Changes in the Dentition from the Early Teens to the Early Twenties.

A Longitudinal Cast Study.[1]

By

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Introduction.

The phenomenon of growth is of vital interest to the professional worker in the orthodontic field. The nature of growth as a process or processes is far better understood than it was twenty years ago. However, contradictions we find in the literature on the nature of growth would indicate that biologists themselves do not yet admit a full understanding. Many valuable contributions through research have been given the profession in recent years explaining the growth and development of the dento-facial. complex. These researches have been diversified in their scope.

Among the researches which have contributed to our knowledge of changes occurring in the dentition of growing children, was one, completed at the University of Michigan in 1944 by Dr. GERALD V. BARROW and Dr. J. ROMALD WHITE, entitled "Growth Changes of the Maxillary and Mandibular Dental Arches". This research was based on the study of longitudinal cast series, representing subjects ranging from three to seventeen years of age. These subjects are now six years older.

[1] This study is submitted in partial fulfillment of the requirements for the Degree of Master of Science in Orthodontics in the Horace H. Rackham School of Graduate Studies at the University of Michigan, Ann Arbor, Michigan, U. S. A. June 1950.

Our present study is based on the belief that study of these longitudinal series increased by six years and thereby including late adolescent development might reveal changes not predictable from the earlier series ending six years younger.

The Data.

At the University of Michigan in Ann Arbor the students in the Orthodontic Department have at their disposal for study longitudinal cast series made on children attending the University Elementary and High Schools. This dental research project was organized by Dr. GEORGE R. MOORE in 1931, one year after the Elementary School was founded for the purpose of research in nutrition, psychometrics and physical development of normal children. The dental program was planned and arranged as a part of these studies.

The collection of dental data has been handled each year by a research assistant — always a graduate student of the Orthodontic Department. The casts are made according to uniform specifications established by the orthodontic profession.

The data available for study consist of serial maxillary and mandibular casts made of children enrolled in the schools, from three to seventeen years of age. The first group of these children has now reached the age of twenty to twenty-five years. Each year the series represent potentially an increase in age range of the material which may be used for study of age changes in the dentition.

Difficulties in contacting our subjects limited the number in this study to forty. New casts were made of each. Sixteen of the group had had orthodontic treatment, twenty-four had not. Separation of treated and non-treated subjects has been maintained throughout the study.

From the longitudinal cast series one cast was selected for each of the forty individuals, presenting at as early an age as possible, the permanent dentition from the first permanent molars anteriorly. This cast served as the basis of comparison of the measurements and observations used in estimating changes on the later cast. The average age difference between the two sets of casts used in the *non-orthodontically treated group* was 8 years and 6 months. The average age range was from 12 years and 10 months

to 21 years and 6 months. The minimum span was 4 years and 11 months. The maximum span was 12 years and 10 months. The average age difference between the two sets of casts used in the *orthodontically treated group* was 8 years and 9 months; the average age range was from 12 years and 9 months to 21 years and 8 months. The minimum span was 6 years and 7 months. The maximum span was 10 years and 1 month. (Ref. Table 1.)

Table 1.

Age.

	No Orthodontic treatment	Orthodontic treatment
Average difference	8 years 6 months	8 years 9 months
Average cast 1	12 » 10 »	12 » 9 »
Average cast 2	21 » 6 »	21 » 8 »
Minimum span	4 » 11 »	6 » 7 »
Maximum span	12 » 10 »	10 » 1 »

Statement of the Problem.

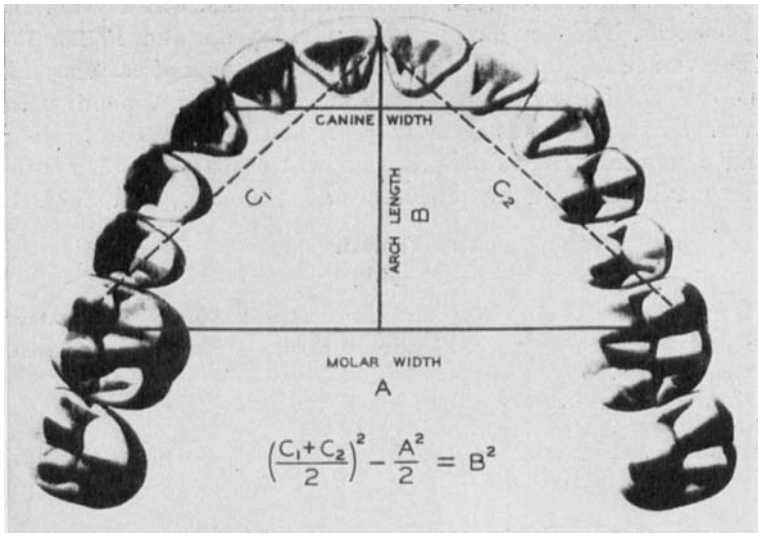
Analysis of this study included:

1. Measurements of the amount of change which had occurred during the period elapsing between the early teen cast and the early twenties cast, in inter-canine width, inter-molar width, arch length and depth of bite.

2. Evaluation of changes in occlusal relationship during the time intervening between the two series of casts. These were observations made on anterior spacing and crowding, and mesio-distal relation of canines and first permanent molars.

The Method.

Measurements were made with Boley Gauges independently by each of us upon agreed points determining the inter-canine width, inter-molar width, arch length and depth of bite. Our measurements coincided in most instances, never varying more than two-tenths of a millimeter; where there was a slight variation, we used the mean of the two findings. Observations were made in collaboration on dentition changes, which did not lend themselves to the measurement technique. These included anterior spacing and crowding and the mesio-distal relation of canines and first permanent molars.



Inter-canine Width.

The width of the dental arches was measured from canine tip to canine tip on both maxillary and mandibular casts in each series. In the casts where the tips were abraded, the anatomical shape of the canines made it possible to approximate the original tip location.

In the non-treated group of 24, measurements on the maxillary casts revealed a decrease in 17 or 70.8 % (a little more than two-thirds of the group). The mean decrease was .89 mm. The range fell between .2 and 3.3 mm. Seven casts or 29.2 % showed an increase. The mean increase was 1.18 mm. The range fell between .3 and 3.1 mm.

In the mandibular arch, two casts or 8.3 % remained unchanged. Eighteen or 75 % (three-fourths of the group) showed a decrease; the mean of decrease was .88 mm. The range was from .2 to 2.6 mm. Four casts or 16.7 % increased. The mean increase was 1.3 mm. The range was from .2 to 2.0 mm.

In the treated group of 16, measurements on the maxilla disclosed a decrease in 6 casts or 37.5 %. The mean decrease was .97 mm. Range from .2 to 2.2 mm. Ten casts or 62.5 % (more than half the group) increased; the mean increase was .71 mm.

The range was between .25 and 1.85 mm. The mandibular had one cast or 6.2 % unchanged. Thirteen or 81.3 % (about four-fifths of the group) showed a decrease. The mean decrease was 1.17 mm. The range was between .1 and 3.75 mm. Two casts or 12.5 % showed an increase. The mean increase was .52 mm, the range falling between .4 and .65 mm. (Ref. Table 2.)

Table 2.

	No orthodontic treatment		Orthodontic treatment	
Maxillary canine width	Decrease	Increase	Decrease	Increase
Number	17	7	6	10
Percentage	70.8	29.2	37.5	62.5
Mean amount	.89	1.18	.97	.71
Range	.2—3.3	.3—3.1	.2—2.2	.25—1.85
Mandibular canine width	Decrease	Increase	Decrease	Increase
Number	18	4	13	2
Percentage	75.0	16.7	81.3	12.5
Mean amount	.88	1.3	1.17	.52
Range	.2—2.6	.2—2.0	.1—3.75	.4— .65
Neither decrease nor increase				
Number	2		1	
Percentage	8.3		6.2	

Inter-molar Width.

This measurement was taken between the first permanent molars at the buccal grooves where they pass to the occlusal surfaces. The untreated group disclosed on examination of the maxillary casts that one cast or 4.2 % showed no change. Fourteen, or 58.3 % (more than half of the group), decreased. The mean decrease was .9 mm. The range fell between .1 and 2.1 mm. Nine or 37.5 % increased. The mean increase was .69 mm. The range was between .4 and 1.75 mm. On the mandibular casts 5 or 20.8 % remained unchanged. Twelve or 50 % showed a decrease in inter-molar width. The mean decrease was .83 mm. The range was between .1 and 1.6 mm. Increase in 7 or 29.2 %. Mean increase 1.0 mm. Range .5 to 1.95 mm.

The treated group revealed one maxillary cast, or 6.2 % of this group unchanged. Eleven or 68.8 % (about two-thirds of the group) decreased with a mean of .78 mm, the range falling between

.1 and 2.3 mm. Four casts or 25 % showed a mean increase of .76 mm, the range being between .5 and 1.05 mm. The mandibular casts in the treated group presented 11 or 68.8 % (about two-thirds of the group) with a mean decrease of 1.03 mm, the range lying between .1 and 2.6 mm. Five or 31.2 % of the mandibular casts showed an increase with a mean of 1.01 mm, falling into the range of .5 to 2.0 mm. (Ref. Table 3.)

Table 3.

	No orthodontic treatment		Orthodontic treatment	
Maxillary molar width	Decrease	Increase	Decrease	Increase
Number	14	9	11	4
Percentage	58.3	37.5	68.8	25.0
Mean amount	.9	.69	.78	.76
Range	.1—2.1	.4—1.75	.1—2.3	.5—1.05
Neither decrease nor increase				
Number	1		1	
Percentage	4.2		6.2	
Mandibular molar width	Decrease	Increase	Decrease	Increase
Number	12	7	11	5
Percentage	50.0	29.2	68.8	31.2
Mean amount	.83	1.0	1.03	1.01
Range	.1—1.6	.5—1.95	.1—2.6	.5—2.0
Neither decrease nor increase				
Number	5			
Percentage	20.8			

Arch Length.

Our arch length was estimated as the line from the anterior midpoint perpendicular to a transverse line connecting the two points used for measuring the inter-molar width. This line was computed by the use of the Pythagorean Theorem.

By the term "midpoint" in this study, we mean that point on the cast where a transverse line connecting the most lingual aspects of the central incisors at their mesial marginal ridges intersects a sagittal line between the central incisors on both the maxillary and mandibular casts. Where the central incisors are spaced, this sagittal line of course passes between the two teeth

equidistant from their approximating surfaces. The level between the incisal edge and the cervical portion at the midpoint was determined by the amount of soft tissue registered in the cast made in the early teen age, and this same level was re-established on the early twenties cast.

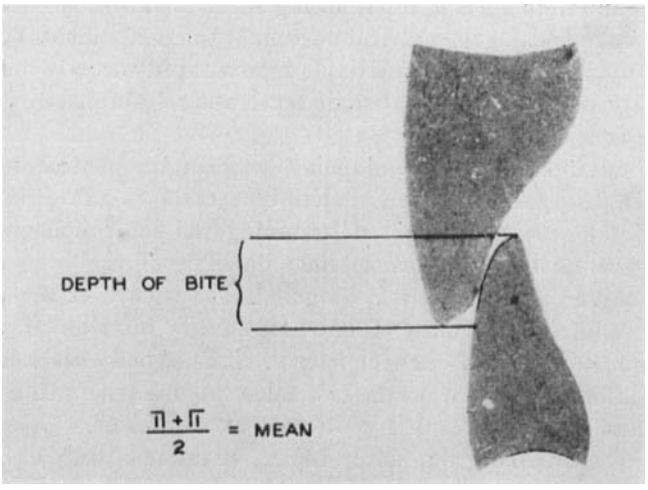
We measured from the midpoint between the central incisors on both the maxillary and mandibular casts to the points on the buccal grooves used in determining the inter-molar width. This gave us our hypotenuse line; one-half of the inter-molar width served as our other known line. The square of the hypotenuse minus the square of one-half of the inter-molar width equalled the square of our arch length. If the hypotenuse measurement differed in length on the two sides, we used the mean of the two measurements as our hypotenuse measurement.

In the untreated group 24 or 100 % of the maxillary casts decreased in arch length. The mean decrease was 1.6 mm, ranging from .4 to 4.7 mm. In the mandibular casts decrease occurred in 23 casts or 95.8 %. The mean decrease 1.7 mm. The range fell between .1 and 3.8 mm. One mandibular cast or 4.2 % increased four-tenths of a millimeter.

The orthodontically treated group of 16 showed a similar decrease in arch length. Fourteen maxillary casts or 87.5 % showed a mean decrease of 1.7 mm. Range was from .2 to 3.9 mm. Two maxillary casts or 12.5 % showed a mean increase of 1.3 mm. Range fell between one millimeter and 1.6 mm. Fifteen mandibular casts or 93.8 % showed a mean decrease of 1.7 mm. Range was from .2 to 3.7 mm. One mandibular cast or 6.2 % increased 1 mm. (Ref. Table 4.)

Table 4.

	No orthodontic treatment		Orthodontic treatment	
Maxillary arch length	Decrease	Increase	Decrease	Increase
Number	24		14	2
Percentage	100		87.5	12.5
Mean amount	1.6		1.7	1.3
Range	.4—4.7		.2—3.9	1.0—1.6
Mandibular Arch Length				
Number	23	1	15	1
Percentage	95.8	4.2	93.8	6.2
Mean amount	1.7	.4	1.7	1.0
Range	.1—3.8		.2—3.7	



Depth of Bite.

Depth of bite was determined by measuring the overlapping of the labial surfaces of the mandibular central incisors by the maxillary central incisors on both series of casts. This measurement was obtained by holding the maxillary and mandibular casts firmly together in the position of occlusion. A marking was then recorded on the mandibular central incisors, where the maxillary central incisors at the incisal edge overlapped them on the labial surface. These markings were made on a plane parallel to the plane of occlusion. The measurements were taken with uniformity from these markings to the lingual aspect of the incisal edge of both the mandibular central incisors. The mean of the two measurements constituted our depth of bite.

In measuring to the lingual aspect of the incisal edge, it is our opinion that we minimized possible errors due to functional abrasion in the dentition.

We found in the non-treated group (24 casts in each series) a decrease in the depth of bite in 17 casts or 70.8 % (more than two-thirds of the group). The range of decrease was from .05 to 1.95 mm with a mean of .78 mm. The depth of bite increased in 7 or 29.7 %. The range of increase was from .2 to 1.22 mm with a mean of .58 mm.

In the treated group (16 casts in each series) we found a decrease in 9 casts or 56.3 % (more than one-half of the group). The range of decrease was from .05 to 1.6 mm with a mean of .77 mm. Seven or 43.7 % of this group showed an increase. The range of increase was from .2 mm to 1.0 mm, with a mean of .52 mm. (Ref. Table 5.)

Table 5.

Depth of Bite.

	No orthodontic treatment		Orthodontic treatment	
	Decrease	Increase	Decrease	Increase
Number	17	7	9	7
Percentage	70.8	29.2	56.3	43.7
Mean amount	.78	.58	.77	.52
Range	.05—1.95	.2—1.22	.05—1.6	.2—1.0

Statistical Analysis.

The Standard Error of the Mean Test was applied to determine if the findings had statistical significance and the Chi Square Test was used to compare the results in the non-treated group to those in the treated group. In this analysis we were assisted by Miss HELEN L. JOHNSON, instructor in Public Health Statistics.

In practically all instances a larger percentage of the measurements showed a decrease with age than showed an increase. The only exception was in the maxillary canine-width in the treated group.

However, because of the relatively small size of samples, these percentages had rather large Standard Errors. The proportions showing decrease were large enough that even allowing for variation within the limits of two Standard Errors, it would still be greater than 50 % (one-half) in similar samples. In these instances it would appear significant that the percent of decrease was sufficiently greater than the percent of increase to be judged indicative.

The results in the treated group were rather similar to those in the untreated group. The Chi Square Test was used to determine whether any of the results were statistically significantly different. This was true only in one instance. In the maxillary canine-width, where the treated group showed a proportionately

greater percent of increase (62.5 %), the differences between the treated and untreated groups seemed to be significantly different. Our statistician informs us that about four times in a hundred such differences could be due to chance.

The size of the mean amount of change was tested to determine whether in any case the amount of change in the treated group differed from the corresponding amount of change in the untreated group and whether the amount of decrease differed significantly from the amount of increase. In no instance were there significant differences in the amount of change.

In the following statistical statements we have excluded the treated group for several reasons. First, the treated group was small and many of the percentages observed in that group were not statistically significant. Secondly, it is possible that the treated group is not a single group (not a single entity) but represents a combination of different types of treatment with different aims in view. The group in itself might not be made up of comparable members.

The following comments refer only to those twenty-four individuals who had received no treatment.

A significantly larger proportion of the measurements of maxillary canine-width showed a decrease with age than showed an increase. A significantly larger proportion of the measurements of the mandibular canine-width showed a decrease than failed to show a decrease (that is, showed an increase or no change). However, in neither instance was the mean amount of decrease significantly different from the mean amount of increase.

A significantly larger proportion of the measurements of maxillary arch length showed a decrease with age than showed an increase. This was also true of the mandibular arch length. Again, the mean amount of decrease did not differ significantly from the mean amount of increase.

A significantly larger proportion of measurements of overbite showed a decrease with age than showed an increase, but again, the mean amount of decrease in overbite did not differ significantly from the mean amount of increase.

The mean amounts of increase and decrease were so alike in both the maxillary and mandibular inter-molar width, when tested statistically, that no significant differences were disclosed.

Spacing and Crowding of the Six Anterior Teeth.

Observations were made in collaboration on both spacing and crowding in the six maxillary and mandibular anterior teeth in the non-treated group. Again the treated group was excluded because treatment was so diversified in aims that the true growth pattern was obscured.

We recorded the change of spacing and crowding between the early teen cast and the early twenties casts on each of the twenty-four individuals. In order to standardize our observations the letter S was used to indicate spacing and the letter C was used to denote crowding. Our scale of spacing and crowding was +, ++, +++; + denoting slight spacing or crowding, ++ denoting definite spacing or crowding and +++ denoting extreme spacing or crowding. The letters S and C in combination indicated neither spacing nor crowding.

Eight early teen maxillary casts revealed neither spacing nor crowding in the six anterior teeth and this condition remained so in the early twenties casts. In the mandibular series only five casts revealed neither spacing nor crowding in both casts.

In the maxillary series five cases showed spacing in the teen group; three of these revealed no change in the amount of spacing in the early twenties casts while two changed to neither spacing nor crowding in the twenty age group.

In the mandibular series only two cases in the teen age group showed slight spacing and remained the same in the twenty age group.

In the remaining maxillary series, one case changed from neither spacing nor crowding to a slight crowding. Four cases showed a slight crowding in both casts while four cases changed from slight crowding to definite crowding.

One case showed definite crowding in both casts and one case changed from definite to extreme crowding.

In the remaining mandibular series five cases showed no crowding nor spacing in the teen casts; four of these cases changed to slight crowding and one case to definite crowding. Nine cases showed a slight crowding in the early teen casts; three of these cases remained unchanged, five cases changed to definite crowding, one case changed to extreme crowding. Two cases showed a definite crowding in both casts and one case showed an extreme crowding in both casts. (Ref. Table 6.)

Table 6.

Spacing and Crowding	No orthodontic treatment		Orthodontic treatment	
	Maxillary	Mandibular	Maxillary	Mandibular
From SC to SC	8	5	5	
From S+ to S+	2	2	1	
From S+ to SC	2		2	1
From S++ to S+			1	
From S++ to S++	1		1	
From SC to C+	1	4	2	3
From SC to C++		1		
From C+ to S+				1
From C+ to C+	4	3	1	
From C+ to C++	4	5	1	4
From C+ to C+++		1		3
From C++ to C++	1	2		
From C++ to C+			1	1
From C++ to C+++	1			1
From C+++ to C+++		1	1	2
	24	24	16	16

SC = no crowding or spacing
S+ and C+ = slight spacing and crowding
S++ and C++ = definite spacing and crowding
S+++ and C+++ = extreme spacing and crowding.

Occlusal Relations.

Observations were made in collaboration on the changes in occlusal relations of the first permanent molars and the canines.

By Class I in molar relation we understand the triangular ridge of the mesio-buccal cusp of the maxillary first permanent molar to occlude in the buccal groove of the mandibular first permanent molar. Any deviation of the maxillary mesio-buccal cusp to the mesial of this relationship was termed Class II. Deviations to the distal were termed Class III's.

By Class I canine relation we understand the maxillary canines to occlude in the buccal embrasures between the mandibular canines and first premolars. Any deviation of the maxillary canine to the mesial was termed Class II. Deviations to the distal were termed Class III's.

Again the orthodontically treated group was excluded for reasons mentioned before.

In the molar relation, of the twenty-four non-treated cases, fifteen subjects presented Class I occlusion in the teen casts; of

these, nine remained in the same occlusal relation in the twenties casts. Two cases changed to a Class II relation on one side only. Three cases changed to a Class III relation on one side only. One case changed to a Class III relation on both sides.

Seven cases showed a Class II molar relation in the teen casts; six of the seven changed to Class I relation on one side and one changed to Class I on both sides.

In one teen cast we observed a Class I on one side with a Class III tendency on the other side; in the twenties cast the Class I relation was maintained on the one side, while the other side, originally showing the Class III tendency, changed to a clear Class III relation.

In one case a Class II relation appeared on the same side in both casts, while the other side showed a Class I relation in the teen cast changing to a Class III relation in the twenties cast.

The canine study revealed only two cases showing a Class I relation existing in both series.

Eighteen cases revealed the canines in a Class II relation in the teen casts; five of these changed to a Class I relation on both sides, twelve changed to a Class I on one side only, and one remained Class II on both sides in the twenties cast.

The four remaining cases displayed varying combinations of the canine relation. One case with a Class III tendency on one side and Class II on the other showed no change in the relation from the teen to the twenties casts.

One case with a Class I on one side remained unchanged while the other side which was Class II in the early teen cast, changed to a Class III tendency in the later cast.

One case, with a Class II on one side, remained unchanged while the other side, which was a Class I in the early teen cast, changed to a Class II tendency in the twenties cast.

One case, with a Class II on one side, remained unchanged, while the other side which was a Class I in the early teen cast, changed into a Class III tendency in the twenties cast.

Summary and Conclusions.

This study has been made on forty individuals of whom 16 had received orthodontic treatment and 24 had not. Our purpose was to investigate changes in the dentition from the early teens

to the early twenties. The study included measurements of age changes in inter-canine width, inter-molar width, arch length and depth of bite, as well as observations on anterior spacing and crowding and occlusal relations of the first permanent molars and canines.

Our measurements showed in all instances except one a larger percentage of decrease with age than increase. This one exception was shown in the maxillary canine width of treated subjects.

Our findings on depth of bite in the untreated group indicate that a larger percentage of decrease than increase can be expected when late adolescent development is included.

In the observations made on anterior spacing and crowding a tendency to space closure and an increase in crowding was evident with age.

Since our teen casts were chosen after the transition shift had occurred, the changes in molar relation indicated no definite pattern, whereas the canine relation revealed a definite tendency to change from a Class II in the teen casts to a Class I in the twenties casts.

Although our sample is a small one, it is indicative of findings in future samples. It is our hope that this study may be extended as larger samples become available.

Zusammenfassung.

Wir haben vierzig Personen untersucht, von denen sechzehn orthodontisch behandelt wurden und vierundzwanzig nicht. Der Zweck unserer Untersuchung war die Veränderungen im Gebiss festzustellen, die im Alter zwischen 11 und 12 Jahren bis zu ca. 20 Jahren eintreten. Die Untersuchung erstreckte sich auf Messung der mit den Jahren eintretenden Veränderungen des Zwischenraumes zwischen den Eckzähnen und zwischen den Backenzähnen, den Veränderungen der Länge des Bogens und der Tiefe des Bisses, und weiters auf Beobachtung des Abstandes und Zusammendrängens der Vorderzähne und des Okklusionsverhältnisses der ersten definitiven Eck- und Backenzähne.

Unsere Messungen zeigten, mit Ausnahme eines einzigen Falles, eine Verminderung mit dem Fortschreiten der Jahre. Diese eine Ausnahme wurde beim Abstand des Oberkiefer-Eckzahns bei der behandelten Gruppe festgestellt.

Was die Tiefe des Bisses bei der unbehandelten Gruppe betrifft, so zeigen unsere Resultate, dass man eher auf Abnahme als auf Zunahme rechnen kann, wenn man auch die spätesten Entwicklungsjahre in Betracht zieht.

Die Beobachtungen des Zwischenraumes, bezw. der Zusammendrängung der Vorderzähne zeigen mit zunehmenden Jahren eine Tendenz zum Verschwinden der Zwischenräume und zu grösserer Dichte.

Da unsere 11- bis 12 Jahre alten Modelle nach dem Zahnwechsel genommen wurden, wurde kein bestimmtes Muster bei den Veränderungen der Molarrelation festgestellt, während das Verhältnis zwischen den Eckzähnen die absolute Tendenz zu einer Veränderung von Klasse II im Alter von 11 bis 12 Jahren zu Klasse I bei Modellen von ca. 20 Jahren zeigte.

Obwohl unsere Versuchsgruppe nur klein war, ist sie doch ein Wegweiser für die wahrscheinlichen Ergebnisse zukünftiger Untersuchungen. Wir hoffen, dass diese Untersuchung auf breiterer Basis durchgeführt werden wird, wenn mehr Versuchsmaterial zur Verfügung stehen wird.

Résumé.

Cette étude a été faite sur quarante individus parmi lesquels seize ont subi le traitement orthodontic, tandis que vingt-quatre ne l'ont pas subi. C'était notre but d'étudier les modifications dans la dentition chez des individus pendant la période de leur âge évoluant de leurs treize ans jusqu'au début des leurs 20 ans. Notre étude comprenait des mensurations sur les changements selon l'âge de l'espace compris entre les canines, entre les molaires, de la longueur de l'arc et de la profondeur de la morsure, aussi bien que les observations sur l'espacement et le dégré de rapprochement des incisives et les relations d'occlusion des premières molaires et canines définitives.

Nos mensurations nous ont montré, dans tous les cas, sauf un, une diminution plutôt qu'une augmentation avec le cours des années. La seule exception était remarquée dans l'espacement canine maxillaire des sujets traités.

Nos résultats sur la profondeur de la morsure sur le groupe non traité indiquaient que l'on pouvait s'attendre un plus grand pourcentage d'attenuation plutôt que d'accentuation lorsque on considère aussi l'adolescence avancée.

Dans les observations faites sur l'espacement et le resserrement des incisives, une tendance à combler l'espacement et à augmenter le resserrement était évidente avec l'âge.

Puisque nos modèles de 11 à 12 ans étaient choisis après leur changement de dents, les changements dans les relations intermolaires n'indiquaient des exemples bien définis, tandis que les relations intercanines révélaient une tendance précise de passer de la classe II chez les individus de 11—12 ans à la classe I pour ceux d'une vingtaine d'années.

Bien que nos exemples soient assez réduits, ils en appellent d'autres plus nombreux. C'est donc notre espoir que cette étude puisse être amplifiée lorsqu'on pourra disposer d'un plus grand nombre de modèles.

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