# LOWER ARCH CHANGES IN AN ORTHODONTIC RETENTION AND NON-RETENTION GROUP

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# INTRODUCTION

One of the primary problems after the completion of active orthodontic appliance therapy has been maintaining the mandibular dental arch in the treated position. This is most frequently termed "relapse change" and creates a difficult phase of treatment for both the patient and the dentist. Furthermore, this relapse in position can vary from frank spacing to mild (0-5 mm.) or severe (10 mm.) crowding with return of incisor rotation positions. This post-treatment physiologic change can so nearly duplicate the original arch form as to cause doubt that the treatment was worthwhile.

Several papers have been written discussing this problem. It is believed that there are certain natural factors that contribute directly or indirectly to this crowding, like the continued normal growth of the patient, muscle action, return of extra oral habits, etc.

On the other hand, we have factors that could have induced relapse by means of improper mechanics. Perhaps there was deficient diagnosis or poorly planned treatment timing. The most common factor has been a real or implied poor cooperation of the patient in the post-treatment use of

orthodontic retainers.

One must then question the value of post-treatment retainer use if, in fact, this use is not documented and the period of dentition stability is unknown. The purpose of this paper was to analyze two post-retention orthodontic treatment groups to determine the usefulness of the various forms of retention utilized. One group consisted of patients who were not retained by any appliances in the lower arch, and the other group had fixed retainers placed. Both groups were more than four years out of retention and past the age of clinically significant facial growth.

# REVIEW OF LITERATURE

There are many factors involved in the retention of orthodontic treatment cases. It is not only the placement of an appliance, but one has to consider the pretreatment type of malocclusion, age, sex, duration of treatment, muscle activity, cooperation of patient, and probably most important, an adequate diagnosis of the treatment to follow.

In the course of the years, there have been numerous studies concerning the retention of the occlusion after the active orthodontic treatment, and different theories have resulted from these studies.

In 1880, Kingsley wrote that the occlusion of teeth is the most potent factor in determining the stability in the new position.[1]

Angle, in his seventh edition book, says that after malposed teeth have been moved into the desired position, they must be mechanically supported until all the tissues involved in their support and maintenance in the new position shall have become thoroughly modified, both in structure and in function, to meet the new requirement.[2]

In 1920, Case stated that the occlusal interlocking of cusps and other harmonious relations afforded by a normal occlusion are of the very greatest importance to retention.[3] In referring to the use of retainers, he wrote that even long standing malpositions which have been involved in a considerable maldevelopment of alveolar process and maxillary bone, require retaining appliances which will hold the teeth in their new position.

Rogers, in 1922, was one of the most strong advocates of muscle balance in retention.[4] He wrote, "We have watched muscles in bad behavior tearing down the results of years of treatment." He thought that with a good balance of internal and external muscles, there is little chance of recurrency of a serious malocclusion.

Oppenheim in 1934, stated that retention is the most difficult problem in orthodontics, and that there is a retrograde process during the period of retention. This process depends upon the time which elapses and upon whether or not the tooth is retained.[5]

Grieve in 1937, had his own theory of relapse---the forward translation theory.[6] He wrote that the under-development of jaws

was the main cause of this relapse.

Brodie in 1939, wrote one of the classic papers concerning retention. He stated that malocclusion cannot arise only from the teeth alone; they are at the mercy of other forces and factors which are on the contrary to teeth highly dynamic (muscles of the tongue, cheeks, etc.).[7] He believed that in cases with muscles in balance, one should try to correct this condition since the beginning of the treatment to restore the muscle normality.

In 1942, Waldrom stated that there is one phase that is indispensable to the success of the orthodontic problem. It is the functional retention of treated cases.[8] In that same article, he quoted Oppenheim. When related to retention, Oppenheim seemed to prefer the removable retainer which allows a maximum freedom to denture, allowing it to function as much as is possible while under retention.

But there have been some others like Merson[9] who believe that if during orthodontic treatment an adjustment of tissue is permitted through functional adaptation, which is aided by intervals of rest with the removal of appliances, few forms of mechanical retention are required.

Grieve in 1944, had a solution for relapse. He thought that forward translated teeth, if not carried back to normal relation with basal bone, are at last recognized as the wreckers of dentures.[10]

McCauley also in 1944, was one of the first authors to recognize the tremendous importance of the mandibular cuspid in retention, saying that usually the first sign of collapse occur in the region of the lower cuspids and underlined the importance of protecting this region throughout the treatment.[11] He explained this because, "the mandible, when released from its prison (retainer) will try to save the cuspids from the trauma of severe interference experienced in lateral bite."

Tweed in 1944, had his own theory of putting the mandibular teeth over basal bone in order to have a balance.[12] He wrote that experience has proved that if the denture is left in protrusion, it will experience a collapse and failure in the lower incisal region as nature endeavored to bring the denture back to its functional mechanical balance.

Hahn in 1944, had eleven points in which he thought were causes

of failure in retention.[13] He proposed that the cuspid to cuspid fixed retainer in conjunction with the lower plate was one of the most valuable methods of retaining lower anterior teeth in position, but agreed with Oppenheim saying that the disadvantage of this appliance was the lack of freedom of movement. In this same article, he quoted Dr. Mershon when he said that you can move teeth where you think they belong, but nature will move them to where they will best adapt themselves to the rest of the organism.

Strang in 1946, wrote that a high percentage of cases disintigrate when mechanical support is removed from a treated deformity.[14] He also suggested that we should place more attention to the original malocclusion if we wanted permanent stability. In 1949,[15] the same author was proclaiming the importance of muscle balance in order to have a successful treatment, and furthermore stated that the key teeth designating the tooth position that is harmonious with muscular forces, constantly in action upon denture are the mandibular cuspids and first molar, and therefore stabilized results can only be gained when width of mandibular denture canine and molar areas are maintained inviolate.

He also said that if all this was accomplished, there was not a necessity of mechanical retention after treatment.

Litowitz in 1948, said that you can move the lower first molars in any direction but the majority of the cases showed a tendency to return to the original position.[16] An even stronger tendency was present for these teeth to move mesially after retention. In general, the cases which exhibited the greatest amount of growth during the time covered by treatment showed the least amount of disturbance of the position of teeth and the smallest degree of relapse.

In 1952, Strang also wrote that the width, as measured across from one cuspid to the other, in the mandibular arch, is an accurate index to muscular balance inherent to the individual and dictates the limit of denture expansion in this area in treatment.[17,17a]

Dona in 1952, found that in all instances, mandibular canine width, whether increased or maintained, at the original dimensions, returned to or maintained the original intercanine width after all retaining appliances had been removed for several years.[18]

Walter in 1953, published an article which was based on 102

white children ranging from six to 36 years old. He found that 12 months after removal of appliances, 89 showed no demonstrable relapse, 11 had minor rotation, and only two had marked rotations. He concluded by saying that you can alter the dimension in width and length of the dental arch; a concept that until then had been thought the contrary.[19]

In 1956, again the importance of cuspid stability was stated by Peak.[20] He made his study from 43 patients and found that mandibular cuspid area expansion in successful orthodontic treatment was limited.

Thompson and others wrote in 1958, that the teeth were held in position by balance pressure of muscles of the lips, cheeks, and tongue.[21] In regard to collagenous fibers, they found that these fibers tend to maintain the original position of tooth when fibers were formed and to resist any changes. He suggested that gingivectomies may be useful in order to avoid the tendency of relapse.

In 1958, Stackler published his study of 20 Class II, division 1 extraction cases that were five years out of retention.[22] He said that mandibular incisors did not tend to maintain themselves in their treated position. The tendency of the incisors to tip forward, suggested

an attempt by nature to develop an occlusion which is in harmony with facial skeleton, muscles, and temporomandibular joint function.

Again, Thompson in 1959, published an article in which he reported that in cases in which gingivectomy had been done had 10% of relapse, meanwhile a control group had 44% of relapse and emphasized that the orthodontist should be more conscious because he is working with a tissue other than bone and it demands a great deal of respect.[23]

Reitan, on the experiment of dogs that he made in 1959, found that gingival fibers displaced and stretched even 232 days after rotations were corrected.[24] Periodontal fibers (from root to bone surface) will be rearranged within a retention period of 28 days. Relapse of rotated teeth seems to be caused by contraction of displaced gingival fibers and other supra alveolar structures. He advises over-corrections, early treatment, and transectomies of fibers around tooth.

In 1960, Riedel wrote one of the more complete reviews of retention and then amplified it out in 1969, in a text book.[25,26] He wrote about the factors that he considered to determine the type and length

of retention. He said, "Retention is a problem of treatment dependent upon the occlusion established, and that the occlusion established must be within the bounds of normal muscle balance and they are dependent upon the amount of apical base and the relationship of apical bases to one another."

Howes[27] wrote that undoubtedly one of the reasons for collapse following expansion was inadequate basal bone for existing amount of tooth material. In some cases he said, during mixed dentition you can alter the dimension of mandibular cuspid width because they move distally into and increase arch width space.

In 1961, Steadman measured the changes of distance of mandibular cuspids of 31 patients with one or more years out of retention and found that the ultimate cuspid position or intercuspid distance is the result not necessarily of orthodontic treatment but of balance of other forces produced by the musculature function and growth of each particular patient.[28] He also noticed that after the removal of the fixed cuspid retainer, the cuspids moved as desired and some did change their intercuspid width. He thought that even this type of retention is

effective in maintaining the lower intercanine width, if this distance is not in balance with all the other forces, the cuspid will move to make this distance be in balance with such forces regardless of retention period.

In 1962, Vego mentioned the possibility that third molars had influence or help in the relapse of crowding in lower anterior region.[29]

Walter in 1962, presented another study which consisted of 50 extractions and 50 non-extraction cases with a mean age of 2.9 years out of retention and found that 62% of both groups had an increase of intercanine width.[30]

Steadman in 1967, said the orthodontist should employ muscle therapy to maintain the mechanical corrections instituted during treatment. He also thought that the fixed cuspid to cuspid retainer was the most effective appliance in order to prevent crowding if placed within 24 hours after the removal of appliances.[31]

Reitan in his 1969 paper, concluded that among the factors causing relapse were abnormal muscle action, occlusal stress and contraction of displaced fibrous structures (in some cases the effects

of fibrous tissue re-arrangement may be observed even after several years).[32] He again suggests a long period of retention placing retainers right after removal of appliances, correcting rotation as early as possible, and that over-corrections are recommended to minimize relapse.

Fastlicht in 1970, compared two groups, one treated and a control group with an age mean of 19.6 and 19.10 respectively of Class II, division 1 and concluded that the crowding of incisors was an anatomic-physiologic phenomenon of adaptation observed in orthodontically treated cases, as well as in the untreated.[33] He also found less crowding in the treated group.

Edwards in 1970 and 1971, made studies related to periodontal ligament and its involvement in relapse and said that prolonged retention of rotated teeth is ineffective in producing a reorganized ation of supra crestal fibers which are stretched and deviated during rotation.[34,35] Alveolar bone and periodontal ligament surrounding teeth reorganized in 50 to 80 days.

In 1970, Muchnic suggested the use of Crozat appliances for retention purposes, indicating that retention time varies upon age,

malocclusion, sex, etc.[36]

Begg in 1971, suggests that the need of lower retention was not necessary; that over-movement of teeth, the attainment of good occlusal and axial relations of teeth and placement of dental arches in good relations with basal bone, are essential for stability of result of treatment.[37]

Rosentein and Jacobson in 1971, wrote that if the diagnosis is correct and treatment mechanics are applied as efficiently as possible, then retention is merely a continuation of mechanotherapy for a reasonable period of time.[37] This period could even be ten years after the removal of all the appliances. Time-wise, he mentions that retention time could vary from "as short as possible for at least half the active treatment time, until the problem of the third molars have been solved or as long as the patient will allow it." He writes as a conclusion that the major problem in retention is the diagnosis concept and treatment mechanics.

Peck and Peck in 1972, found a relationship between the mandibular incisor shape in the presence and absence of crowding

and that well aligned incisors have a distinctive shape in their crown.[38] (The more square the less tendency to slip, therefore less crowding.)

De Kock in 1972, made a study from casts of 26 subjects with an age varying from 12 to 17 and 23,2 to 30,1 and showed that maxillary and mandibular arch depth decreases with age, that every person showed a decrease after 15 years old in arch depth and that no evidence exists to reject the null hypothesis of no sex difference.[39]

Lombardi in 1972, showed that there was a correlation between the mandibular coefficient of crowding and total width of mandibular arch.[40]

Lewis in 1973, suggested that in order to minimize relapse in the lower incisor area we could strip them and then splint them with wire ligatures.[41] He also recommended the use of the cuspid to cuspid fixed retainer.

In 1974, Shapiro made a study of 80 casts 10 years post-retention.[42] He found that intercanine mandibular width tends to return to its original dimension, but in a Class II, division 2 group; also that the mandibular arch length decreased in all groups. The amount of this

decrease was dependent on extraction or non-extraction therapy.

After reviewing all this material, one should ask if there is a reasonable answer to this problem, and probably there will be some theories better than others. But all of these theories appear to lead to one single direction, a better approach to the retention problem.

Looking at all the possibilities that could cause any type of relapse, approach them as soon as possible and always try to individualize every case remembering that there is no one problem alike to another.

# MATERIALS AND METHODS

The data for this longitudinal study consisted of measurements that were taken from the orthodontic study models of 38 patients at the beginning, end, and post-retention period treated at the Department of Orthodontics, University of Oregon School of Dentistry, Portland, Oregon. The treatment was the routine used at the graduate level accomplished by a .022 edgewise bracket technique under staff supervision.

The patients ware all Caucasians from a middle socio-economic group. They were all free of systemic disease, oral dental habits, and all had malocclusions of a dental rather than a skeletal nature. They were divided into a retention group (N-17) and a non-retention group (N-21).

The retention group consisted of 13 females and four males with a mean age of 12-3 at the beginning of treatment (range 9-3 to 17-2). At the end of active treatment the mean age was 15-2 (11-7 to 20-0), and the post-retention final records were taken at a mean age of 21-4

(17-10 to 26-8). They consisted of six Angle Class I cases, nine Class II, division 1; one Class II division 2, and one Class III. Three patients were treated by upper extraction only and three by non-extraction techniques. The remaining members of this group were treated with premolar extractions (Table II). All patients in this group wore orthodontic retainers after termination of active treatment for an average period of two years minimum time. The final records were obtained after an average time of 4-2 years after the removal of the retaining appliances. The usual method of retention was a lower cuspid to cuspid fixed lingual arch and an upper removable Hawley appliance. All patients cooperated to the best of our knowledge. This group was representative of the treatment employed in this clinic during the middle 1960's and considered random. The treatment was neither unusually precise and exact nor were they hastily and poorly finished. That is to say, an average result for this teaching clinic was obtained (Tables I and II).

The non-retention group consisted of 16 females and five males at a mean starting age of 11-8 (range 9-5 to 16-11). The end of

treatment average age was 14-5 (11-6 to 18-10) and final records were taken at an average age of 19-2 (14-11 to 23-6). The malocclusion breakdown was six Angle Class I cases, two Class II, division 1; two Class II, division 2; and three Class III cases. Three were treated non-extraction, three by upper extraction only, and the remainder were treated by four premolar extraction techniques (Table III). These patients wore no retainers after the termination of the active treatment, and the average time out of active treatment was 4-7. This was a stratified sample selected from a possible group of 65 patients on which recall records could be obtained and reasonably closely matched the retention group by age, sex, treatment time, etc. We considered a one-third recall response satisfactory for this study. The finished quality of these cases appeared somewhat superior to the other group but could likewise be considered average for this clinic. No consideration was given to the empirical judgement values used in the decision to not retain (Tables I and II).

Seven parameters were measured on the mandibular dental casts of each group at the beginning of the treatment ($T_1$), end of active

treatment ($T_2$) and final records ($T_3$). These measures were:

1. Inter-canine width - measured from cusp tip to cusp tip.

2. Arch length, left side - mesio buccal cusp tip of the permanent first left molar to the mesial labial incisal edge of the lower left central.

3. Arch length, right side - mesio buccal cusp tip of the permanent first right molar to the mesial labial incisal edge of the lower right central.

4. Arch width - mesial labial contact of the lower left permanent canine to the mesio labial contact of the lower permanent right canine.

5. Space required - sum of the mesio distal contact point width of the lower four incisors.

6. Space available - the space required is subtracted from the measurement made between the lower left canine from its mesial contact point to the mesial contact point of the left lateral, then to the distal contact of the lower left central to the mesial of the lower right central, then to the mesial of the lower right lateral

and then to the lower right canine contact (method of Moorees[43]).

7. Crowding - space required minus space available.

Measurements were made by a needle point dividers directly from the study casts and transferred to a cardboard file card by perforation. Measurements were transferred from the file card by a Bull caliper* and read to the nearest 0.1 mm. A replicate measure of random cards from 12 patients was made 45 days after the completion of the first measurement. The standard error of the measure was found to be 0.61 mm.

$$SEM = \sqrt{\frac{\Sigma (x - y)^2}{2n}}$$

The data was analysed by various standard statistical methods. Between group differences were analysed by means of the Student "t" test for independent samples at an alpha .05 level. Within group parameters were analysed by means of a one-way analysis of variance. Significant values at p .05 level were further analysed by a Newman-Keul test. Within group selected values were also tested by the paired "t" test (alpha .05)

*British Indicators, Ltd., St. Albans, England

by a Pearson correlation coefficient and one parameter (crowding) were normalized by logrymthic transformation and further analysed.

# RESULTS

A comparison of the six parameters between the two groups was made by the use of the Student "t" test for independent samples (Table IV). Significant differences between the retention and non-retention groups at the p .05 level of significance was only found for the arch length parameter. The remaining variables were not statistically significant. Both absolute values at start of treatment ($T_1$), end ($T_2$), and final ($T_3$) time points as well as incremental changes $T_1$ to $T_2$, $T_2$ to $T_3$, and $T_1$ to $T_3$ were subject to analysis.

Statistical testing within five parameters of each group was made by a one-way analysis of variance (Tables V to XIV). Absolute values only were tested at the p .05 level and all were found significant except arch width. Further testing to define the source of this significance was made by a Newman-Keul student test between $T_1$ to $T_2$, $T_2$ to $T_3$, and $T_1$ to $T_3$ (Tables XV and XVI). The retention group showed significance at the $T_1$ to $T_2$ stage in arch length (left) and space available. The $T_1$ to $T_3$ stage showed significance in arch length (right and left).

The non-retention group demonstrated significance in all parameters at the $T_1$ to $T_2$ stage and at the $T_2$ to $T_3$ stage arch width; intercanine width and space available were significant. The $T_1$ to $T_3$ stage showed arch length (right and left) significance. All remaining parameters in both groups were non-significant.

The within-group crowding was further examined by means of a paired "t" test on the absolute values (Tables XIX to XX). No significant difference was found. Correlation coefficients within the retention group crowding ($T_1$ to $T_3$) were r .43, and the non-retention group ($T_1$ to $T_3$) r .28.

A percentage improvement was attempted with each group.

$$\frac{T_1 - T_3}{T_1} \times 100$$

In order to more nearly approximate a normal distribution logarithm, transformation was accomplished. This was plotted as a histogram, which showed a strong positive or right skewness (Graphs I and II).

# DISCUSSION

An attempt to compare a retention group and a non-retention group was made to see the effect of the lower retainer on arch width, arch length, intercanine width, space available, and crowding. It is possible that post-orthodontic retention only delays the inevitable relapse that occurs anyway. Both groups were matched as evenly as possible in regards to age, time of treatment, and Angle classification of the beginning malocclusion.

A statistical comparison between the retention and the non-retention groups was made by means of a "t" test for independent samples to investigate if any difference existed in these two groups. After the completion of the test, it was found that no significant difference existed between the two groups in each of the five investigated lower arch parameters, with the exception of arch length left and right. This significant difference was attributed to sample selection in that the non-retention group had two more Class III cases than in the retention group and that also in the non-retention group were two upper extraction

cases that should be considered for the purpose of the study as non-extraction since only parameters of the lower arch were investigated.

An analysis of variance was performed to locate possible within-group significance at the p .05 level of significance. All of the parameters were found statistically significant indicating that there was a definite within-group change during the period of treatment and post-retention with the exception of the arch width parameter in the retention group.

In all the parameters that showed a significant change in the analysis of variance, a Newman-Keul student test[44] was performed in order to determine by a multi-comparison test if the significance was in $T_1$ to $T_2$, $T_2$ to $T_3$, or $T_1$ to $T_3$ time periods. The formula used for this was:

$$LSR - \left(\frac{\sqrt{MSE}}{n.}\right) q$$

where MSE = mean square error
N = number of observations
q = value found in "q" table.

This procedure was a step-wise method of using the range as a statistic to measure differences among means. It may be used to measure unequal sample sizes.

The retention group (Table XV) showed that in arch length in the

right side the only statistically difference was found between the beginning and the final ($T_1$ to $T_3$) time periods, probably due to the extraction therapy that the majority of the group underwent in order to eliminate the crowding. Between the beginning and end of active treatment there was no significant difference possibly because in many cases the lower central incisor was in a more lingual or labial position due to the presence of crowding and the arch length measurement was made to the mesio-labial contact area. No significant difference was found between the end of active treatment and the final measurement ($T_2$ to $T_3$) showing that arch length in this parameter did not decrease during this period of time. Arch length on the left side was significant between the beginning and the final, and the beginning and end of active treatment, possibly due to the same extraction therapy. Likewise, in the right side parameter there was not a significant difference between the end of active treatment and the final records probably because the arch length did not change during this period of time.

Arch width and intercanine width were not significant at any time

period in this group, demonstrating that there was not an expansion of the lower canine during or after the treatment. This is a strong confirmation of existing orthodontic theory that the beginning intercanine width is the clinicians best estimate of the probable end result.

The space available was significant between the beginning and end of active treatment showing that crowding was eliminated after the end of active treatment. No significant difference between the end of active treatment and final measurement was found. Also, no difference was found between the beginning and final measurement,so an assumption was made that the amount of crowding that the patients had to begin with tended to return after the removal of the retainer. This finding is not in agreement with the previous ($T_2$ to $T_3$) no significant finding.

The non-retention group (Table XVI) showed in the parameter of arch length on right side and left side to be significant at the beginning and end of treatment, and the beginning to final measurement due probably to the extraction therapy that was necessary in treatment to eliminate the crowding. This was similar to the retention group.

In arch width and in intercanine width there was no significant

difference between the beginning and the final measurement indicating that the arch width was the same at the beginning of treatment and final measurement. This tends to demonstrate that the canines return to their original position. There was a difference between $T_1$ to $T_2$ and $T_2$ to $T_3$ indicating that slight canine treatment expansion subsequently relapsed. This is a most important finding since it complimented the retention group finding and tends again to point out the relative stability of the intercanine dimension in this age group.

The space available, like the two parameters described above, had a significant difference between the beginning and end of treatment and end of treatment with final measurement showing that crowding was not present at the end of active treatment, but like in the retention group, there was no significant difference between beginning and final measurements indicating that there was a tendency to return to the original arch crowding.

Within-group crowding was compared by a paired "t" test for each of the two groups to see if any difference existed between the original and the final crowding, and it was not statistically different. This

further confirmed the tendency of crowded dental arches to tend to return to a similar crowding pattern after treatment (Table XVIII).

The general conclusion that was drawn from this rather extensive statistical inference is that the end result of orthodontic treatment is not strongly influenced by the two-year interim wearing of passive orthodontic retainers. Other factors such as the functional benefit of ideal occlusion, age at onset of therapy, growth change, etc.,should be investigated to determine their long-term effect on stability.

## SUMMARY

The purpose of this study was to compare an orthodontic treatment group that wore retainers after treatment (n=17) and a non-retention group. Both groups were treated with the conventional edgewise technique used during the mid-sixties at the University of Oregon Dental School, Portland, Oregon.

The retention group had an average age of 4-2 years out of retention and the non-retention group averaged 4-7 out of active treatment. Measurements of the mandibular parameters of arch width left and right side, space available, space required, and intercanine width, were obtained directly from the study models at the beginning of the treatment, end of active treatment, and at final or post-retention. These were transferred to a file card where they were measured with a Bull caliper capable of measurements to a .10 mm.

Both groups were analysed within themselves and between each other by means of several statistical analyses. A "t" test for independent samples was performed between groups in six parameters and it was found

that the only ones with significant values were arch length left and right sides, probably due to the extraction therapy, suggesting that there was a strong similarity in the two samples. An analysis of variance was then made within each group and it was found that the only non-significant parameter was arch width in the retention group possibly for the conservation of the intercuspid dimension during this period of treatment. The rest of the parameters tested, i.e., arch width, arch length, left and right intercanine width were found significant, indicating that there was a change within this group. To find the possible variable, a multiple comparison Newman-Keul student test was applied to these parameters. The results indicated that in the retention group every variable (time period) was not significant at the p .05 level with the exception of arch length left between the period of beginning and final. Arch length on the right side was significant between the beginning and the end of treatment and the beginning and final measurements. These were believed to be because of the reduction in the dimension of the lower arch due to the extraction therapy. Space available was also significant between the beginning and the end of active treatment showing

the elimination of crowding at the end of treatment.

In the non-retention group, arch length right and left in the period between the end and the final measurements were significant probably showing that these dimensions stayed unchanged. Arch width, intercanine width and space available had no significant difference between the beginning and the final measurement probably to the return of its original dimensions.

With respect to crowding, a paired "t" test was made between the amount of crowding at the beginning and the amount of crowding at the final measurement, finding that there was no significant difference in either group showing that the crowding returned in both groups regardless of retention.

Observing the similarity of the groups at the beginning, end, and final measurements, one wonders if one should put retainers in every patient as a routine or in selected cases, leaving the question open if really the retention period if of any long-term benefit in the overall result of a treated orthodontic patient.

# CONCLUSIONS

The following statements are the result of rigorous statistical testing of several parameters in the mandibular dental arch of a retention group versus a non-retention group.

1. There is strong evidence to suggest that the expansion of the mandibular intercanine width is not a successful orthodontic treatment plan.

2. There is a marked tendency in the crowded dentition for return to its original crowding.

3. Retainers did not prove their effectiveness in this study.

4. No parameters were discovered to aid in the differential diagnosis of retention of the completed orthodontic cases.

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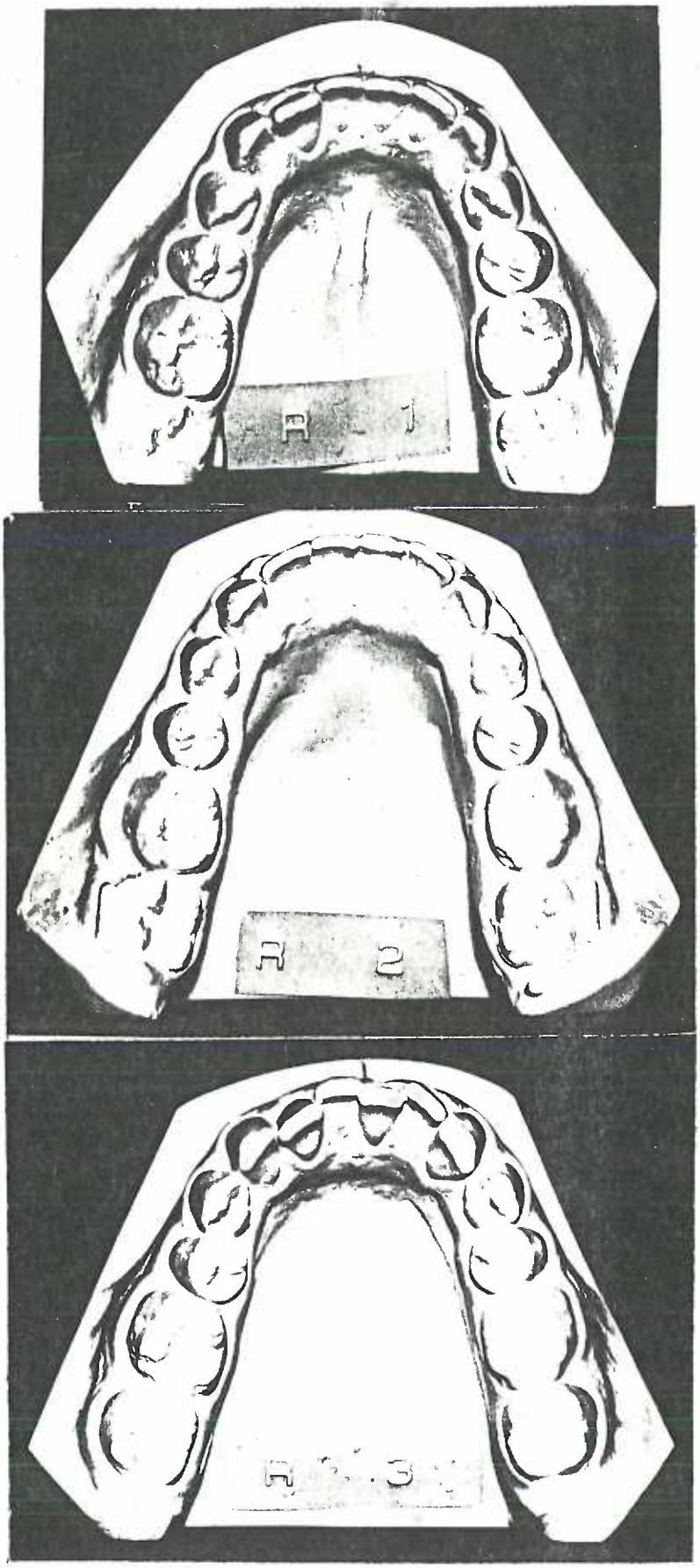

Fig. 1 Lower arch at beginning, end, and final of a considered poor overall result in retention group patient.

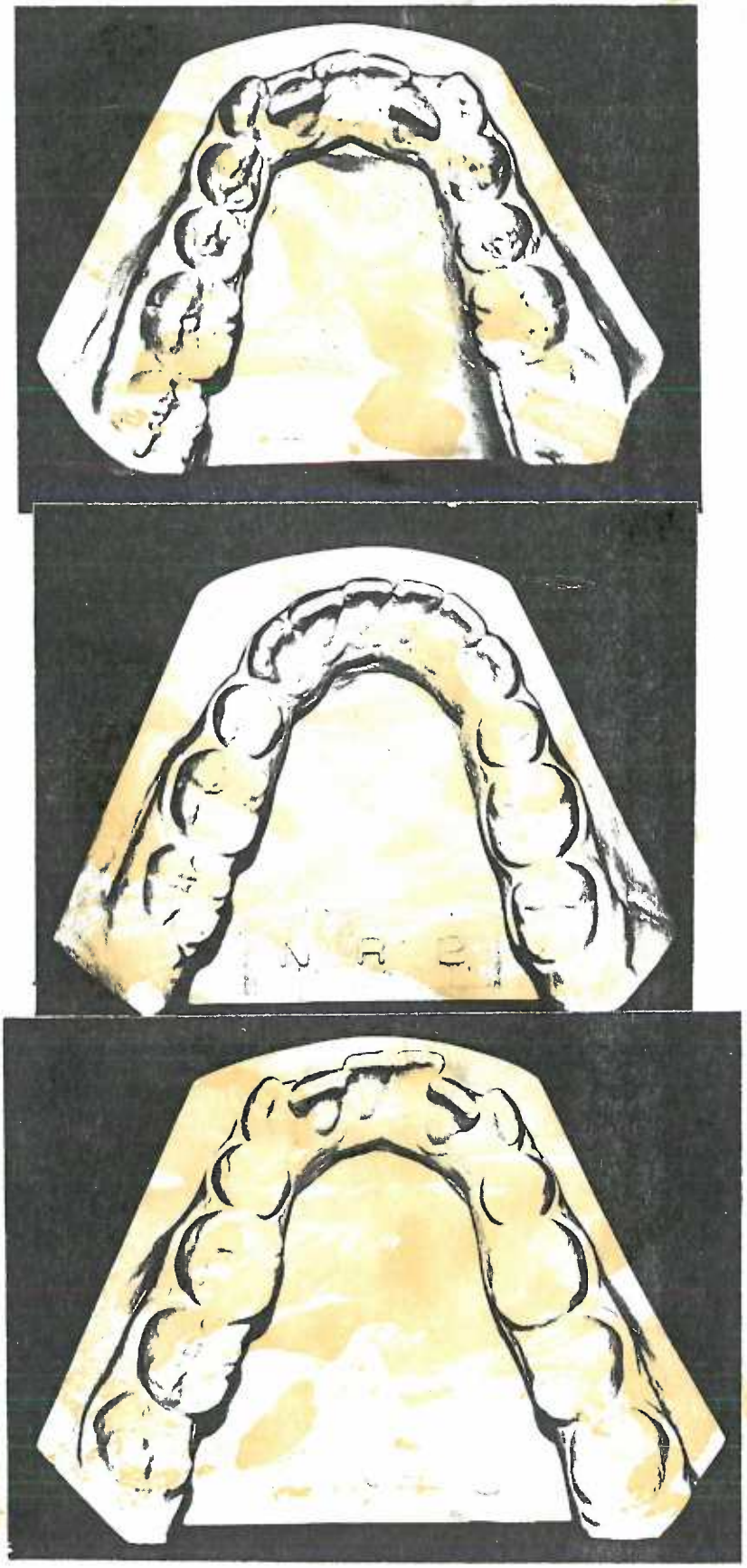

Fig. 2 Lower arch at beginning, end, and final of a considered poor overall result in a non-retention patient.

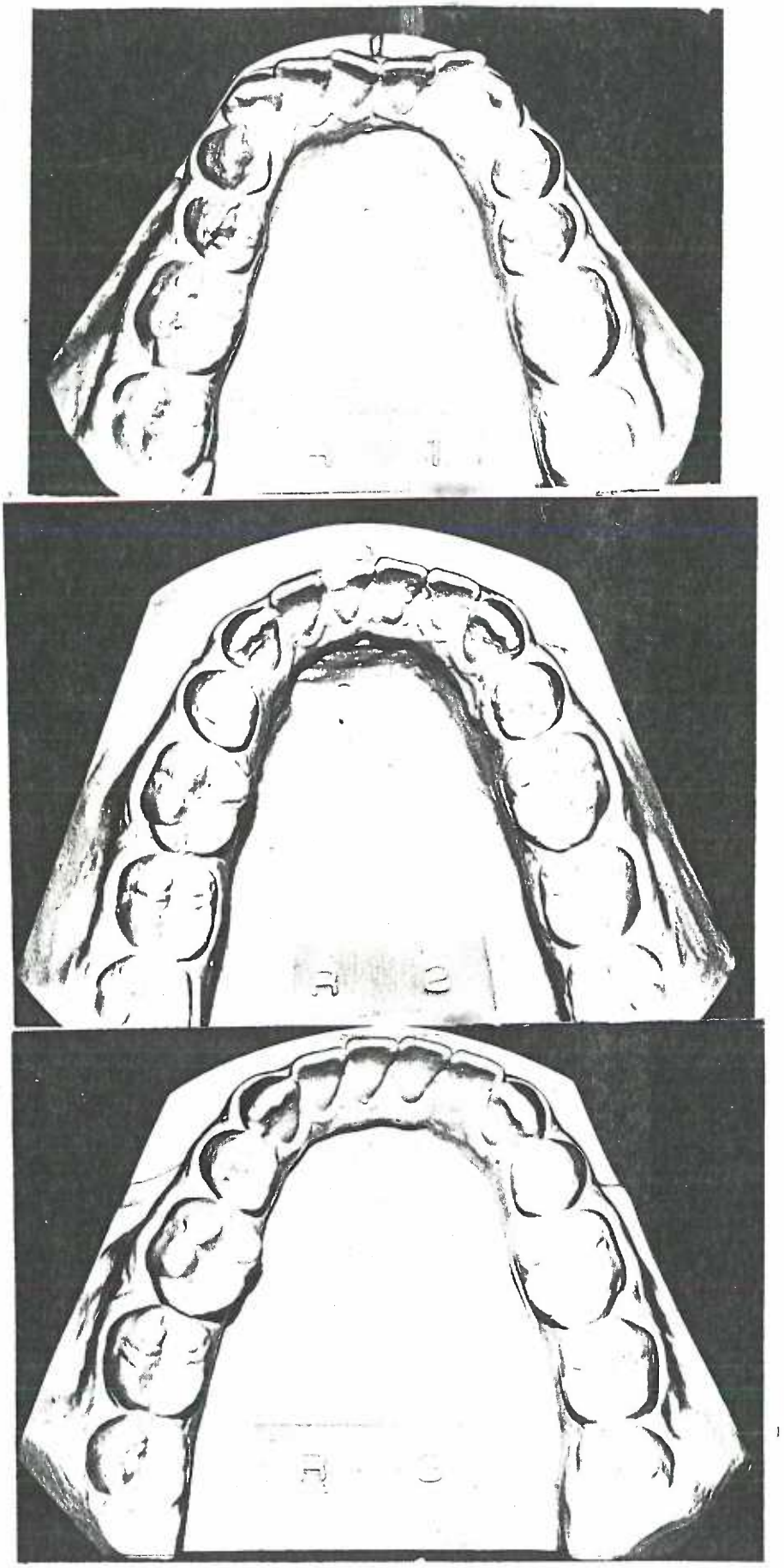

Fig. 3 Lower arch at beginning, end, and final of a considered good overall result in a retention patient.

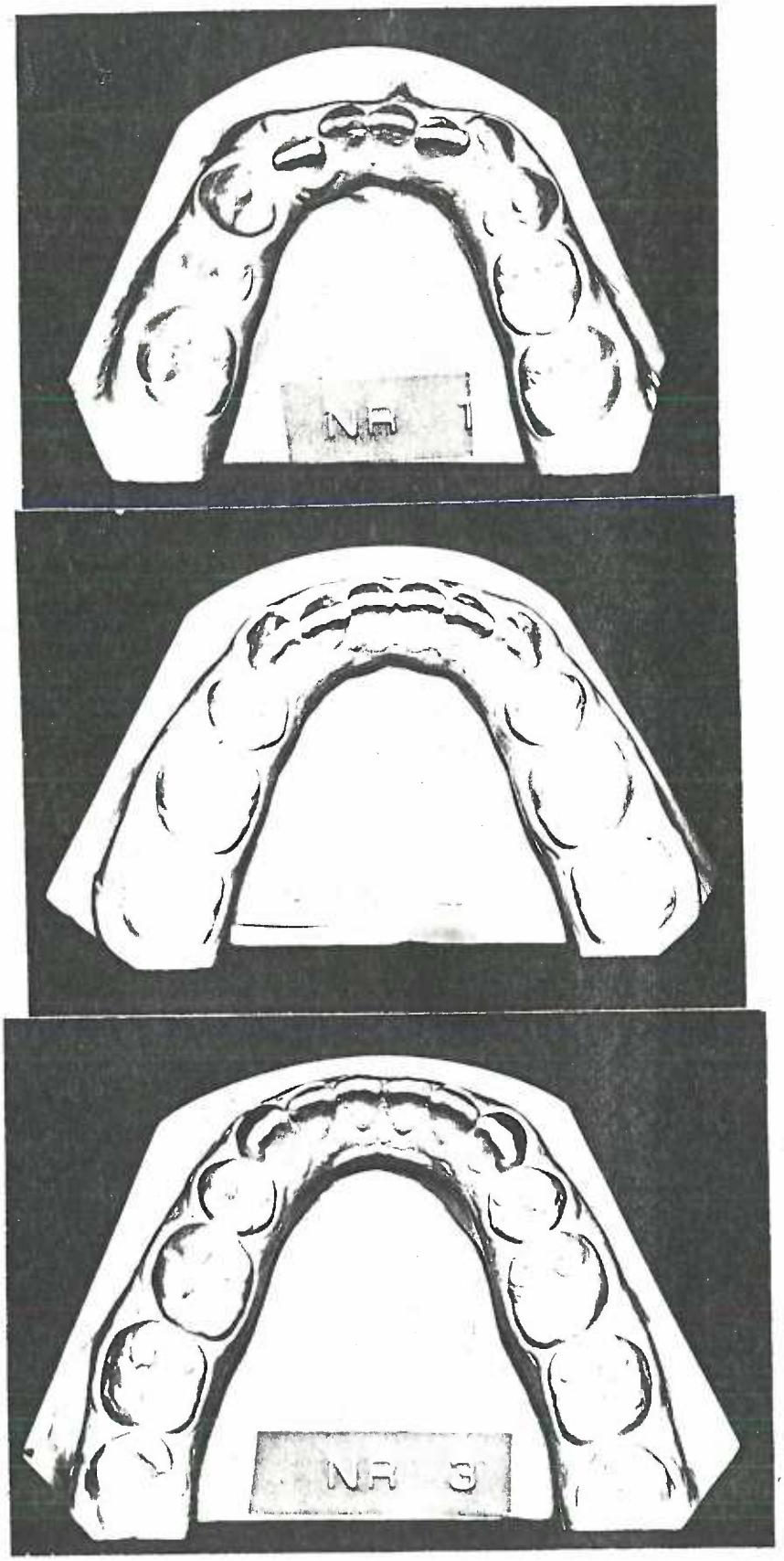


Fig. 4 Lower arch at beginning, end, and final of a considered good overall result in a non-retention patient.

Table I Composition of sample

| | Retention | Non-Retention |
|---|---|---|
| | 17 | 21 |
| Females | 13 | 16 |
| Males | 4 | 5 |
| Cl 1 | 6 | 6 |
| Cl 2/1 | 9 | 10 |
| Cl 2/2 | 1 | 2 |
| Cl 3 | 1 | 3 |

Table II Ages of sample

| | Retention | Non-Retention |
|---|---|---|
| Mean age at start | 12-3(9-3,17-2) | 11-8(9-5,16-11) |
| Mean age at finish | 15-2(11-7,20-0) | 14-5(11-6,18-10) |
| Mean age at end | 21-4(17-10,26-8) | 19-2(14-11,23-6) |

Table III Treatment therapy applied to sample

| | Retention | Non-retention |
|---|---|---|
| Upper first premolar<br>Lower first premolar | 12 | 13 |
| Upper second premolar<br>Lower second premolar | - | 1 |
| Upper first premolar<br>Lower first premolar | 1 | 2 |
| Upper second premolar<br>Lower first premolar | 1 | - |
| Upper first premolar | - | 2 |
| Non-extraction | 3 | 3 |

Table IV "t" test for independent sample between groups

(All values in tenths of millimeter)

INTERCANINE WIDTH

| | Start (T1) | End (T2) | Final (T3) | $\Delta_1$ | $\Delta_2$ | $\Delta_3$ |
|---|---|---|---|---|---|---|
| $\bar{x}$ | 245.8 | 260.4 | 246.0 | 10.7 | -12.6 | 1.6 |
| $\bar{y}$ | 243.1 | 254.2 | 237.4 | 12.9 | -16.8 | -5.6 |
| Sx | 21.6 | 17.8 | 16.3 | 15.7 | 11.4 | 14.8 |
| Sy | 19.0 | 14.6 | 16.4 | 10.7 | 10.8 | 12.1 |
| V | 36 | 36 | 36 | 36 | 36 | 36 |
| t | 0.41 | 1.17 | 1.60 | 0.51 | 1.14 | 1.66 |

$\bar{x}$ = Mean retention group
$\bar{y}$ = Mean non-retention group
Sx = Standard deviation retention group
Sy = Standard deviation non-retention group
V = degrees of freedom
t = t value (P.05 t=2.03 df 36)

SPACE AVAILABLE

| | | | | | | |
|---|---|---|---|---|---|---|
| $\bar{x}$ | 208.4 | 229.8 | 217.6 | 21.3 | -12.2 | 9.1 |
| $\bar{y}$ | 212.5 | 233.3 | 217.9 | 17.3 | -15.4 | 2.9 |
| Sx | 20.3 | 15.7 | 19.1 | 18.6 | 11.1 | 17.8 |
| Sy | 17.6 | 14.6 | 19.4 | 24.2 | 11.7 | 21.9 |
| V | 36 | 36 | 36 | 36 | 36 | 36 |
| t | 0.65 | 0.71 | 0.05 | 0.55 | 0.83 | 0.93 |

ARCH LENGTH RIGHT

| | | | | | | |
|---|---|---|---|---|---|---|
| $\bar{x}$ | 274.6 | 255.3 | 243.7 | -19.3 | - 9.6 | -28.9 |
| $\bar{y}$ | 291.3 | 253.6 | 241.4 | -24.5 | -14.7 | -50.3 |
| Sx | 30.2 | 30.1 | 31.1 | 24.5 | 6.5 | 2.5 |
| Sy | 27.8 | 25.1 | 26.9 | 28.5 | 14.0 | 20.7 |
| V | 36 | 36 | 36 | 36 | 36 | 36 |
| t | 1.76 | 0.18 | 0.26 | 0.59 | 1.38 | 2.86 |

ARCH LENGTH LEFT

| | | | | | | |
|---|---|---|---|---|---|---|
| $\bar{x}$ | 281.5 | 259.5 | 248.6 | -19.0 | -10.2 | -29.9 |
| $\bar{y}$ | 295.4 | 255.0 | 242.6 | -41.4 | -12.4 | -53.3 |
| Sx | 28.5 | 28.8 | 29.9 | 23.4 | 9.5 | 22.5 |
| Sy | 23.0 | 23.7 | 25.2 | 18.2 | 8.6 | 19.1 |
| V | 36 | 36 | 36 | 36 | 36 | 36 |
| t | 1.66 | 0.52 | 0.66 | 3.27 | 0.72 | 3.47 |

MESIAL OF THE CUSPIDS

| | | | | | | |
|---|---|---|---|---|---|---|
| $\bar{x}$ | 209.6 | 221.5 | 207.1 | 11.9 | -14.4 | - 2.47 |
| $\bar{y}$ | 206.9 | 225.0 | 205.8 | 18.1 | -19.2 | - 1.14 |
| Sx | 15.0 | 13.2 | 14.6 | 12.0 | 7.9 | 13.4 |
| Sy | 13.1 | 21.1 | 13.6 | 18.3 | 20.7 | 11.9 |
| V | 36 | 36 | 36 | 36 | 36 | 36 |
| t | 0.57 | 0.59 | 0.28 | 1.19 | 0.90 | 0.32 |

CROWDING

| | | |
|---|---|---|
| $\bar{x}$ | -20.3 | -11.2 |
| $\bar{y}$ | -15.6 | -11.0 |
| Sx | 19.3 | 12.3 |
| Sy | 20.0 | 10.1 |
| V | 36 | 36 |
| t | 0.72 | 0.08 |

Table V Analysis of variance for arch length right side on absolute values (retention group).

N = 1
n = 17
a - 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 27.50000 | 9.10000000 |
| 2 1 1 | 25.50000 | 9.00000000 |
| 3 1 1 | 24.40000 | 9.80000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 83.98000000 | 2 | 41.99000000 | 4.515053 | |
| Error | 446.40000000 | 48 | 9.30000000 | 1.000000 | 3,18 |

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Table VI Analysis of variance for arch length left on absolute values (retention group).

N = 1
n = 17
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 28.10000 | 8.10000000 |
| 2 1 1 | 25.90000 | 8.30000000 |
| 3 1 1 | 24.90000 | 8.90000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 91.12000000 | 2 | 45.56000000 | 5.402371 | |
| Error | 404.80000000 | 48 | 8.43333333 | 1.000000 | 3.18 |

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Table VII Analysis of variance for intercanine width on the absolute values (retention group)

N = 1
n = 17
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 24.60000 | 4.70000000 |
| 2 1 1 | 26.00000 | 3.20000000 |
| 3 1 1 | 24.60000 | 2.70000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 22.21333333 | 2 | 11.10666666 | 3.143396 | |
| Error | 169.60000000 | 48 | 3.53333333 | 1.000000 | 3.18 |

Table VIII Analysis of variance for space available on absolute values (retention group)

N = 1
n = 17
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 20.90000 | 4.10000000 |
| 2 1 1 | 23.00000 | 2.50000000 |
| 3 1 1 | 21.80000 | 3.60000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 37.74000000 | 2 | 18.87000000 | 5.550000 | |
| Error | 163.20000000 | 48 | 3.40000000 | 1.000000 | 3.18 |

Table IX Analysis of variance for arch width on absolute values (retention group)

N = 1
n = 17
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 21.00000 | 2.20000000 |
| 2 1 1 | 22.10000 | 17.40000000 |
| 3 1 1 | 20.80000 | 2.10000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 16.66000000 | 2 | 8.33000000 | 1.151612 | |
| Error | 347.20000000 | 48 | 7.23333333 | 1.000000 | 3.18 |

Table X Analysis of variance for arch length right on absolute values (non-retention group)

N = 1
n = 21
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 29.10000 | 7.70000000 |
| 2 1 1 | 25.30000 | 6.30000000 |
| 3 1 1 | 24.10000 | 7.20000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 286.15999999 | 2 | 143.07999999 | 20.247169 | |
| Error | 424.00000000 | 60 | 7.06666666 | 1.000000 | 3.15 |

Table XI Analysis of variance for arch length left on absolute values (non-retention group)

N = 1
n = 21
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 29.50000 | 5.30000000 |
| 2 1 1 | 25.50000 | 5.40000000 |
| 3 1 1 | 24.30000 | 6.30000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 311.35999999 | 2 | 155.67999999 | 27.472941 | |
| Error | 340.00000000 | 60 | 5.66666666 | 1.000000 | 3.15 |

Table XII Analysis of variance of intercanine width on absolute values (non-retention group)

N = 1
n = 21
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 24.30000 | 3.60000000 |
| 2 1 1 | 25.50000 | 2.10000000 |
| 3 1 1 | 23.70000 | 2.70000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 35.28000000 | 2 | 17.64000000 | 6.300000 | |
| Error | 168.00000000 | 60 | 2.80000000 | 1.000000 | 3.15 |

Table XIII Analysis of variance for space available on absolute values (non-retention group)

N = 1
n = 21
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 21.30000 | 3.00000000 |
| 2 1 1 | 23.30000 | 2.10000000 |
| 3 1 1 | 21.80000 | 3.80000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 45.49999999 | 2 | 22.74999999 | 7.668539 | |
| Error | 178.00000000 | 60 | 2.96666666 | 1.000000 | 3.15 |

Table XIV Analysis of variance of arch width on absolute value (non-retention group)

N = 1
n = 21
a = 3

| CELL | MEAN | VARIANCE |
|---|---|---|
| 1 1 1 | 20.70000 | 1.70000000 |
| 2 1 1 | 22.50000 | 4.40000000 |
| 3 1 1 | 20.60000 | 1.80000000 |

| SOURCE | SS | DF | MS | F | Significant F |
|---|---|---|---|---|---|
| A | 48.01999999 | 2 | 24.00999999 | 9.117721 | |
| Error | 158.00000000 | 60 | 2.63333333 | 1.000000 | 3.15 |

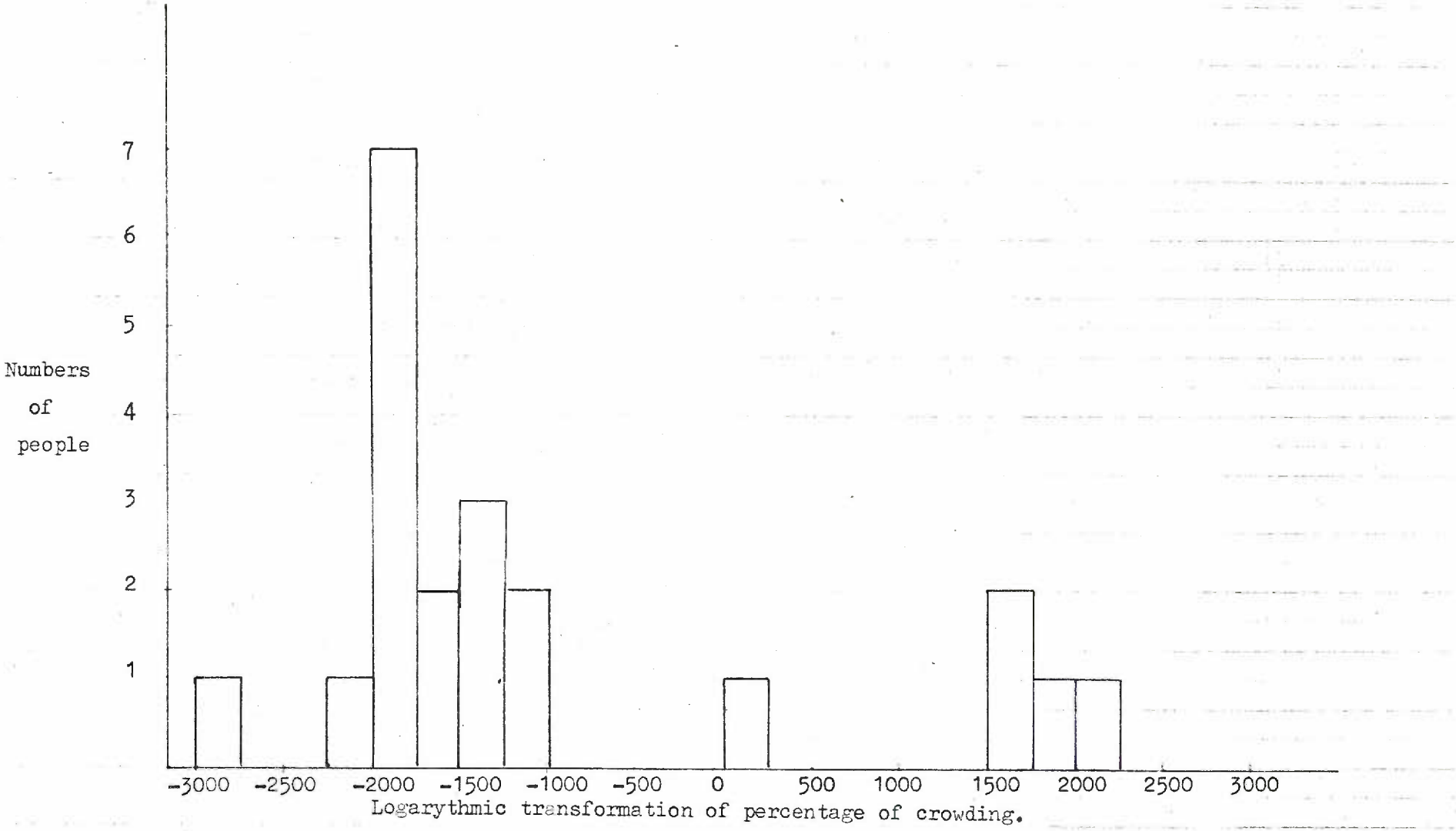
Table XV Summary of Newman-Keuls student test in retention group

| | $T_1$-$T_2$ | $T_2$-$T_3$ | $T_1$-$T_3$ |
|---|---|---|---|
| Arch length (R) | NS | NS | S |
| Arch length (L) | S | NS | S |
| Arch width | NS | NS | NS |
| Intercanine width | NS | NS | NS |
| Space available | S | NS | NS |

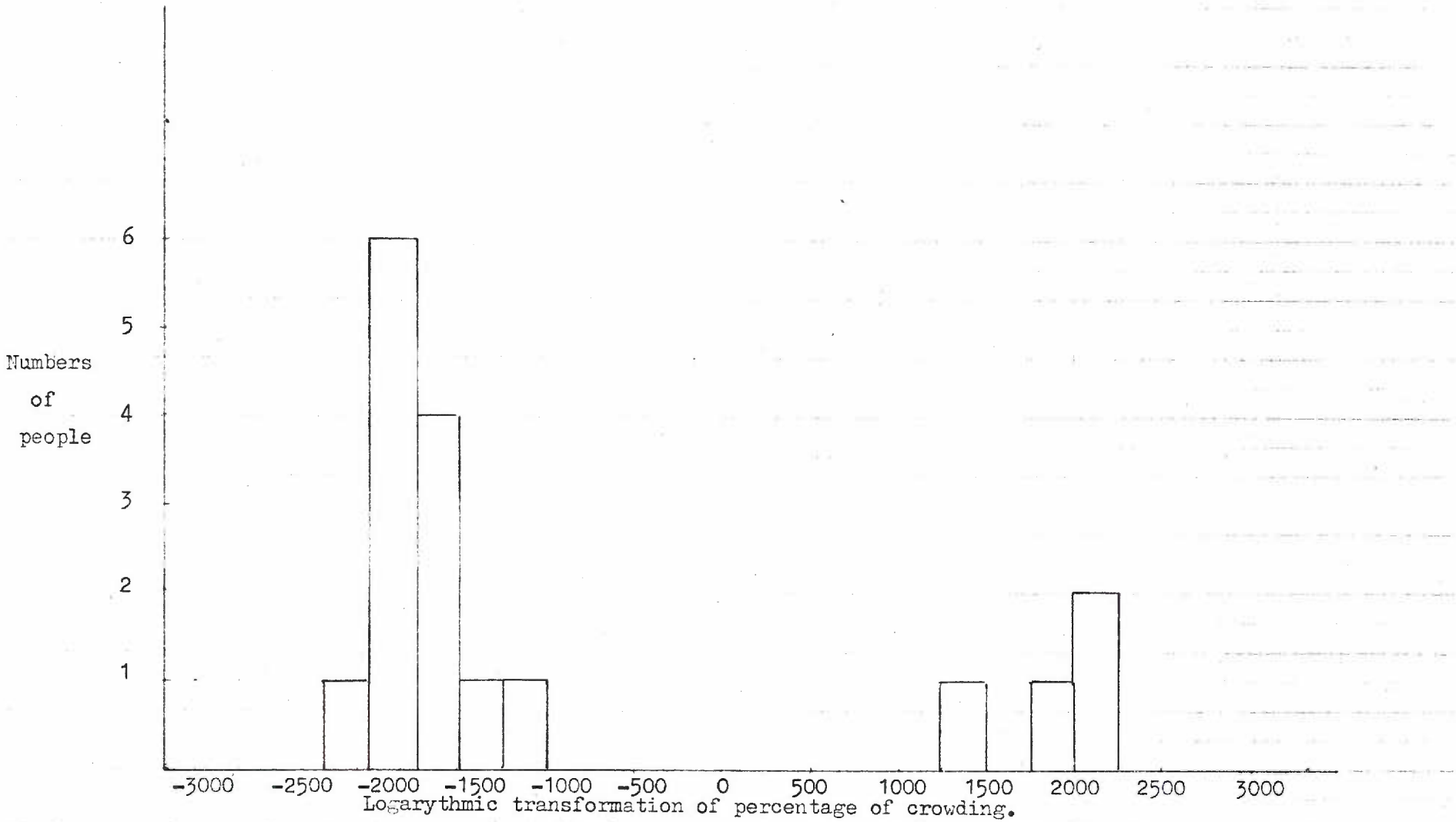
S = Significant at p .05 level
NS = Non-significant

Table XVI Summary of Newman-Keuls student test in the non-retention group

| | $T_1$-$T_2$ | $T_2$-$T_3$ | $T_1$-$T_3$ |
|---|---|---|---|
| Arch length (R) | S | NS | S |
| Arch length (L) | S | NS | S |
| Arch width | S | S | NS |
| Intercanine width | S | S | NS |
| Space available | S | S | NS |




Graph 1.- Histogram showing the distribuition of the non retention group.(Crowding.)




Graph 2.- Histogram showing the distribuition of the retention group. (Crowding)