



**DENTO-FACIAL CHANGES**  
**DURING STAGE 1 ORTHODONTIC TREATMENT**  
**WITH THE BEGG APPLIANCE**

A report submitted in partial fulfilment for  
the degree of Master of Dental Surgery

by

Kurupin Chaowakitcharoen

Orthodontic Unit  
Department of Dentistry  
Faculty of Dentistry  
University of Adelaide  
South Australia

1996

## CONTENTS

	page
List of figures	vi
List of tables	viii
List of diagrams	xi
List of graphs	xii
Summary	xiv
Signed statement	xviii
Acknowledgments	xix
Chapter 1 Introduction	1
Chapter 2 Aims	2
Chapter 3 Literature Review	3
3.1 Growth changes of the cranio-facial skeleton and facial profile	3
3.1.1 Growth of the maxilla	3
3.1.2 Growth of the mandible	7
3.2 Growth of the soft tissues	8
3.2.1 Growth change of the soft tissue profile	8
3.2.2 Lips	8
3.3 Orthodontic treatment	9
3.3.1 Treatment effects on the facial profile - skeletal	9
3.3.2 Treatment effects on the facial profile - soft tissue	10
3.3.3 Begg treatment effects	11

	page	
Chapter 4	Materials and methods	16
4.1	Sample selection	16
4.2	Radiography	17
4.3	Pilot study	17
4.4	Tracing and superimposition	19
4.5	Digitizing	19
4.6	Plotting	24
4.7	Transmission of data	24
4.8	Computation of variables	24
4.9	Statistical evaluation	25
4.10	Error study	25
Chapter 5	Results	27
5.1	Error determination	27
5.2	Sample - differences between genders	29
5.2.1	Pre-treatment	29
5.2.2	At stage 1 treatment	31
5.2.3	Changes	33
5.3	Sample - treatment differences	35
5.3.1	Male-extraction and male-nonextraction	35
5.3.1.1	Male-extraction and male-nonextraction - pre-treatment	35
5.3.1.2	Male-extraction and male-nonextraction - at stage 1	37
5.3.1.3	Male-extraction and male-nonextraction - changes	39
5.3.2	Female extraction and female-nonextraction	42
5.3.2.1	Female-extraction and female-nonextraction - pre-treatment	42

	page
5.3.2.2 Female-extraction and female-nonextraction	
- at stage 1	44
5.3.2.3 Female-extraction and female-nonextraction	
- changes	45
5.4 Interlabial gap	48
5.5 The mandibular plane changes	49
5.6 The Downs occlusal plane changes	50
5.7 Results of correlation analysis	52
5.7.1 Male-nonextraction group	54
5.7.2 Male-extraction group	55
5.7.3 Female-nonextraction group	57
5.7.4 Female-extraction group	60
5.8 Comparison of the results from the present study with published longitudinal growth studies	61
Chapter 6 Discussion	66
6.1 Sample size	66
6.2 Age of patients	66
6.3 Treatment time	66
6.4 Reference planes	67
6.5 Tracing and digitizing of radiographs	68
6.6 Differences between genders	69
6.7 Differences between extraction and nonextraction in each gender	70
6.7.1 Male-extraction and male-nonextraction	70
6.7.1.1 pre-treatment	70
6.7.1.2 at stage 1	70
6.7.1.3 changes	71

	page
6.7.2 Female-extraction and female-nonextraction	72
6.7.2.1 pre-treatment	72
6.7.2.2 at stage 1	72
6.7.2.3 changes	73
6.8 Interlabial gap	73
6.9 The mandibular plane angle	74
6.10 The Downs occlusal plane angle	75
6.11 Results of correlation analysis	76
6.12 Comparison of the results from the present study with published longitudinal growth studies	78
Chapter 7 Conclusions	81
Chapter 8 Appendices	82
8.1 Appendix 1 Landmark identification	82
8.2 Appendix 2 Superimposition technique	85
8.3 Appendix 3 Variable descriptions	86
8.4 Appendix 4 Comparisons of average tracings	87
8.4.1 Comparison of average tracings of male-extraction and male-nonextraction patients at pre-treatment	87
8.4.2 Comparison of average tracings of male-extraction and male-nonextraction patients at stage 1	88
8.4.3 Comparison of average tracings of male-extraction patients at pre-treatment and at stage 1	89
8.4.4 Comparison of average tracings of male-nonextraction patients at pre-treatment and at stage 1	90
8.4.5 Comparison of average tracings of female-extraction and female-nonextraction patients at pre-treatment	91

	page
8.4.6 Comparison of average tracings of female-extraction and female-nonextraction patients at stage 1	92
8.4.7 Comparison of average tracings of female-extraction patients at pre-treatment and at stage 1	93
8.4.8 Comparison of average tracings of female-nonextraction patients at pre-treatment and at stage 1	94
Chapter 9   References	95

## LIST OF FIGURES

		page
Fig. 1	Human growth rates	4
Fig. 2	Comparison of cranial and facial growth	5
Fig. 3	Average vertical displacement of the basal maxillary structures	5
Fig. 4	Average vertical growth of the upper alveolar process	6
Fig. 5	Average vertical displacement of the glenoid fossae	6
Fig. 6	Average annual growth increment at the mandibular condyles	7
Fig. 7	Average vertical growth of the lower alveolar process	8
Fig. 8	Example of a patient with a relatively flat mandibular plane which becomes even flatter during a period of free growth between 7 to 12 years of age	12
Fig. 9	Example of a patient with a relatively steep mandibular plane which flattens very little during a period of free growth between 7 to 12 years of age	12
Fig. 10	The flattening process of the mandibular plane has been counteracted by treatment effects	13
Fig. 11	Following treatment, the dominance of the flattening trend of the occlusal and mandibular planes reasserted itself	13
Fig. 12	Calculation of the enlargement factor for points lying on the mid-sagittal plane	18
Fig. 13	Landmarks and order of digitizing	20
Fig. 14	Principal structures used for cranial base superimposition	23

		page
Fig. 15	Comparison of average tracings of male-extraction and male-nonextraction patients at pre-treatment	87
Fig. 16	Comparison of average tracings of male-extraction and male-nonextraction patients at stage 1	88
Fig. 17	Comparison of average tracings of male-extraction patients at pre-treatment and at stage 1	89
Fig. 18	Comparison of average tracings of male-nonextraction patients at pre-treatment and at stage 1	90
Fig. 19	Comparison of average tracings of female-extraction and female-nonextraction patients at pre-treatment	91
Fig. 20	Comparison of average tracings of female-extraction and female-nonextraction patients at stage 1	92
Fig. 21	Comparison of average tracings of female-extraction patients at pre-treatment and at stage 1	93
Fig. 22	Comparison of average tracings of female-nonextraction patients at pre-treatment and at stage 1	94



## LIST OF TABLES

		page
Table 1	Changes in vertical dimension of molars and incisors	14
Table 2	Landmarks and symbols for digitizing	21
Table 3	Variable abbreviation	22
Table 4	Results of double determinations	28
Table 5	Mean values for dento-facial variables in males and females pre-treatment	30
Table 6	Mean values for dento-facial variables in males and females at stage 1	31
Table 7	Mean changes for each variable with treatment in males and females	33
Table 8	Mean values for dento-facial variables in male-extraction and male-nonextraction groups pre-treatment	35
Table 9	Mean values for dento-facial variables in male-extraction and male-nonextraction groups at stage 1	37
Table 10	Mean changes for each variable with treatment in male-extraction and male-nonextraction groups	39
Table 11	Mean values for dento-facial variables in female-extraction and female-nonextraction groups pre-treatment	42
Table 12	Mean values for dento-facial variables in female-extraction and female-nonextraction groups at stage 1	44
Table 13	Mean changes for each variable with treatment in female-extraction and female-nonextraction groups	45
Table 14	Interlabial gap of patients pre-treatment, at stage 1, and the mean change	48

	page	
Table 15	Mandibular plane change relative to cranial base (sn plane) in males and females	49
Table 16	Mandibular plane change relative to cranial base (sn plane) in male-extraction, male-nonextraction, female-extraction, and female-nonextraction groups	50
Table 17	Changes in the Downs occlusal plane in males and females	51
Table 18	Changes in the Downs occlusal plane in male-extraction, male-nonextraction, female-extraction, and female-nonextraction groups	51
Table 19	Results from correlation analysis of change in dento-facial variables with face height ratio	53
Table 20	Mean changes in variable 29 (distance from lower incisor to mandibular plane, 11-mdp) of individuals with high, average, and low ratios of posterior face height to total anterior face height in the male-nonextraction patients	54
Table 21	Mean changes in variable 7 (mandibular plane to sn plane angle, mdp/sn) of individuals with high, average, and low ratios of posterior face height to total anterior face height in the male-extraction patients	55
Table 22	Mean changes in variable 25 (posterior face height, pfh) of individuals with high, average, and low ratios of posterior face height to total anterior face height in the male-extraction patients	56

	page	
Table 23	Mean changes in variable 27 (ratio of posterior face height to total anterior face height, pfh/tafh) of individuals with high, average, and low ratios of posterior face height to total anterior face height in the female-nonextraction patients	57
Table 24	Mean changes in variable 29 (distance from lower incisor to mandibular plane, 11-mdp) of individuals with high, average, and low ratios of posterior face height to total anterior face height in the female-nonextraction patients	58
Table 25	Mean changes in variable 33 (nasolabial angle, nasolab/a) of individuals with high, average, and low ratios of posterior face height to total anterior face height in the female-nonextraction patients	59
Table 26	Mean changes in variable 6 (maxillary plane to sn plane angle, mxp/sn) of individuals with high, average, and low ratios of posterior face height to total anterior face height in the female-extraction patients	60
Table 27	Comparison of the results for males in the present study with the published Michigan, and the published Bhatia and Leighton longitudinal growth studies	61
Table 28	Comparison of the results for females in the present study with the published Michigan, and the published Bhatia and Leighton longitudinal growth studies	63
Table 29	Variable descriptions	86

## LIST OF DIAGRAMS

		page
Diagram 1	Classification of the samples	16
Diagram 2	Scatter diagram of change in variable 29 (I1-mdp) with face height ratio in the male-nonextraction patients	54
Diagram 3	Scatter diagram of change in variable 7 (mdp/sn) with face height ratio in the male-extraction patients	55
Diagram 4	Scatter diagram of change in variable 25 (pfh) with face height ratio in the male-extraction patients	56
Diagram 5	Scatter diagram of change in variable 27 (pfh/tafh) with face height ratio in the female-nonextraction patients	57
Diagram 6	Scatter diagram of change in variable 29 (I1-mdp) with face height ratio in the female-nonextraction patients	58
Diagram 7	Scatter diagram of change in variable 33 (nasolab/a) with face height ratio in the female-nonextraction patients	59
Diagram 8	Scatter diagram of change in variable 6 (mxp/sn) with face height ratio in the female-extraction patients	60
Diagram 9	Perpendicular distance of lower incisor to mandibular plane changes in different face types	76

## LIST OF GRAPHS

		page
Graph 1	Variables displaying statistically significant differences between male-extraction and male-nonextraction groups pre-treatment	37
Graph 2	Variables displaying statistically significant differences between male-extraction and male-nonextraction groups at stage 1	39
Graph 3	Variables displaying statistically significant differences in change with treatment between male-extraction and male-nonextraction groups	41
Graph 4	Variables displaying statistically significant differences between female-extraction and female-nonextraction groups pre-treatment	43
Graph 5	Variables displaying statistically significant differences between female-extraction and female-nonextraction groups at stage 1	45
Graph 6	Variables displaying statistically significant differences in change with treatment between female-extraction and female-nonextraction groups	47
Graph 7	Interlabial gap of patients pre-treatment, at stage 1, and the mean change	48
Graph 8	Mandibular plane change relative to cranial base (sn plane) in males and females	49
Graph 9	Mandibular plane change relative to cranial base (sn plane) in male-extraction, male-nonextraction, female-extraction, and female-nonextraction groups	50

	page	
Graph 10	Changes in the Downs occlusal plane in males and females	51
Graph 11	Changes in the Downs occlusal plane in male-extraction, male-nonextraction, female-extraction, and female-nonextraction groups	51



## SUMMARY

The present study observed the dento-facial changes of Class II division 1 malocclusion patients treated by Begg appliance from pre-treatment until stage 1.

All of the 85 patients displayed Class II division 1 malocclusions and were treated with the Begg appliance in the Orthodontic Post-graduate Course at the University of Adelaide. The female patients were aged between 10.5 to 16.0 years, and the males between 12.2 to 15.5 years. The average age of subjects was 13.6 years, implying that some would have experienced their adolescent growth spurt during the treatment period and therefore some of the observed changes were related to rapid growth superimposed on treatment effects.

The sample was divided into 15 male-extraction, 17 male-nonextraction, 29 female-extraction, and 24 female-nonextraction groups according to the type of treatment performed. Each was further subdivided according to face type by using the ratio of the posterior face height to the total anterior face height.

The cephalometric analysis was completed with care and caution. The data were transferred by electronic digitizer in association with a program for computerized cephalometry. All measurements were adjusted to allow for radiographic enlargement (8.8%). Some points located on a smooth curve, such as, superior labial sulcus (sls), soft tissue pogonion (pos), pogonion (pog), displayed significant errors along the y-axis. The images of landmarks of the molar teeth on the lateral cephalograms were also poorly resolved and made determination of their positions difficult. This caused all of the variables that involved the molar teeth and the occlusal planes to be associated with relatively large errors in location.

Basic descriptive statistics were computed for all variables to summarize the data, and ANOVA was used to compare the mean values between groups. Correlation analysis quantified the strength of the association between each variable to the face type (long, average, and short face types).

Many pre-treatment variables showed statistically significant differences at  $p < 0.05$  level between males and females, for example :

- the angle of the lower incisor to the mandibular plane was more proclined in females than in males;
- the perpendicular distance from the lower incisal edge to the mandibular plane was larger in males than in females;
- overbite was deeper in males than in females;
- maxillary and mandibular length was longer in males than in females;
- upper anterior face height and total anterior face height were longer in males than in females;

- the distance from the tip of nose to the soft tissue chin was longer in males than in females;
- the hard tissue chin point along y-axis, pogonion (pog-y), was longer in males than in females;
- the distance from the lower lip, sll, along the y-axis was longer in males than in females.

This indicates that males have a facial skeletal size larger than females, and also that the lower incisors in males are less proclined than in females. Although the ages of males and females in the present study were quite similar and normally females in this age are close to adult size, males still showed a larger cranio-facial skeleton size.

Male-extraction and male-nonextraction groups showed statistically significant differences at  $p < 0.05$  for the following pre-treatment variables :

- upper incisor inclination in the male-extraction group was more proclined than in the male-nonextraction group;
- the nasolabial angle in the male-extraction group was more obtuse than in the male-nonextraction group. However, the nasolabial angle was one of the variables that showed relatively large errors;
- the interlabial gap in the male-extraction group was larger than in the male-nonextraction group.

Female-extraction and female-nonextraction groups showed statistically significant differences at  $p < 0.05$  level for the following pre-treatment variables:

- the inclination of the lower incisor to mandibular plane in the female-extraction group was more proclined than in the female-nonextraction group;
- mandibular length (co-gn) in the female-extraction group was shorter than in the female-nonextraction group.

Treatment from banding until the end of stage 1 produced a reduction of the interlabial gap in both male-extraction and female-extraction groups. This was statistically significant at  $p < 0.05$  level only in the male-extraction group where the interlabial gap was reduced by an average of 2.72 mm. The relatively large variation in interlabial gap reduction between individuals ( $sd = 2.2mm$ ) may have been partly due to some patients not having their lips completely relaxed at the time when the radiographs were taken.

Patients were divided into groups according to their face type by using the ratio of the posterior face height to total anterior face height. This ratio was low in long-faced patients, and high in short-faced patients. Correlation analysis was then used to quantify the strength of association between the change of each variable with face type. The results of this analysis showed that in the male-nonextraction group, the change of the perpendicular distance from lower incisal edge to mandibular plane was negatively correlated ( $r = -0.66$ ) with the face height ratio. This indicates that long-faced patients tended to display a greater change in this variable than short-faced patients.



In the male-extraction group, the steepness of the mandibular plane angle to sn plane had a significant negative correlation ( $r = -0.65$ ) with face height ratio. This indicates that long-faced patients, who normally have steep mandibular plane angles, tended to have more mandibular plane opening than short-faced patients from pre-treatment until stage 1 in Begg treatment technique. The change in posterior face height showed a positive correlation with face height ratio. This indicated that long-faced patients tended to have a smaller increase in the posterior face height than short-faced patients.

In the female-nonextraction group, the change in the ratio of posterior face height to total anterior face height, the change of the perpendicular distance from lower incisal edge to mandibular plane, and the change of the nasolabial angle, all showed negative correlations with face height ratio. This means that long-faced patients tended to have a smaller increase in posterior face height or a greater increase in the anterior face height than short-faced patients. On the other hand, short-faced patients had a larger increase in posterior face height and smaller increase in the anterior face height than long-faced patients. The nasolabial angle in long faced-patients was larger, and had a greater increase due to treatment than occurred in short-faced patients.

In the female-extraction group, the steepness of maxillary plane showed a significant negative correlation ( $r = -0.43$ ) with the face height ratio. This means that long-faced patients tended to show greater change in the steepness of the maxillary plane than short-faced patients.

The Begg treatment technique during stage 1 also produced a reduction in the interlabial gap in the male-extraction patients in the present study. Males and females showed statistically significant differences in some variables, especially skeletal size. The different treatment groups, extraction and nonextraction, also responded differently to treatment. The results from correlation analysis indicated that the treatment responses of some variables depended upon the face type. The results from ANOVA confirmed that the changes in each face type group were different.

The results from the present study rejected the null hypothesis that treatment responses are independent of face types. It can be concluded that each face type (short, average, and long faced patients) responds differently to the Begg treatment stage 1. This result is quite similar to the findings of Leighton and Hunter (1982) who found that the spacing and crowding of the mandibular teeth are associated with the face type and that severely crowded patients are likely to have a steep mandibular plane angle and short posterior face height. The findings of the present study and that of Leighton and Hunter (1982) contrast with the findings of Bishara et al. (1994), who could not find any significant difference in post-treatment change in each face type.

The further study of the treatment responses in Begg treatment technique during stage 2, stage 3, and post-treatment in different face types would be interesting and a useful study.

## STATEMENT

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University. To the best of my knowledge and belief, it contains no material previously published or written by another person except where due reference has been made in the text of the thesis.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Kurupin Chaowakitcharoen

14 February 1996

## ACKNOWLEDGMENTS

I would like to acknowledge the following people for their assistance in the completion of this thesis.

Prof. W. Sampson, Head of Orthodontic Unit, University of Adelaide, for his valuable advice, supervision, and editorial assistance in the preparation of my research.

Prof. G. Townsend, Professor of Dental Science, University of Adelaide, for everwillingness to help and provide guidance in the field of statistics.

Prof. T. Brown, Department of Dentistry, for his advice on using the computer and digitizing programme.

Mrs. Wendy Schwerdt, for assisting me with the statistical analysis of the data.

Dr. Simon Freezer, for generating the average tracings for this study with his personal computer.

Mr. Scott Dullaway, my best friend in Australia, for always being by my side and helping me.