

Postretention Status of Maxillary Incisors with Root-end Resorption

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Root-end resorption of maxillary incisor teeth has been observed for years as a phenomenon accompanying orthodontic treatment more often than the orthodontist would like to admit. It has been seriously described as a scar or price to be paid for treatment. Root-end resorption scarcely elicits a raised eyebrow in orthodontic circles unless the x-ray discloses beautifully aligned incisor crowns with essentially no root structure remaining. Unfortunately, the fate of teeth having suffered varying degrees of root-end resorption in course of treatment is largely unknown. Understandably, the orthodontist prefers not to disturb the status quo once retention has been completed/or, perhaps worse, final x-rays have not been taken and he has no knowledge of root-end resorption having occurred in any of his patients. While we tend to believe that the resorption process will stop once the appliance is removed, there appears to be a dearth of information to support such a contention. Recently, Stucki has suggested the possibility that root-ends of such affected teeth may ultimately be remodeled. This, too, remains unanswered.

One finds many references to root resorption in the orthodontic literature as well as many diversified ideas to explain its etiology. At the present time we are forced to the conclusion that the cause or causes for this phenomenon have not been established. The early work of Ketcham published in the

twenties reported a radiographic survey of some 500 orthodontically treated patients in whom he described apical root loss using highly descriptive words and phrases such as "startling," "potent in danger to the orthodontic patient," and "prolific of recrimination to the orthodontist." Words such as these must have had more than passing impact on both the family dentist and orthodontist when we recall that dental radiography was already widely accepted by the profession by that time.

Articles by Ketcham and others were followed by investigations concerned not only with the etiology of root-end loss but also with the entire histologic process accompanying tooth movement. The period extending from 1929 to 1942 was marked by contributions from outstanding investigators such as Schwartz, Marshall, Oppenheim, Gottlieb, Orban, Stuteville, Kronfeld, Becks and others. The incidence of root-end resorption accompanying orthodontic treatment had to be readjusted upward from a previously accepted level of about twenty per cent following the studies by Rudolph at the University of Minnesota. It will be recalled that he concerned himself mainly with the variables of patient age and length of banding treatment. His reported incidence of root-end resorption, fifty per cent at the end of one year of treatment to one hundred per cent after three years, undoubtedly gave impetus to the opinion among orthodontists that it was smart clinical practice to treat vigorously and in the shortest possible time. Rudolph's studies also showed a positive correlation between the incidence of root-end resorption and age of the patient at the time of treatment.

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Nevertheless, so-called early treatment did not begin to regain popularity until the early 1950's. Rudolph's sample, while more than adequate in numbers, was selected wholly from a student-treated population involving the multiplicity of uncontrolled variables inherent in such groups. Erroneously, the orthodontist has been held responsible for all root-end resorption in some quarters. In others, the length of treatment, age at initiation of treatment, sex differences, ethnic differences, genetic differences, nutritional deficiencies, and endocrine disturbances have been indicted.

The first major study to investigate root-end resorption on a physiologic basis was conducted by Becks at the University of California. He divided the probable etiologic factors into three groups: those of inflammatory origin, those supposedly resulting from traumatic pressures, and thirdly those of unknown or "idiopathic form." It soon became apparent to Becks that a great share of root-end resorption encountered in orthodontic treatment had its origins on a physiologic rather than on a simple mechanical basis. Thus, a patient with what he termed a "systemic predisposition" would be the most likely candidate for loss of root structure. He found a high level of correlation between hypothyroidism and root-end resorption based on blood cholesterol determinations and basal metabolic rate. In fairness, it must be pointed out that Becks was much too wary to have said that hypothyroidism caused root-end resorption although he has been quoted out of context in this regard for years. There is serious doubt whether some of Becks' cases would still be diagnosed as hypothyroid today in view of the more sophisticated quantitative diagnostic tests currently in use, such as radioactive iodine uptake and protein-bound iodine. For example, it is now known that a patient might

have a normally functioning thyroid gland and still have a basal metabolic rate below minus twenty, the level at which Becks' patients were considered as being hypothyroid. Interestingly, John Hopkins University reported only 164 cases of true hypothyroidism in twenty years. Wylie and Mathews, in an unpublished study involving about a dozen orthodontic patients with root-end resorption from the University of California School of Dentistry, were unable to find any patient outside of the accepted normal range of protein-bound iodine levels. Obviously, this does not discount true endocrine imbalance as a factor in root-end resorption whether or not the patient has undergone orthodontic treatment.

In a paper reported before this group, Stucki surveyed the incidence of root-end resorption in a clinical sample taken from the University of California School of Dentistry of orthodontically treated and untreated patients. Approximately five per cent of the untreated group exhibited some root resorption as compared with fifty per cent in the posttreatment orthodontic group. The incidence of resorption in the treated group in his study is considerably different from the values reviewed earlier in this paper. This reintroduces the continuing problem in defining exactly what constitutes root-end resorption as judged by successive x-rays. While Stucki considered minor blunting as evidence of the process, others have used a magnifying glass to detect minute apical changes as evidence of resorption and would thereby report a much higher incidence of the phenomenon. Stucki did not attempt to quantify root loss in millimeters, a procedure which is subject to errors in magnification and distortion inherent in intraoral x-rays.

Additional review of Stucki's work seems indicated since this paper arises as an outgrowth of his earlier work.

In his posttreatment group of individuals treated with removable appliances approximately twenty-one per cent exhibited some root-end resorption of maxillary incisor teeth. On the other hand, thirty-nine per cent of the non-extraction patients with maxillary bands showed comparable resorption. In cases where maxillary bicuspid had been extracted, the incidence of maxillary incisor root resorption increased from thirty-nine to seventy-five per cent. This suggests the possibility of a positive correlation between root-end resorption and magnitude of tooth movement. His data depicting a slightly greater incidence of resorption in females over that encountered in males were probably not significant. His data seem to be in general agreement with earlier reports with respect to the length of banding treatment time. The incidence of resorption of maxillary incisor teeth was reported at approximately four per cent with less than one year of treatment, about sixteen for between one and two years of treatment and about eighteen when treatment lasted for more than two years. These percentages are obviously much lower than those reported by Rudolph but not really out of line with the twenty per cent incidence reported years ago.

Again, Stucki's data are in agreement with studies indicating a low level of root involvement in patients subjected to treatment at age ten or younger. If one is willing to overlook the inherent bias in sample selection and is equally eager to relate root loss to biochemical and endocrine changes at puberty, there is excellent support to be found in the eleven to fourteen age group in Stucki's data where the incidence of root-end resorption soars to sixty-three per cent. Moderate to severe loss of root structure was reported in only one per cent of the nonextraction cases and five per cent of those having

had extraction of maxillary bicuspid teeth. Perhaps we can take solace in this low level of severe involvement, but its etiology remains as confused as before.

One might relate root-end resorption solely to the surface area of maxillary incisor root structure where short roots are sometimes taken to be pathognomonic for root loss. Support could be found in this contention in a survey of 168 incisor teeth where Stucki reported a five per cent higher involvement of lateral incisor root-ends over that of the central incisor teeth. This does not agree with Phillips' survey of 824 incisor teeth at the University of Washington that reported maxillary centrals more likely to suffer root-end loss than maxillary lateral incisors. Stucki and others before him seem to agree that orthodontic tooth movement is the chief mitigating factor in root-end resorption. This, as well as other reviews of the existing body of data with respect to the etiology of root-end loss, does not permit the luxury of a single preconceived solution to this most difficult problem.

MATERIALS AND METHODS

A general appeal was made to all members of the Northern California Component of the Edward H. Angle Society of Orthodontia for treatment records of patients who were known to have had varying degrees of root-end resorption of the maxillary incisors in the course of orthodontic therapy. Cases out of retention for three or more years were requested in order to evaluate possible morphologic changes in the previously affected teeth. Seventy-three per cent of the membership indicated their willingness to contribute to the study. Initially, it was hoped that each member would offer two or more cases for evaluation.

A total of fifty-seven patient records were received from twelve offices.

Unfortunately, sixty per cent of the fifty-seven patient records were from only three offices which obviously does not represent a cross section of clinical practice in the society. Of the fifty-seven cases, thirty-six were female and twenty-one were male. Patient age calculated at the time of placement of maxillary incisor bands ranged from eight to forty-one years. The average age, excluding the single forty-one year old female, was thirteen years. The postretention period ranged from twenty-seven months to two hundred and four months (seventeen years). The average postretention period was six and one-half years with a median of five and one-half years.

Arbitrary standards defining various levels of severity of root-end resorption were chosen to conform to the three groups used previously by Phillips and Stucki:

Group I: Slight or minimal blunting of the root apices (Fig. 1)

Group II: Moderate or up to approximately one-fourth root length loss. (Fig. 2)

Group III: Excessive or over one-fourth root length loss. (Fig. 3)

RESULTS

It was apparent immediately that the small sample size would preclude statistical evaluation of the data. Division of the fifty-seven cases into the various subdivisions reduced the numbers in some categories below acceptable limits for statistical significance.

Inquiry was made in each case in an attempt to discover whether the clinician had evidence which he found of value in prognosticating root-end resorption in the course of treatment; thirty-one out of fifty responses were negative while an affirmative answer was given in nineteen instances. In the opinion of the contributing orthodontists, sixty-two per cent of the patients



Fig. 1 Slight or minimal root loss.

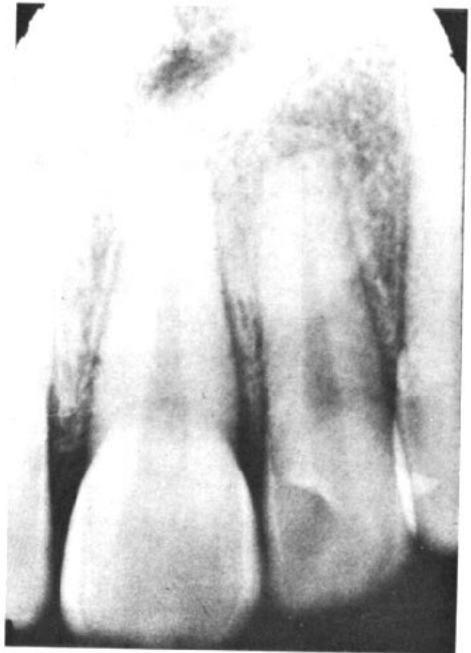


Fig. 2 Moderate or up to one-fourth root loss.



Fig. 3 Excessive or over one-fourth root loss.

that had root resorption in excess of simple blunting indicated no predisposition for resorption prior to treatment. Respondent criteria for prognostication of resorption included short roots, irregularly shaped roots, existing root-end resorption, lack of normal developmental form, hypothyroidism, and tongue thrusting habits. This represents, I think, a truly interesting spectrum of clinical opinion at the prognostic level.

In this sample of cases, anterior incisor bands were placed on the patients as early as eight years of age and as late as forty-one years of age. The ages of the patients when anterior bands were placed were recorded in each of the three resorption groups. Eliminating the few cases that started before eleven or after fourteen years of age, there is a fairly uniform grouping in all three of the resorption groups.

The length of treatment time is often considered to be a factor in the amount

of root loss. In Group III there were sixteen cases whose bands remained on the maxillary incisors for an average of 28 months. The range was from 9 to 55 months.

Group II had thirty-one cases with an average treatment time of 29 months and a range of 9 to 68 months. Group I had nine cases with an average of 30 months and a range of 16 to 60 months. Two cases in this group were treated much longer than the other seven. If these two could be disregarded, the average of Group I would be 22 months.

In this sample it appears that the more severely resorbed roots were treated about the same length of time as those that had less root resorption. Therefore, one might conclude that the treatment time did not influence the amount of resorption.

The sample was divided into the Angle classifications and each compared with the various levels of root-end resorption. In Group I the percentage was fairly close in each of Class I, Class II, Div. 1, and Class II, Div. 2 cases; eleven, eighteen and twenty per cent, respectively. In the moderate resorption group the percentages are: sixty-one, Class I; fifty-three, Class II, Div. 1; and forty, Class II, Div. 2. Group III or excessive root resorption cases had twenty-eight per cent in Class I, twenty-one in Class II, Div. 1, and forty in Class II, Div. 2. This would seem to indicate that we tend to get approximately the same amount of resorption whether the patient is Class I or Class II.

A comparison of the incidence of resorption between extraction and non-extraction cases shows that thirteen cases or one third of the extraction cases fall in the severe resorption group as compared to five cases or twenty-eight per cent of the nonextraction cases. Twenty-two cases or fifty-seven per cent of the extraction cases fall

in the moderate resorption group and eight or forty-four per cent of the nonextraction cases are in this group. In Group I there are four or ten per cent extraction cases and five cases or twenty-eight per cent nonextraction cases. There were more than twice as many extraction cases than nonextraction. Sixty-eight per cent of the patients had some bicuspid removed. A higher percentage of extraction cases was found to be in both Groups II and III than there were nonextraction cases.

In comparing the degree of root-end resorption to the amount of translatory tooth movement (Fig. 4) it appears that the relative severity of resorption increases as the amount of movement increases. There is a higher percentage of Group I resorption cases and a lower percentage of Group III cases in the group that had minimal translatory movement. Group I has fewer cases and a lower percentage, while Group III has more cases or a higher percentage in the patients with extensive tooth movement.

Figure 5 shows the severity of root-end resorption accompanying root torquing movement. As the amount of torque increased, the percentage of cases showing minimal root resorption decreased, and the percentage showing more resorption increased.

The elapsed time between posttreatment and postretention x-rays in the fifty-seven cases varied from 27 to 204 months. The average was 6.5 years and the median 5.5 years. The oldest patient at the time of postretention x-rays was fifty years old. She had been out of retention for seven years.

The posttreatment and the postretention x-rays for each case were evaluated as carefully as possible. Several obvious problems exist when trying to measure or evaluate root change from x-rays that are taken at different times and by different technicians.

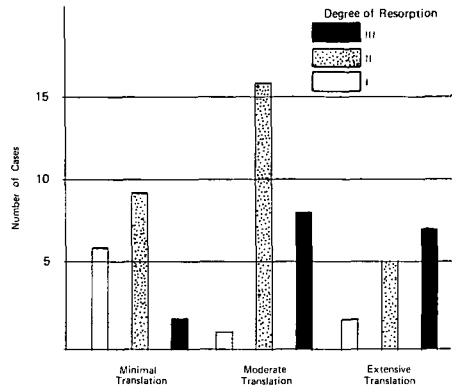


Fig. 4 Distribution of cases is shown in relation to translatory tooth movement and root-end resorption.

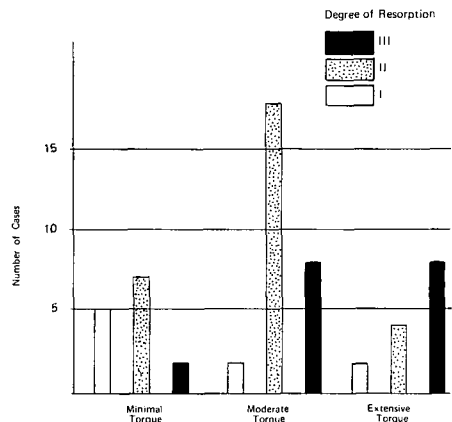


Fig. 5 Distribution of cases is shown in relation to root torquing movement and root-end resorption.

There were apparently no morphological changes in the roots of fifty of the patients. Only two cases exhibited some change in root morphology. This change was not interpreted as reflecting additional shortening of the roots but rather a slight remodeling of the root tips. Several of the root tips showed a sharp or more pointed area on one side of the root because of a more uneven or diagonal type of resorption. Some of the more pointed areas tended to be rounded off. There were five cases that could be considered questionable as to whether or not there was any further

root resorption. Varying degrees of distortion and enlargement of the incisor roots in the dental x-rays precluded measurement of loss of root structure. However, additional root loss subsequent to band removal with accompanying morphologic change could nonetheless be determined.

Of considerable interest is the finding that in only one case did the orthodontist report clinical mobility of the affected teeth. This respondent felt upon second inquiry that the mobility of the teeth in question was slight and probably of no clinical significance.

Responses to the question regarding possible thyroid dysfunction were largely negative. Three out of forty-nine responses were positive as evaluated by basal metabolic rate tests. In two instances patients with root-end resorption were apparently free of thyroid imbalance and yet had a parent or sibling on thyroxin medication.

DISCUSSION

The limited sample presented in this study does not purport to represent a cross section of patients having been treated by members of the Northern California Component of the Angle Society since approximately sixty per cent of the cases were contributed by only three orthodontists. Findings reported in this work, like so many earlier studies, must be considered tentative and evaluated on a pilot study basis.

There seems to be no clear-cut evidence either here or elsewhere to indicate whether or not sex plays a role in the predisposition to root resorption; it depends in part on knowing whether or not the sample is weighted. The same holds true for the possible relation between extensive incisor tooth movement which characterizes some extraction cases as contrasted with that seen in nonextraction cases. Failure to recognize the significance of sample weighting might lead to erroneous con-

clusions in the present work where sixty-eight of the fifty-seven were treated with extraction.

A highly subjective evaluation results when one must evaluate x-rays to determine the amount of root loss and minor change in root morphology. As was mentioned previously, it is practically impossible to avoid uncontrolled image enlargement and distortion accompanying intraoral roentgenography. Considerable subjectivity would be eliminated if the degree of incisor root torque and tooth translation were evaluated solely from headfilms taken in normal lateralis.

Even though there was unanimity of opinion with respect to the lack of mobility of the affected teeth and that no case showed a definite continuation of root resorption once the appliances were removed, we still do not know whether or not these teeth will suffer premature loss. For example, it is widely held among orthodontists that deciduous teeth without permanent successors will be lost after a given number of years, a figure that is probably deduced through a series of secret incantations and consultation with a ouija board. Serial x-rays shown in Figures 6 and 7 are of the lower right and left second deciduous molars taken at ages nine, eleven, and twenty-one years in a female patient in whom these teeth had no permanent successors. This points out the difficulty in trying to prognosticate the longevity of teeth with little or no root structure. At age twenty-four years these deciduous molars were free of clinical mobility so often observed in teeth about to be shed. Who is to say how long they will last?

In spite of the fact that root-end resorption seems to be a companion with orthodontic treatment at about the twenty per cent level, it is encouraging to report the considerable difficulty encountered by some of the con-



Fig. 6 Lower right deciduous 2nd molar at 9, 11 and 21 years of age.

Fig. 7 Lower left deciduous 2nd molar at 9, 11 and 21 years of age.

tributors in finding cases with root-end resorption of sufficient magnitude to be of use in this study. For example, one contributor went through approximately two thousand cases to find twenty which he considered adequate for this survey.

CONCLUSION

Two findings of positive nature in this limited sample may well offer a degree of comfort to the orthodontic clinician. First, it appears that root resorption which is apparently initiated by orthodontic treatment does not continue when the appliance is removed. I think we have tended to believe this, but it is nice to hear such reassurances. Secondly, none of the respondents con-

tributing to this sample reported mobility of the affected teeth.

Generally speaking, there appears to be negative correlation between root-end loss and the assorted variables such as age, treatment time, extraction, non-extraction, and classification of the malocclusion. The results of this study would not support the hypothesis that root ends are remodeled subsequent to treatment. Thus, the infrequency of adult patients with root resorption as judged by clinical blunting of the roots in Stucki's sample of treated patients cannot be explained by the data gathered in this study.

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