonextraction Sample Characteristics of Age, Facial Contour Angle and Ricketts' E-Line Values for Before and After Orthodontic Treatment

	BEFORE		AFTER	
	MEAN	**STD. DEV.**	**MEAN**	**STD. DEV.**
Age (Nonextraction)	13.26	3.83	15.77	3.87
Age (Extraction)	16.32	7.00	19.10	7.29
Facial Contour Angle (°) (Nonextraction)	12.55	3.90	12.42*	4.27
Facial Contour Angle (°) (Extraction)	16.25	4.51	14.28	4.64
Ricketts' E-Line (mm) (Nonextraction)	-0.4	3.88	-1.5*	2.79
Ricketts' E-Line (mm) (Extraction)	1.45	2.67	-1.53	3.02

*All groups are n=20 except for those indicated by an asterisk where n=19

UNIVERSITY
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APPROVAL FORM

Principal Investigator: Dr. Dan Stuart

Protocol Reference Number: H2002:165
Date: November 8, 2002

Protocol Title: **"The Evaluation of Post-Orthodontic Soft Tissue Profiles: Non-extraction and Four Bicuspid Extraction Profiles Compared by Dentally Trained and Untrained Individuals"**

The following are approved for use:

- **Protocol (dated November 5, 2002)**
- **Research Participant Information and Consent Form (Version 1.2 dated November 1, 2002)**
- **Letter to participant (dated November 4, 2002)**
- **Data collection form survey (submitted November 5, 2002)**

The above was approved by Dr. A. Katz, Chair, Health Research Ethics Board, Bannatyne Campus, University of Manitoba on behalf of the committee per your letters dated October 23, 2002 and November 5, 2002. The Research Ethics Board is organized and operates according to Health Canada/ICH Good Clinical Practices, Tri-Council Policy Statement, and the applicable laws and regulations of Manitoba. The membership of this Research Ethics Board complies with the membership requirements for Research Ethics Boards defined in Division 5 of the *Food and Drug Regulations.*

This approval is valid for one year only. A study status report must be submitted annually and must accompany your request for re-approval. Any significant changes of the protocol and informed consent form should be reported to the Chair for consideration in advance of implementation of such changes. The REB must be notified regarding discontinuation or study closure.

This approval is for the ethics of human use only. For the logistics of performing the study, approval should be sought from the relevant institution, if required.

Sincerely yours,

Alan Katz, MD., Ch.B., CCFP, FCFP.
Chair,
Health Research Ethics Board
Bannatyne Campus

Please quote the above protocol reference number on all correspondence.
Inquiries should be directed to the REB Secretary
Telephone: (204) 789-3255/ **Fax:** (204) 789-3414