THE RESPONSE OF PERMANENT TOOTH BUDS TO DECIDUOUS TOOTH MOVEMENT

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TABLE OF CONTENTS

INTRODUCTION, PURPOSE, AND REVIEW OF LITERATURE

This study was initiated to determine if there was any significant measurable change in the position of the forming permanent buds when their deciduous counterparts were moved by an orthodontic appliance.

In 1940, Carl Breitner (1) found that orthodontic tooth movement of deciduous teeth in monkeys had the following effects upon the permanent buds. Movement of deciduous teeth induces movement of the underlying or adjoining tooth germs. The direction of this migration is the same as the direction of the movement of the roots of the deciduous teeth. A tooth germ situated between the roots of a deciduous tooth follows the movement of these roots. This is made possible by resorption and deposition of the surrounding bone. A tooth germ situated next to the roots of a deciduous tooth in the path of its movement is pushed in the direction in which the root moves. A tooth germ situated next to the root of a deciduous tooth and behind this root in respect to the movement is pulled in the direction of the root.

Strang (2) indicated that moving the permanent and primary molars distally will not take the crypts of the premolars and canines with them because the roots of the primary molars, at least those of the first primary molars, are too far absorbed to influence the underlying crypt of the premolar teeth and there is no possible way of overcoming the abnormal mesial position of the crypt of the permanent canines.

Mershon (3) interpreted the reason why many orthodontists began treatment in the primary dentition is that corrections made early will be reflected in an improvement of the permanent teeth and alveolar process while they develop. He felt this reasoning was fallacious because the primary alveolar process goes with the loss of the primary teeth and the permanent teeth are supported by a new alveolar process which develops as the teeth erupt. What generally results from treatment of the primary denture is an increased rapidity of the resorption of the roots of the primary teeth and, in consequence, resorption of the primary alveolar process.

Baker(4) (1933) was aware of malocclusion in the primary dentition. The primary dental arches should receive corrective orthodontic treatment in cases where there is an abnormal anteroposterior arch relationship, in cases of crossbite, in cases where there is a lack of occlusion of the posterior teeth, and in cases of open bite. Baker went on to say that although we do not know that the permanent teeth will erupt in normal positions as a result of the correction of malocclusion of the primary arches, we do know that abnormal occlusal interference has been eliminated, that normal function, which is generally considered so important in the development of the lower half of the face has been restored, and that the opportunity for subsequent normal development has been improved.

Craig(5) was of the opinion that each malposed primary tooth exerts an unfavorable influence on the permanent teeth. By allowing the malocclusion to persist without treatment, complicated and reinforced the same malocclusion in the permanent dentition. Cross bites of primary teeth are invariably followed by similar malocclusions in permanent teeth with coincident facial development. Orthodontic movement of primary molars invariably results in favorable influence on succeeding teeth. "This is understandable, for we know that the premolars develop between the widespread primary molar roots. Therefore, the best time to begin crossbite correction is while the roots are fully developed, 3 to 5 years."

Presently, there still exists this breach in our knowledge about treatment timing. Many clinicians advocate early therapy in order to restore "normal" function while others stand firm on their watch and wait approach. If Breitner's findings could be confirmed by a quantitative approach; that the developing bud position is changed by deciduous tooth movement, then a treatment plan could be directed such that potential permanent dentition malocclusions could either be interceded or at least their severity reduced.

MATERIALS AND METHODS

The research animal chosen for the study of deciduous tooth movement and ensuing bud movement is the Hanford White Pig. It has similar advantages for a research animal, as enumerated by Weaver (6), for the Pitman-Moore strain. These animals have deciduous and permanent dentitions, therefore, similar representation of structures and timing could be chosen which would represent like circumstances and be germane to the human dentition. Six male animals approximately 7½ months old were selected for the study; one from one litter, two from another, and three from a third litter. Their birth dates were within 6 days of each other. The ages which would best represent the desired situation, where a minimum of deciduous root resorption had occurred, was 7½ months. This appropriate time was determined by study of intraoral x-rays and hard tissue disection of a skull preparation.

The planned design was to effect tipping tooth movement of the deciduous teeth to the degree where maximum reciprocal or direct translation would be delivered to the forming permanent tooth bud. The resulting change of bony architecture then could be documented by marking with a Tetracycline,* as described by Cleall (7). The sites of new bone formation, before and after treatment, were marked with 500 mg. of Tetracycline, intravenous. Quantitative evaluation of bud movement was determined from hard tissue preparation under the microscope using ultra violet light for illumination, Boyne (8).

* Liquamycin, Pfizer Laboratories, New York, New York.

measurements were to be made between oriented fluorescent lines which represent new bone formation at the beginning and the end of the period of tooth movement.

The second technique utilized was photographs of frontal plane sections through developing second, third, and fourth premolars. From the photographs, two reference points were selected on the forming tooth buds; the cusp tip and the crest of the pulp chamber. These two points were the most representative of the long axis of the bud and could be easily duplicated. From these two reference points, minimum linear measurements to the cortical plate could be scribed, and thereby the buds relative position buccal-lingually could be quantitated.

The mandibular arch was chosen for study because of ease of access and the facility for measurement to the two parallel alveolar cortical plates. The right posterior segment composed of the first permanent molar, deciduous molars two, three, and four, was selected as the experimental side while the opposite (left) segment was the control. The buds of interest were the second, third, and fourth premolars. The opposing maxillary teeth of both arches were reduced with a high speed diamond stone to eliminate interferences. The permanent first molar and deciduous third and fourth molars were banded with conventional pinched stainless steel bands and edgewise attachments. The second deciduous molar was grooved to receive the free end of the arch wire. The bracket on the third deciduous molar was ground so that the channel width was increased, thereby avoiding any binding of the arch wire as the tooth tipped. A sectional arch wire .0215 x .028 edgewise was so fashioned that it delivered a lingual tipping action of approximately 8 ounces; measured by dontrix gauge, to the second and third deciduous molars. (see illustration)

All procedures were preformed after the animals had been anesthetized with Diabutal * intravenous, approximately 25 c.c. per induction; Weaver. The appliances were activated at 3 week intervals to maintain the desired 8 ounce force. Periodically the appliances were checked to make certain that they were intact.

Initially the animals were housed in wire cages. But, by biting through the wire they were able to dislodge their appliances, so at the end of the first two weeks of treatment their quarters were changed to a solid wall cage and the appliances were reconstructed. The appliance remained intact from this time until the end of treatment.

In the process of anesthetizing one of the animals, in preparation for the first three week adjustment, it succumbed to respiratory arrest.

The appliances were in place and active for 78 days. Five days prior to sacrificing the animals received their second intravenous injection of 500 mg. of Liquamycin. Upon sacrificing, the intact mandible was dissected and sectioned grossly into the control (left) side and experimental (right) side and placed in formalin fixation. Further sectioning was made of each side. Each of the three sections were to contain the desired deciduous molar and its succeeding premolar. It was desired that these cuts should be made interproximal to the developing premolar. Upon examination of earlier x-rays, it was found

* Pentobarbital Sodium, Diamond Laboratories, Inc.

that this was not necessarily represented by the interproximal contacts of the deciduous molars. Therefore, x-rays of the mandibular halves were taken; then by superimposing x-rays over the mandibular section the developing bud could be oriented to the external surface. Three reference points were scribed on the external cortical plate which represented the center of the forming bud. From these scribed points, further sections were made which contained a single developing bud.

The sections were next dehydrated through a series of alcohol solutions and organic solvents in preparation for imbedding. A Wards Bioplastic was the selected media for imbedding. Further refinement of the gross sections was accomplished by a rotating 6 inch carborundum radial saw. Sections from this procedure were selected which were approximately 1 mm. in thickness and which represented the mid-section of the developing bud. Sections of 50 u, Frost,[9] give the best results for dark field ultraviolet microscopy. Several methods were attempted to achieve this dimension; namely an automated lapping device, manual reduction on a glass plate with different grades of pumice, and on wet-dry carbide paper. Several samples were reduced to the desired dimension, but upon microscopic examination, no specific area of florescence could be detected which would represent the laying down of new calcified tissue. There was a generalized autoflorescence which was not specific for any one area. A listing of the possible cause and improvements in technique will follow in the discussion section.

In the second portion of the study, all sections were photographed and enlarged 3.5 times. From the photographs, measurements as described were made from cusp tip to both buccal and lingual cortical plates and from highest point of the pulp chamber to both buccal and lingual cortical plates.

Also, duplicate tracings of all sections were made on acetate tracing material. Then the control and experimental tracings were superimposed over each other relying on the best fit orientation of the inferior one half of the mandible and the mandibular canal. The superior one half was covered so that the forming bud deciduous molar, and alveolar process position would not influence the orientation. From this procedure, it was anticipated that a visual demonstration of the experimental buds relative position to the control bud, of the opposite side of the jaw, could be shown.

FINDINGS

Tables I and II give the statistical analysis comparing the changes in bud position; by measuring from the bud to cortical plate of experimental side of the arch versus those of the control side, using the Student's "t" Test. A probability of 0.05 or less was chosen as the level which would indicate that the differences in the two groups are significant. Any probability over 0.05 shows that the differences were probably due to chance. The means indicated on Table I represent the average dimension from bud to cortical plate for all 10 second and third experimental premolars and second and third control premolars. Table II states the same dimension for the second, third, and fourth premolars.

The hypothesis that the two means are equal in the eight cases compared could not be rejected at probability of 0.05; therefore, we have no reason to believe the hypothesis is not true and we accept that movement of deciduous teeth in these five experimental animals causes no significant movement of the underlying tooth bud.

Observations of the superimposed tracings of experimental and control sections indicated no set pattern of bud movement. While movement of the experimental deciduous molars and its alveolar process, when compared to the control side, was quite evident.

TABLE I

Differences in linear measurements for developing tooth bud to adjacent cortical plates, for control and experimental sides, as measured directly from photographs.

DEVELOPING SECOND AND THIRD PREMOLARS

Dimension Measured	Control		Experimental		"t" Value
	Mean	S.D.	Mean	S.D.	
Mean dimension for cusp tip and pulp chamber to buccal cortical plate.	20.8	26.24	20.6	12.44	.102
Mean dimension for cusp tip and pulp chamber to lingual cortical plate.	13.9	7.32	14.0	2.44	.203
Dimension for cusp tip to buccal plate.	18.7	23.23	18.5	10.81	.108
Dimension for cusp tip to lingual plate.	10.9	9.17	11.1	5.32	.166

DEVELOPING SECOND, THIRD, AND FOURTH PREMOLARS

Dimension Measured	Control		Experimental		"t" Value
	Mean	S.D.	Mean	S.D.	
Mean dimension for cusp tip and pulp chamber to buccal cortical plate.	22.3	5.05	21.7	4.58	.345
Mean dimension for cusp tip and pulp chamber to lingual cortical plate.	15.0	3.38	15.9	3.93	.823
Dimension for cusp tip to buccal plate.	20.1	4.52	19.3	2.84	.544
Dimension for cusp tip to lingual plate.	12.6	4.07	13.3	4.58	.456

DISCUSSION

The experimental appliance was constructed such that the force application to move the developing bud would be of the greatest magnitude. This could be best accomplished in a tipping movement, if our theories on tooth movement are correct. That is a tipping movement is an easier maneuver than bodily movement and that the center of rotation lies some where near the middle of the root and not at the apex. Working under these assumptions, it was thought that the developing bud would be moved in the opposite direction from that of the crown. On the other hand, if the center of rotation lies near or beyond the root apex, little or no bud movement would be discernible.

There is a clinical implication directly related to this question and that is; should cross bites be corrected early in the primary and mixed dentitions by the routine use of an appliance which tips teeth. If the bud is moved in the opposite direction to that of the crown the cross bite could become more severe and complicated upon eruption of the permanent teeth, if their direction and position of eruption is related to their initial position within the jaw.

From the data collected, we could not determine a significant change in bud position on the experimental side as compared to the opposite in animal control. There may be several reasons for this finding: the deciduous molar was moved insufficiently, root resorption was such that no force was directed to the bud, sample size was too small, variation was too great, and possibly that the center of rotation is near the root apex.

There are several possible answers to the question; why the first portion of the study did not succeed; That is the inability to elicit florescence from the sections. Bevelander (10) and Wallman (11) found that the brown discoloration of the yellow pigment and loss of florescence in the bone sections may be due to an oxidation of the tetracyclines. The formation of which is hastened by the action of light. Frost (9) states that the best results can be obtained with sections which are prepared fresh undehydrated (to prevent loss of the label which was administered less than one week), and the sections should be unmounted. Also, prolonged immersion in fixatives and organic solvents will accelerate fading even in old labels. A mounting media, Harleco Synthetic Resin, should be used for permanent storage of the sections. It has the advantage that no fading of the tetracycline occurs upon storage while other media allow the marker to fade. It has been shown that mg. for mg. demethylchlortetracyclene (declomycin) produces the brightest florescence. Frost (12) also found old drugs, on many occasions, lost their ability to floresce and even to label. For best results the material should also be stored in a deep freeze. Strict adherance to the above mentioned instructions and precautions would have improved the quality of the finished tissue material.

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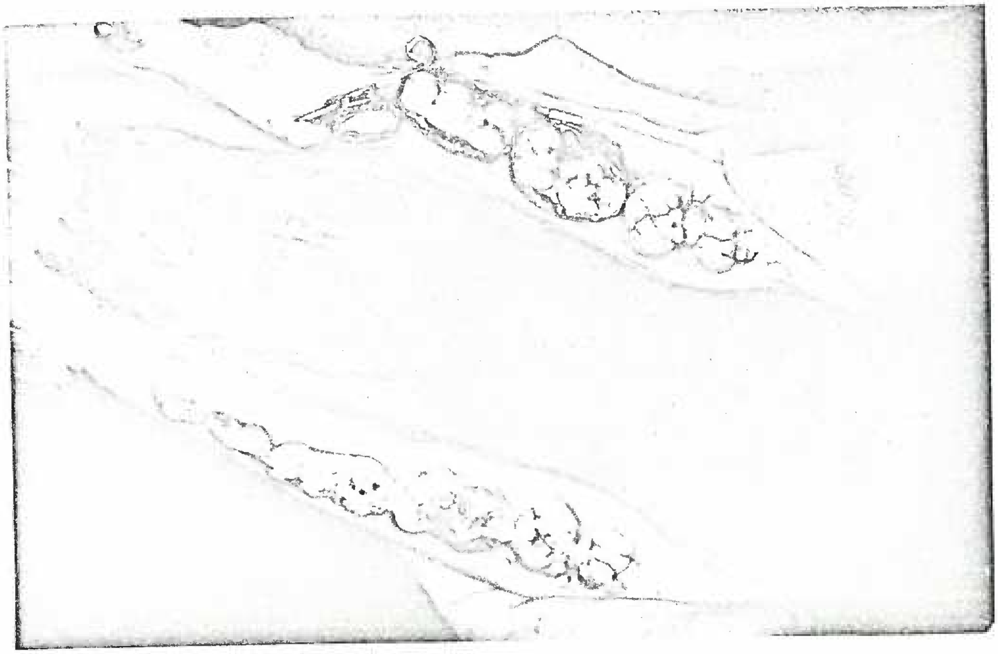

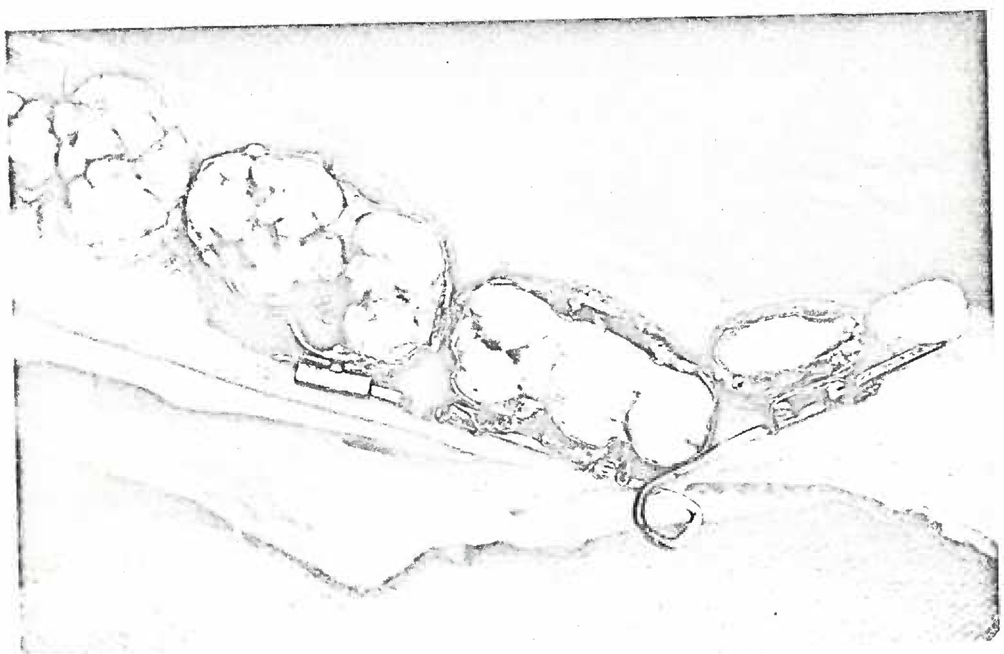

Illustration of Activated Appliance