AGE CHANGE IN TORSIVERSION OF THE MAXILLARY PERMANENT FIRST MOLAR TEETH

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INTRODUCTION

In 1929 Brash[3] stated: "My own studies of the growth of the alveolar processes of the jaws, convincing me of the constant changes taking place in that remarkable bone and leading to the general conclusion that at least throughout the growth period the teeth 'erupted' and 'erupting' alike are constantly moving in the bone and that, shall we say, occlusion is but the expression of the relative position of teeth which are slowly but surely moving in the growing bone in three related directions -- these studies must have their bearing upon aetiology, if they in any way throw light on the mechanism of the production of what we consider to be malocclusion." Later, in the same discourse he stated: "May we perhaps look forward to the time when the orthodontist will possess exact knowledge of the direction and extent of the normal growth-movement of each individual tooth for any age period during which he may be applying treatment."

This investigation was designed to study some possible growth-movements of maxillary permanent teeth.

As will be observed from a review of literature, it has been the generally held opinion of dentists that the maxillary permanent first molars rotate, mesial toward the midline, if given the opportunity to drift mesial by such circumstances as early loss of maxillary primary molars, loss or absence of maxillary bicuspids or loss of restraining lip pressure as in maxillary dental protrusion malocclusions (Class I, div. 1).

It is an observed fact that, on the average, the sum of the mesio-distal diameters at the contacts of the maxillary <u>permanent</u> cuspids and first and second bicuspids is smaller by about 1 to 1.5 mm. than the same diameters of the maxillary <u>primary</u> cuspids and <u>primary</u> first and second molars which they replace. This difference in this dimension is called leeway space. This slight temporary excess of space in the latter stages of the mixed dentition and early stages of the permanent dentition results, usually, in a slight decrease in arch length by eventual closure of the space by mesial drift of the maxillary permanent first molars or by distal movements of the maxillary anterior teeth or by a combination of both.

In particular then, the purpose of this investigation was to: (1) Measure the change of the torsiversion (rotation around the long axis) of the maxillary permanent first molar teeth in a longitudinal series of Class I (molar), untreated, occlusions; and (2) Correlate such change with maxillary leeway space; change in maxillary arch length from mixed to permanent dentitions; change in inclination of maxillary permanent central incisors from mixed to permanent dentitions, (as an indication of whether maxillary arch length change and closure of leeway space resulted predominately from distal movements of maxillary anterior teeth or from mesial drift of maxillary permanent first molars).

REVIEW OF LITERATURE

Variation of position of the maxillary first permanent molar in the three planes of space (antero-posteriorly, medio-laterally, and superio-inferiorly), in normal occlusion and malocclusion, has been investigated by many. Rotation of the maxillary first permanent molar on its axis, torsiversion (Lischer),[12] is a positional variation that has not received equal attention.

The presence of torsiversion of maxillary first permanent molars has been noted by many authors. Angle,[1] in 1900, mentioned "torsal position" of a maxillary first permanent molar and its treatment in a discussion of Class I malocclusion. In 1912, Lischer[12] suggested the suffix "version" as applied to tooth position. In a discussion of torsiversion, he stated that in rare instances, the molars will require rotation in treatment. Hellman,[6] in 1920, wrote that on the examination of 800 cases of malocclusion, it was found that in a very high percentage of instances, the upper molars were rotated. The rotation seemed to affect the position of the mesio-lingual cusp in such a manner as to influence its occlusion mesio-distally in a very slight degree, this cusp being the center of rotation, while the buccal cusp may at the same time appear in a decided malposition.

Smyth[15] wrote on the etiology and treatment of abnormally rotated molars in 1931. She selected this subject for two reasons. First, departure from the normal position and occlusion which is described as abnormal rotation is so small in terms of millimeters, that it is an irregularity which is often overlooked. Second, abnormal rotation of molars has a definitely harmful effect on occlusion of each case. In 100 unselected cases, boys ages 9 and 10 years, "about 60" showed rotations of the maxillary first permanent molar. The great majority of these were associated with premature loss of deciduous molars. This study was based on gross visual determination of the rotations.

Seipel[14] considered free rotation (a positional variation of the teeth where there has not been any rotating contact influence through crowding either coronally or apically) as part of a larger study in 1946. He counted rotations of 1/4 right angle or more. In a total of 436 thirteen year old patients without extractions, he found one free rotated maxillary first permanent molar. In a group of 64 thirteen year old patients with one or more extractions, he found one free rotated maxillary first permanent molar. This study was also based on gross visual determination of the rotation.

Atkinson[2] found that in many instances in which the anterior teeth were lapped or crowded, there was forward rotation of the maxillary first permanent molar.

Dewel[4] expressed the opinion that a diagnostic aid in analyzing mesial movement of maxillary posterior teeth, was the characteristic rotation of the maxillary first molar which usually accompanied its forward displacement.

Hemley[7] and Strang[16] stressed the importance of noting rotated maxillary first permanent molars as a guide in the classification and treatment of malocclusion.

Stoller[17] observed that the maxillary first permanent molar showed a definite orientation of this tooth to arch form in normal occlusion when viewed from the occlusal surface.

Henry,[8] in 1956, presented the first quantative investigation of rotation of maxillary first permanent molars utilizing a measurement technic. He studied dental casts of individuals with normal occlusion and different classes of malocclusion. He concluded that the maxillary first permanent molars in the malocclusions studied were rotated in approximately 83 percent of the cases.

Friel,[5] in 1959, reported a study of the angle of rotation of the maxillary first permanent molar to the median raphe of the palate in different classes of malocclusion and in normal occlusion. The study included 34 cases of normal occlusion in the premolar-molar area, 30 cases of distoclusion (post-normal) with labioversion of maxillary incisors, and 30 cases in which the maxillary second deciduous molar had been prematurely extracted. He found a significant difference between the left and right first molar angulation in the normal and distoclusion sample, the left first molar being rotated more. There was a significant difference between the normal and distoclusion sample when both left and right first molars were considered together. The extraction cases were rotated far more than the other two sample groups. No attempt was made to explain the difference in rotation between the left and right first molars in this study. In regard to the shape of the arch, Friel[5] stated that if there was a V-shaped arch, the first molar would be rotated naturally and that was why the distoclusion sample was rotated more than the normal sample.

Linder-Aronson,[11] in 1960, studied the effect of premature loss of deciduous teeth (mostly first or second molars) in 14 and 15-year olds. Plaster models from 41 children with unilateral premature extractions were used in this study (25 upper jaw and 16 lower jaw). Measurements were made in both jaws of the tooth width and perimeter of the dental arch, and in the upper jaw of displacement of the midline, the saggittal relation between right and left first molars and rotation of the right and left first molars.

The mean value of the differences between the perimeter of the dental arch on the side of extraction and that on the control indicated a significant though small (0.74 ± 0.3 mm) decrease in arch perimeter of the extraction side to that of the control side. No evidence was found that premature extraction of maxillary deciduous teeth results in displacement of the midline or in mesio-lingual rotation of the maxillary permanent first molar.

On the other hand, the first molar on the side of extraction was found to have a more mesial position than on the control side, the mean value being 1.01 ± 0.28 mm. This difference is significant.

Keso,[9] in 1961, measured torsiversion of the maxillary permanent first molar in good occlusion (33 white children) and in distoclusion (23 white children)(mean age both groups 13.2 years) to determine whether a relationship existed between first-molar torsiversion and maxillary arch form, and to compare torsiversion of the maxillary permanent first molar in good occlusion and in distoclusion. From his findings, he concluded that: (1) There is no significant difference between the torsiversion of the left and right maxillary permanent first molars in good occlusion or in distoclusion; (2) There is no significant relationship between torsiversion of the maxillary permanent first molar and arch form in good occlusion or in distoclusion. Greater than mean mesio-lingual torsiversion of the maxillary permanent first molar is found associated with ovoid or square arch form as frequently as it is found associated with tapering arch form; and (3) Maxillary permanent first molars exhibit significantly greater mesio-lingual torsiversion in distoclusion than in good occlusion.

Lamons and Holmes,[10] in 1961, measured maxillary permanent first molar rotation in 10 and 25-year old persons with good occlusions and 11-year old persons with malocclusions seeking orthodontic treatment. They stated what they believed to be a norm value useful for diagnostic purposes since their malocclusion group, especially Class II, div. 1

(90-95 percent), had more molar rotation than the good occlusion groups.

Apparently no one has reported a study of the change in torsiversion of the maxillary permanent first molars from a longitudinal series of dental records.

MATERIAL AND METHODS

In accordance with the purpose of this study, the records of all children with untreated Class I occlusion who had been enrolled in the Child Study Clinic of the University of Oregon Dental School, were examined and 28 children were selected for study. Basis of selection was that they be Caucasian children on whom dental models and standardized lateral head roentgenograms were made from middle mixed to early permanent dentition. All measurements were made on two sets of records for each child. The first set included the last dental models and standardized lateral head roentgenograms made before loss of any maxillary <u>primary</u> cuspids or molars and mandibular <u>primary</u> molars. The second set of records was made approximately one year after eruption of maxillary and mandibular <u>permanent</u> cuspids and first and second bicuspids into occlusion. The mean age of the children at the first set of records selected was eight years, six months (standard deviation 9.6 months). The mean age at the second set of records was 13 years, four months (standard deviation 15 months). No siblings were included in the sample. Twenty were girls and eight were boys.

The change of the torsiversion of the maxillary permanent first molars was measured by first projecting the maxillary dental models, enlarged 10 times, in an opaque projector, (Ernst Leitz Wetzlar, type VH). Both buccal cusp tips of the right and left maxillary permanent first molars were marked on the projected image on individual paper "screens." The angle between right and left side lines drawn through mesial and distal cusp tips (Figure 1) was measured with a drafting instrument and the difference between mixed and permanent dentitions was recorded as the change in torsiversion occurring during this period of time.

Maxillary leeway space was measured as the difference between the sum of the mesio-distal diameters of the maxillary primary cuspid, first and second molars and the sum of the mesio-distal diameters of the maxillary permanent cuspid, first and second bicuspids. Measurements were made on the best teeth available (right or left side determined by examination of models) on the 10 x enlarged projected image and on one side only.

Change in arch length was measured on 10 x enlarged images of the dental models as the shortest distance between a line tangent to the labial surfaces of the maxillary permanent central incisors and a line connecting the mesial contacts of the right and left maxillary permanent first molars (Figure 1). The difference in this measurement between mixed and permanent dentitions was recorded as the change occurring during this time period.

The change in inclination of the maxillary permanent central incisors from mixed to permanent dentitions was measured since it is a possible indication of whether maxillary leeway space was closed from distal tipping of maxillary incisors and distal drift of cuspids or by mesial drift of maxillary molars.

The inside angular measurements of the long axis of the saggittal image of the maxillary permanent central incisor (the most labial) to the anterior nasal spine-posterior nasal spine (ANS-PNS) and sella-nasion (S-N) planes were made on standardized lateral head roentgenograms of the two ages (Figure 2). The difference in these angles between mixed and permanent dentitions was recorded as the change occurring during this time period.

Although not included in the original design of the study, arch width change was measured to investigate a possible relationship to torsiversion of the maxillary permanent first molars. Arch width was measured on the 10 x enlarged images, as the right-left distance between the mid points of the lines connecting mesial and distal buccal cusp tips of the maxillary permanent first molars. The difference in this dimension between mixed and permanent dentitions was recorded as the change occurring during this time period.

All measurement procedures were repeated one week later to determine the error of measurement of the methods. All linear measurements made on enlarged images were reduced by a factor of 10 before computations were done.

Correlation scattergrams were plotted between torsiversion change and leeway space (Figure 3), arch length change (Figure 4), change in maxillary central incisor inclination

(Figures 5 and 6), and change in arch width (Figure 7). The changes occurring in the various dimensions measured are summarized in Table 1.

FINDINGS

As can be observed from Table 1, the method for determining the torsiversion change exhibited a rather large measurement error and the method should be revised. Marking cusp tips before projection and better focusing (discussed under leeway space measurement error) would probably improve measurement error of this change. However, the variation of this change was greater than measurement variation. Seven children out of 28 changed more than two standard errors of measurement (four rotating mesio-buccal and three rotating mesio-lingual).

Measurement error for leeway space calculated from measurements made on the projected image could possibly be reduced by focusing on the contact "level" of the models but one "compromise" focus was used so that cusp tips, arch length and tooth sizes could be determined on the same projection without adjustment. If different levels of the dental models are focused on, the projector must be moved backward or forward, as the case may be, to maintain the same enlargement factor. This "compromise" focus necessitated the acceptance of some blurring of the image.

The two different planes that were used to relate the inclination of the maxillary permanent central incisor proved equally reliable. The average angular change was different in these measurements indicating that these two planes behave differently, as would be expected, with growth.

The change in torsiversion of the maxillary permanent first molars exhibited a wide range of variation around a mean of essentially no rotation. In 14 children, the molars rotated inward and in 14 they rotated outward.

Maxillary leeway space is approximately 1.24 mm. in this sample. The sum of the mesio-distal diameters of the maxillary primary cuspid, first and second molars is, on the average, this much larger than their successors.

Leeway space was also calculated from measurements made directly on the models of ten children and compared to the leeway space calculated from measurements made on the projected image of models of the same ten children. The mean of the differences of the paired leeway spaces obtained by the two methods did not differ significantly from zero at the 0.95 confidence level. There is, therefore, no consistent error between the two methods of measurement.

Arch length decreased on the average, 1.37 mm. Maxillary permanent central incisors tipped lingually on the average indicating that part of the arch length decrease and part of the leeway space loss is probably a result of this tipping. This cannot be an altogether positive statement because the change in this angular measurement may be due solely to growth changes in the two planes to which the central incisor was related.

Arch width on the average increased from mixed to permanent dentitions by 1.36 mm. The changes occurring in arch length and arch width were very close to those observed by Moorrees.[12]

The existence or absence of spacing distal to the maxillary cuspids in the permanent dention was observed to show no consistent relationship to change in torsiversion of the maxillary permanent first molars.

The scattergrams of the various measurements with torsiversion change indicated very little, if any, correlation; certainly none of predictive value. Correlation coefficients were, therefore, not calculated.

SUMMARY

Change in torsiversion of the maxillary permanent dentitions of 28 Caucasian children was measured. An attempt was made to relate this change with other changes occurring in the dentition during this time. Although a wide range of change in torsiversion was observed for this group of children, there appeared to be no consistent relationship for the individual between this and the amount of leeway space, change over the same period of time in maxillary central inclination, in arch length, in arch width or presence or absence of spacing distal to the maxillary cuspids in the permanent dentition.

Table 1 - Summary of Findings

	$\overline{X}$	SEMeas.[3]	SD
Torsiversion change in maxillary permanent first molars	+0.093°	3.23°	5.77°
Maxillary leeway space	-1.24 mm[1]	0.28 mm	0.79 mm
Arch length change	-1.37 mm	0.22 mm	0.95 mm
Arch width change	+1.36 mm	0.17 mm	1.21 mm
Angular change in maxillary permanent central incisor in relation to ANS-PNS plane	-0.49°	1.57°	4.33°
Angular change in maxillary permanent central incisor in relation to S-N plane	-1.15°	1.43°	4.56°
Difference between leeway space calculated from measurements on dental models and projected images	+0.078 mm[2,4]		0.59 mm

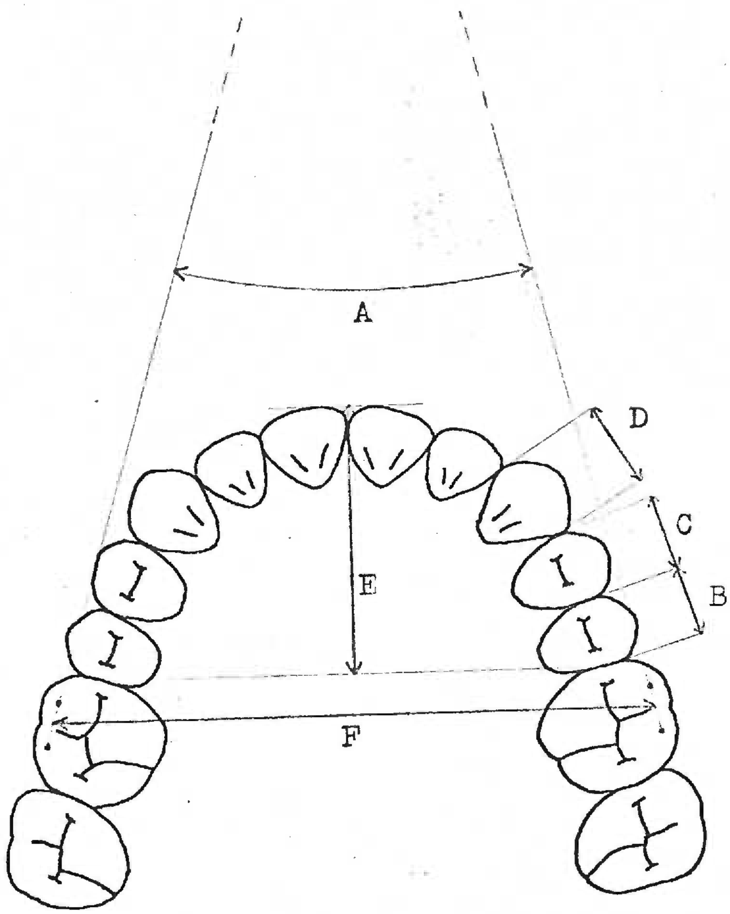
1 - Maxillary <u>permanent</u> cuspid, first and second bicuspids smaller than <u>primary</u> cuspid, <u>first and second</u> molar by this amount

2 - Leeway space calculated from measurements on dental models larger on the average than leeway space

3 - $\text{SEMeas} = \sqrt{\frac{\Sigma d^2}{2N}}$

4 - $t = \frac{\overline{d} - 0}{s/\sqrt{N}}$

Figure 1 - Linear and Angular measurements on Dental Models



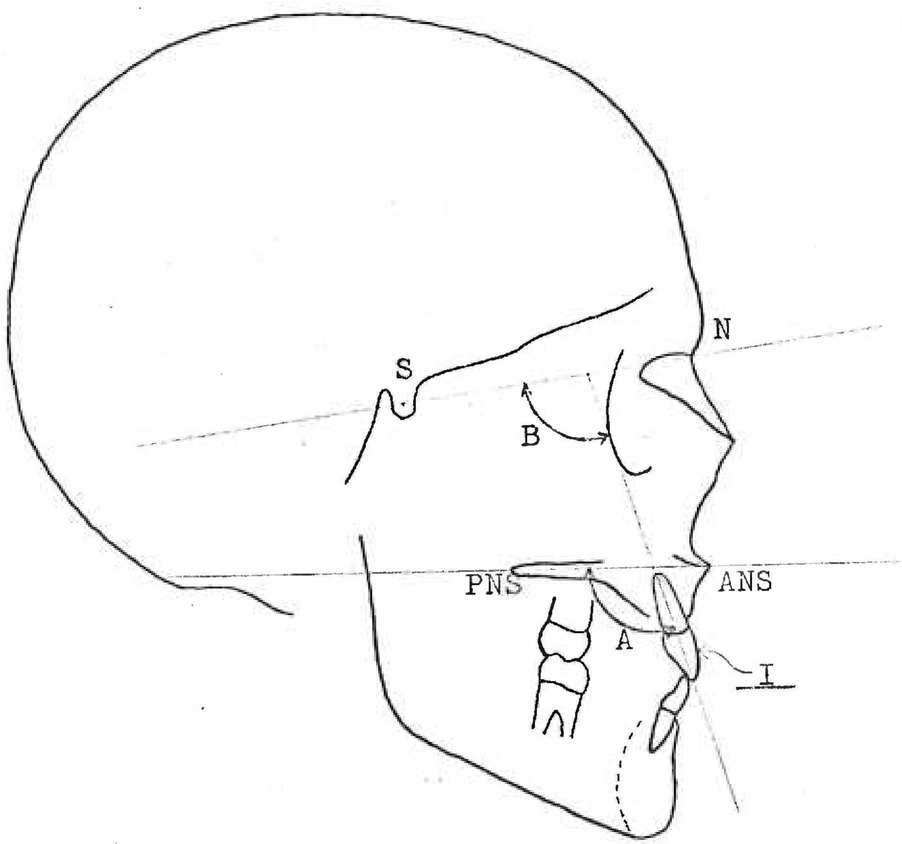
A Angular measurement of torsiversion of maxillary permanent first molars

B, C, D Tooth diameters for computation of leeway space

E Arch length

F Arch width

Figure 2 - Angular measurements on Roentgenograms



I	Maxillary permanent central incisor
S	Center of sella tursica
N	Nasion
ANS	Anterior nasal spine
PNS	Posterior nasal spine
A	Angular measurement between I/ANS-PNS
B	Angular measurement between I/SN

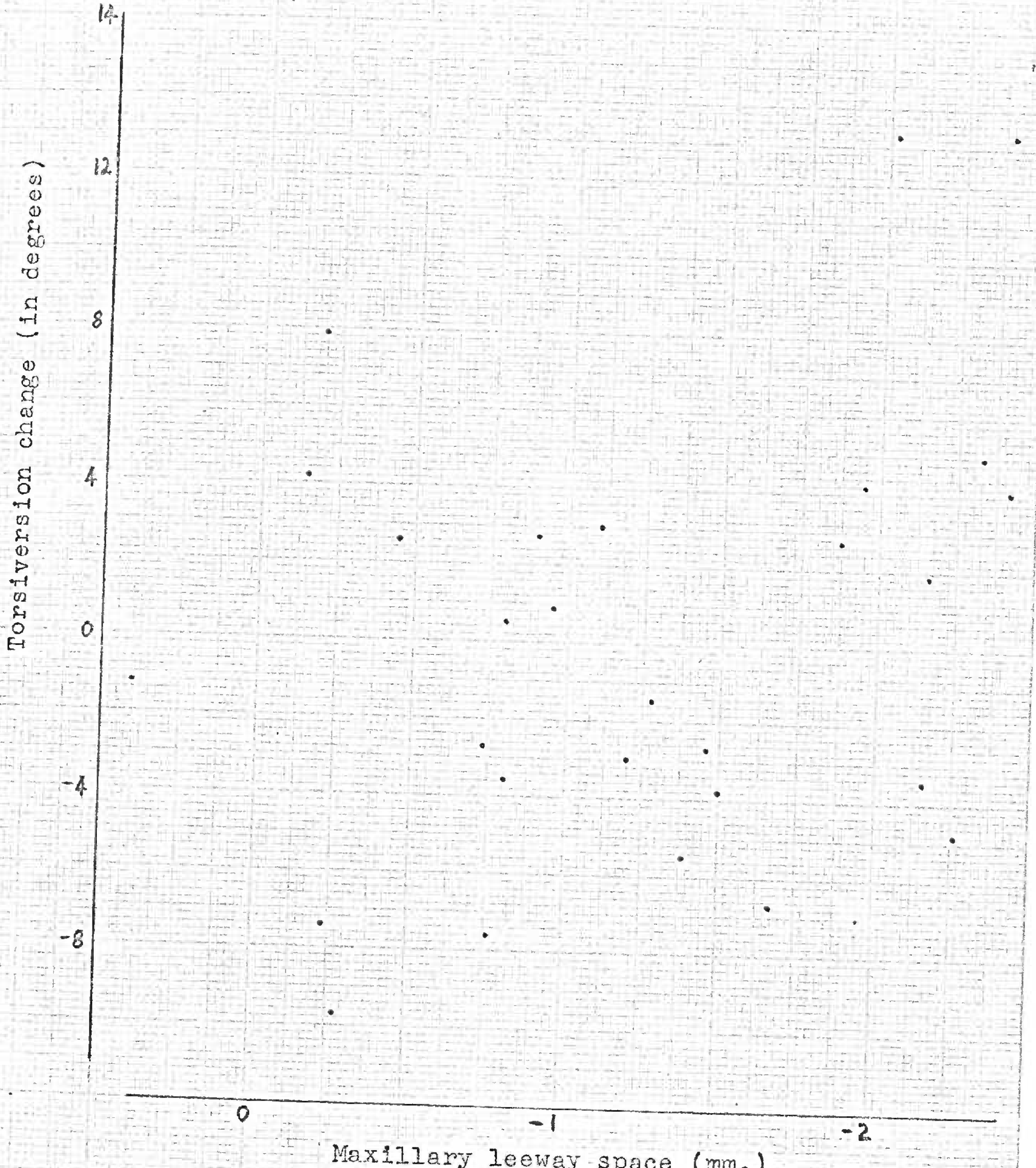


Figure 3 - Correlation scattergram, torsiversion change with leeway space

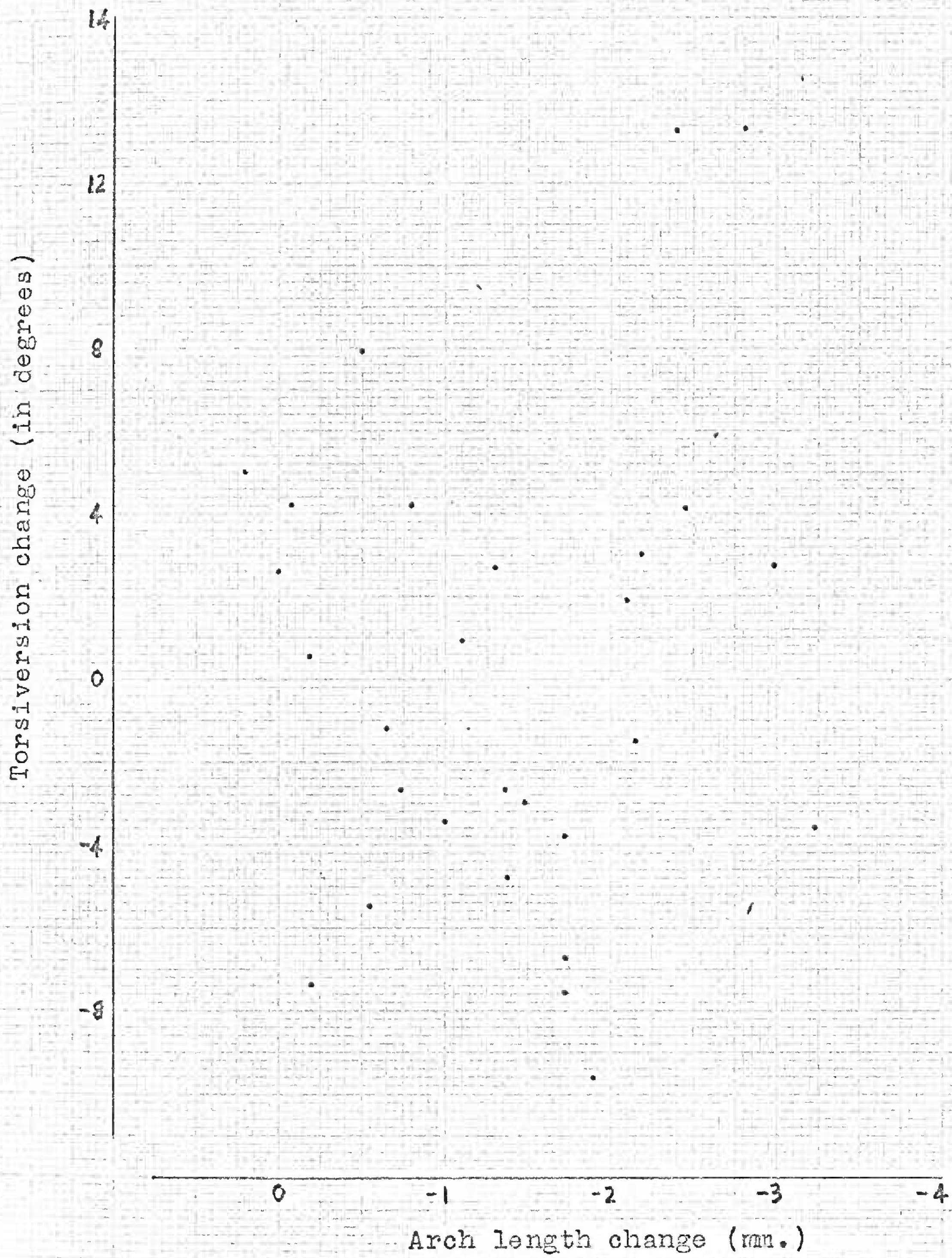


Figure 4 - Correlation scattergram of torsiversion change with arch length change

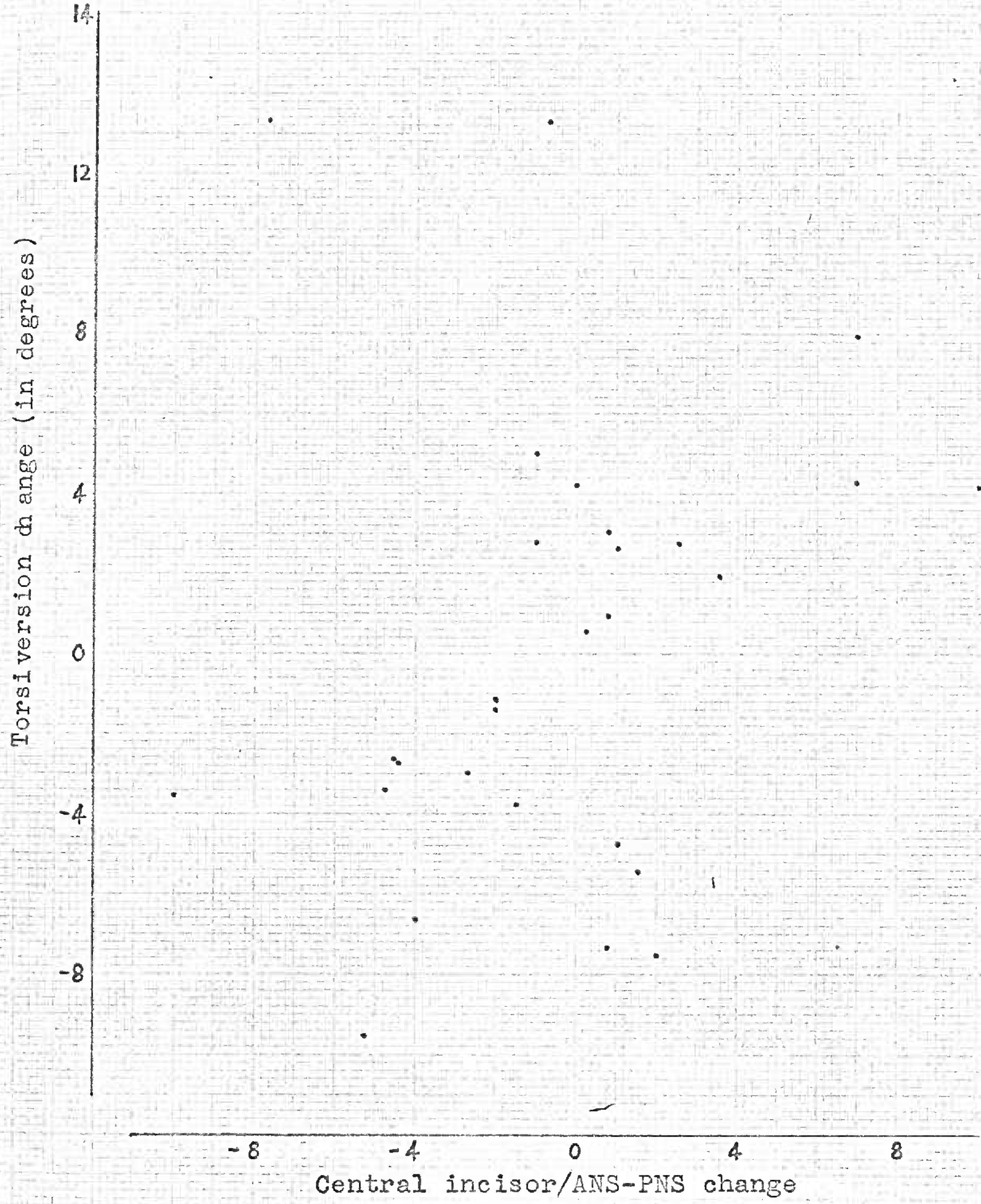


Figure 5 - Correlation scattergram of torsiversion change with central incisor/ANS-PNS change

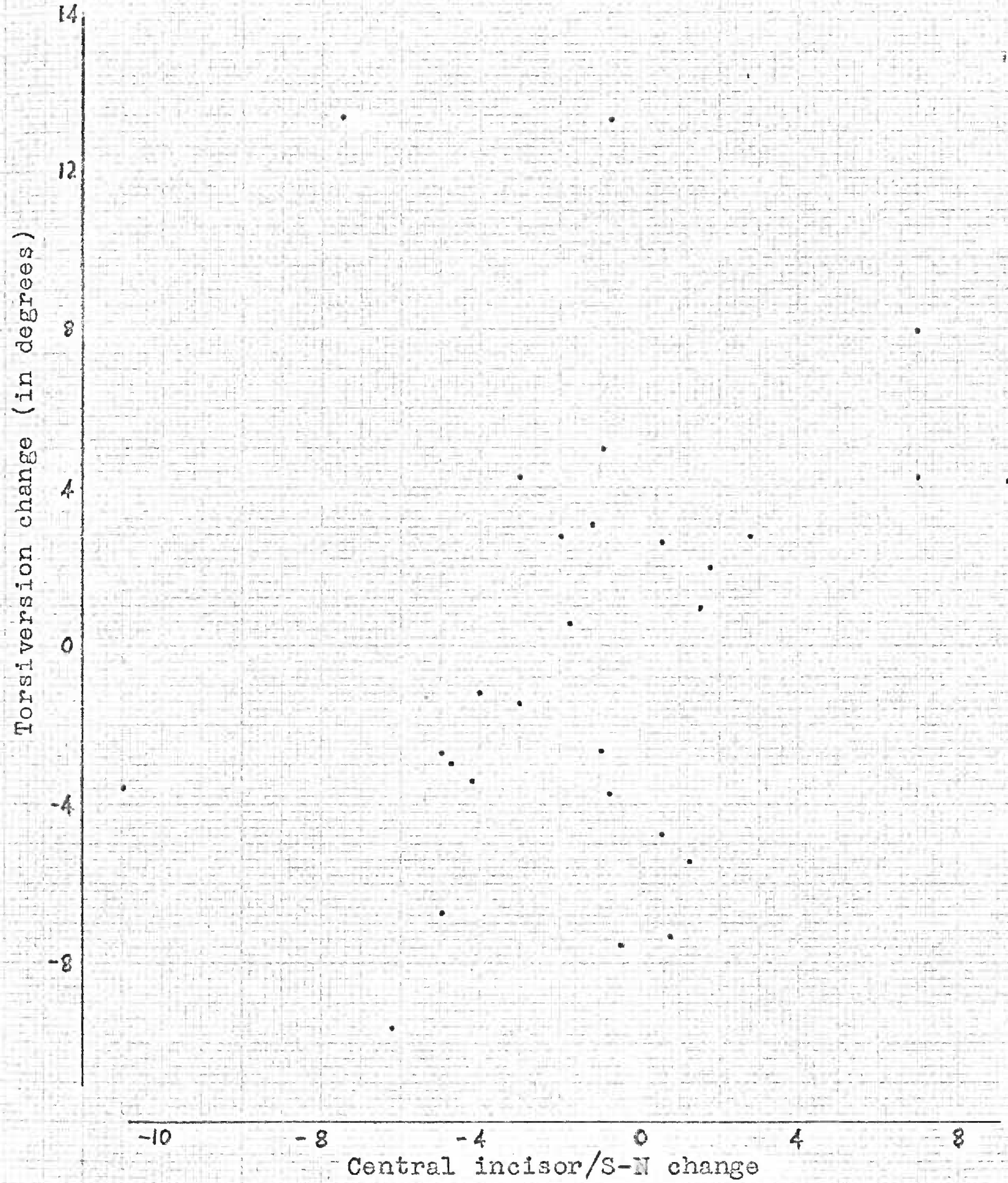


Figure 6 - Correlation scattergram of torsiversion change with central incisor/S-N change

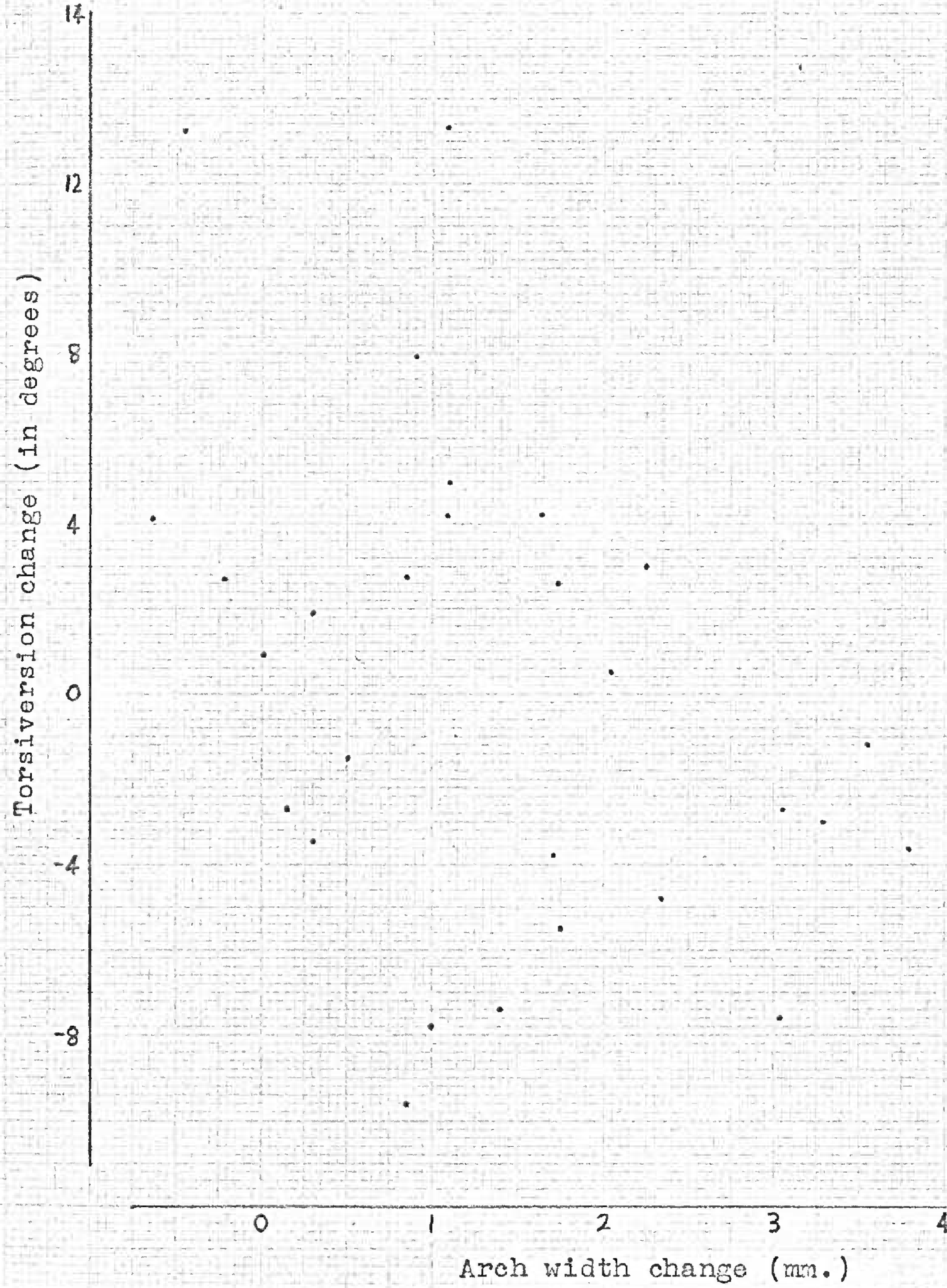


Figure 7 - Correlation scattergram of torsiversion change with arch width change

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