Cone beam computerized tomography survey of anatomical dimensions associated with retained deciduous teeth

by

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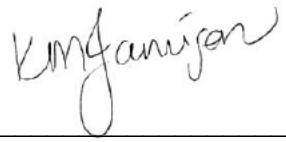

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ABSTRACT

Cone beam computerized tomography survey of anatomical dimensions associated with retained deciduous teeth:

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This retrospective cross-sectional prevalence study proposes a method for treating patients with retained deciduous teeth. The current literature shows that permanent teeth are congenitally missing in a significant part of the population, yet little is known about the biological mechanisms underlying retention and resorption of these teeth. Retained deciduous teeth may remain functional for an extended period of time, yet can cause problems with clinical treatment planning. Restorative options create complex periodontal and prosthodontic challenges, particularly when faced with placing an implant in these sites.

Eight hundred and twenty seven cone beam scans were reviewed which resulted in 21 patients with 33 retained deciduous teeth. The cone beam CT scans were reviewed for eleven measures of structural information regarding the site. Additionally, information from the patient's chart was gathered to determine if the tooth was left as part of the dentition, if an immediate implant was attempted, the number of cases that required adjunctive procedures, and if a delayed implant was placed and the initial torque of these implants.

Since the present study was considered a pilot study and exploratory in nature, advanced statistical analysis and hypothesis testing for the existing data set was unable to be completed due to the low n value. In addition, data taken from patient charts was often inadequate or inconsistent between clinicians. Any statistically significant finding may be misleading given the small data set. Treatment options for managing retained deciduous teeth were discussed as well as periodontic and prosthodontic considerations when treatment planning these patients.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

No table of figures entries found.

CHAPTER 1: INTRODUCTION

In most individuals, the primary teeth are normally exfoliated by 12 years of age and succeeded by the permanent dentition. Exfoliation of the primary teeth involves root resorption, an event that appears to be dependent on the presence of the underlying permanent tooth. In some individuals, the underlying permanent tooth fails to develop, with the result that one or more primary teeth can be retained beyond the time of normal exfoliation and into adulthood. The biological mechanisms underlying retention and resorption remain unknown.

The current literature shows the course and longevity of these retained teeth to be unpredictable. Although such persistent teeth are often functional, allowing them to remain as part of the dentition can lead to clinical problems such as periodontitis, caries, ankylosis, loss of vitality and esthetic concerns. However, extraction of these teeth often leads to supra-eruption of the opposing tooth and drifting of adjacent teeth. Restorative options create complex periodontal and prosthodontic challenges, particularly when faced with placing an implant in these sites. Periodontal concerns include lack of properly developed bone, lack of keratinized tissue, and the width of the roots impinging on the attachment of the adjacent teeth. Prosthodontic concerns include the infra-occluded tooth, width discrepancy of the restorative space and esthetic issues.

To date, few published studies have looked at issues concerning non-syndromic retained deciduous teeth, and an evidentiary basis for clinical treatment strategies addressing the question of whether the retained teeth should be extracted or left in place is lacking.

Dental agenesis (the failure to develop one or more teeth) is the most common developmental anomaly. Hypodontia is the absence of one or few teeth, oligodontia is the agenesis of greater than 6 teeth and anodontia is the total absence of any dental structure.[1] Absence of the permanent dentition is encountered relatively frequently and exhibits variations between racial groups as well as a female predilection, with females exhibiting dental agenesis 1.37 times greater than males. With the exception of third molars, mandibular second premolars are the most frequent succedaneous tooth missing (2.9-3.2%) followed by maxillary lateral incisors (1.6-1.8%), maxillary second premolars (1.4-1.6%), and mandibular incisors (0.2-0.4%). Overall, unilateral agenesis is more common than bilateral, but bilateral agenesis of maxillary lateral incisors is more common than unilateral.[2]

Most deciduous teeth are smaller than their analogous permanent teeth. However, when looking specifically at the dimensions associated with teeth that are most commonly found to be congenitally missing, this association is not true. The mesiodistal and buccolingual widths of deciduous maxillary and mandibular second molar crowns are consistently larger than their permanent counterparts, although the crown height of these primary teeth is significantly shorter. The roots of primary molars are long and slender when compared to those of permanent premolars. In addition, they flare outward allowing space for the crowns of permanent premolars during their formative phase. These flared roots can impinge on adjacent permanent teeth that can lead to attachment loss and esthetic concerns if implants are being considered as part of treatment. In contrast, maxillary lateral incisors display a smaller size both mesiodistally and labiolingually than the permanent maxillary lateral incisor.[3]

Normal exfoliation of deciduous teeth involves the presence of erupting permanent teeth. The roots of the deciduous molar undergo resorption and spontaneously exfoliate when approximately three-fourths of the root of the replacing premolar has formed.[4] Retained deciduous teeth without permanent successors may function for many years past normal exfoliation time.[5] However, for unknown reasons, root resorption might still occur. Currently there is no way to predict the initiation of root resorption in deciduous teeth without permanent successors, although it is often delayed as compared to the resorption of deciduous teeth with permanent successors.[6]

Local causes for over retained deciduous teeth are malposition of the tooth germ, abnormal resorption of the roots, ankylosis, supernumerary teeth in the path of eruption, presence of an odontogenic tumor and agenesis of the permanent tooth. However, the most important factor in the management of over-retained deciduous molars is whether the permanent successor is present or congenitally missing.[4,7]

Prolonged retention of deciduous teeth without a permanent replacement can present numerous problems. One of the most noted problems is the altered occlusion seen in these patients, including shifting of adjacent teeth, super-eruption of opposing teeth and creation of imbalance in the dental arch due to the size discrepancies between the primary and permanent dentition as well as the tooth morphology of both the crowns and roots. This leads to restorative difficulties and compromised esthetics. In addition, retained deciduous teeth commonly exhibit root resorption, loss of vitality, and ankylosis, which can result in severe loss of alveolar bone following extraction, making future restorative and orthodontics treatment more complex. Where the permanent teeth fail to develop, there is a corresponding underdevelopment of the alveolus. Reduced bone

volume may complicate implant treatment necessitating ridge augmentation. Multiple authors have also included caries risk as a potential problem when deciduous teeth are retained.[5,6,8]

In summary, the current literature shows that permanent teeth are congenitally missing in up to 6.9% of the population,[2] yet little is known about the biological mechanisms underlying retention and resorption of these teeth. Retained deciduous teeth may remain functional for an extended period of time, yet can cause problems with clinical treatment planning. Allowing them to stay as part of the dentition can cause further problems such as periodontitis, caries, ankylosis, loss of vitality, and esthetic concerns. However extraction of these teeth can lead to supra-eruption of the opposing tooth and drifting of adjacent teeth. If a prognosis can be made, then evidence-based guidelines could be determined for the course of treatment of these teeth.

The purpose of this study was to perform a retrospective cross-sectional prevalence study to develop a better understanding of the longevity and prognosis of retained deciduous teeth and to quantify the complex periodontal and prosthodontics concerns that result from replacing these teeth with implants. Additionally, the study used a retrospective CBCT analysis on retained deciduous teeth to quantify and provide detailed measurements of these teeth and the remaining bone present in hopes of producing an evidentiary basis for clinical treatment strategies addressing the question of whether retained deciduous teeth should be extracted or left in place.

HYPOTHESES

Sites not undergoing root resorption will have a more favorable implant prognosis than sites undergoing root resorption at the time of extraction.

Retained deciduous teeth showing signs of resorption will show lower insertion torque values than those of non-resorbing teeth.

CHAPTER 2: MATERIAL AND METHODS

Following institutional review board (IRB) approval (BAMC IRB C.2015.155d), a retrospective study of individuals possessing retained deciduous teeth was carried out in order to measure dimensions associated with these retained teeth. A single operator reviewed all of the available files of saved cone beam computerized tomography (CBCT) scans on the current server at Tingay Dental Clinic, Fort Gordon, Georgia. All images were taken using a Morita Accuitomo 170 CBCT, but may vary in individual scan settings. A comprehensive list of patient scans was collected in accordance with guidance from the IRB. Patient charts were then referenced to gather biographical (age and gender) data on these patients when available.

The cone beam CT scans were reviewed for eleven measures of structural information regarding the site, and entered into a spreadsheet for analysis; sites of teeth congenitally missing, evidence of resorption/ankyloses, presence of decay or restorations (Figures 1-2), occlusal plane discrepancy and the degree of infraocclusion (measured from the height of the adjacent teeth to a line connecting points on the retained deciduous tooth), cemento-enamel junction (CEJ) discrepancy as an alternate measure of infraocclusion (measured from the retained deciduous CEJ to a line connecting the adjacent teeth CEJs), mesio-distal space discrepancy (measured from the heights of contour of the adjacent permanent teeth), mesio-distal and bucco-lingual ridge width (measured at a pre-defined or consistent point for all scans and compared to "normal"), the distance of the most mesial root to adjacent teeth, the distance of the most distal root to adjacent teeth, and buccal plate thickness (figures 3-6). Additionally, information from

the patient's chart was gathered to determine if the tooth was left as part of the dentition (figure 7), if an immediate implant was attempted, the number of cases that required adjunctive procedures, and if a delayed implant was placed and the initial torque of these implants. Finally, ten percent of CT scans were reviewed with a second operator to verify consistency between examiners.

CHAPTER 3: RESULTS

Eight hundred and twenty seven cone beam scans were reviewed which resulted in 21 patients with 33 retained deciduous teeth. The patients included 15 males and 6 females with an age range of 22-46 years old with a mean age of 31.7 years. Of these retained deciduous teeth, 58% were primary second molars (19: 6 maxillary, 13 mandibular), 27% were primary canines (9: 8 maxillary, 1 mandibular), 9% were primary central incisors (3: all in the mandible), and 6% were primary lateral incisors (2: all in the maxilla) (Table 1). Seventy-nine percent had resorption present (26 of 33 teeth), 18% had decay present (6 of 33 teeth), and 18% had restorations present (6 of 33 teeth) (Table 2).

Fifty-eight percent of the retained deciduous teeth reviewed were primary second molars. The mean occlusal plane discrepancy of these second molars was 1.06 mm apical to the occlusal plane, while the mean cemento-enamel junction discrepancy was 0.34 mm apical to the adjacent CEJs. The maxillary deciduous second molars had a mean mesio-distal space discrepancy of 8.93 mm, and mean ridge widths of 9.96 mm mesio-distally and 10.83 mm bucco-lingually. The mandibular deciduous second molars had a mean mesio-distal space discrepancy of 9.98 mm, and mean ridge widths of 12.2 mm mesio-distally and 9.45 mm bucco-lingually. The mean buccal plate thickness was 1.19 mm. The mean value of the most mesial root to adjacent teeth was 2.71 mm and the mean value of the most distal root to adjacent teeth was 1.06 mm (Tables 3,4).

Records were located for all but one of the patients. Record reviews provided heterogeneous levels of detail concerning treatment plans. Not all clinicians recorded

implant insertion torque or detailed annotation of failed immediate placement attempts. Twenty-six of the 33 retained deciduous teeth were extracted, 6 were left in place, and no record was found for one tooth. Six retained deciduous teeth that were extracted had impacted permanent counterparts. Of the 26 extractions, 6 immediate implants were attempted, all on deciduous second molars. Two of these were removed at the time of placement due to torque values less than 15 newton centimeters (Ncm). The remaining 4 immediate implants had torque values of 25 Ncm or greater. Eleven other retained deciduous teeth extractions had delayed implants placed at least 4 months after healing, all with torque values of 35 Ncm or greater (Table 5).

CHAPTER 4: DISCUSSION

This study found the most commonly retained deciduous tooth to be the primary mandibular second molar. This finding is consistent with the reported literature;[2] however, the reported prevalence differs from the current study. Twelve patients out of 827 had retained primary second molars, giving an overall prevalence of 1.4%. Across all categories, the prevalence found for the current study fell below expectations based on the literature. Surprisingly, the prevalence of congenitally missing maxillary lateral incisors, previously reported at 1.7%, was found to be only 0.4% for the given population (3 patients out of 827). Thus, the current study population was found to underrepresent the prevalence rates found in the literature.

Several factors may explain the lack of representativeness in a military population as compared to the reported epidemiological literature. First, patients are referred for a variety of reasons to the specialty clinic from which the database was drawn. The sample population is not a random cross-sectional sample of the larger population. The military does provide a diverse cross-section of the American population, not necessarily drawn across socio-economic or demographic lines. However, the study sample may not generalize to the larger military population. It is a snapshot of those referred for specialty care over a given period of time. Second, by definition, the military population studied excludes younger patients. The military population presents a natural survivor bias in that only retained deciduous teeth present beyond the age of 18 years old will be available to be identified on a CBCT. The sample population inherently excludes all teeth lost prior to joining the military. Third, patients may have received care for retained

deciduous teeth prior to referral and scanning in the current specialty clinic. Prior treatment creates a similar survivor bias as that of lost teeth. Patients may have received orthodontic treatment prior to joining the military, and retained deciduous teeth may have been addressed at an early age. Notably, this confounder may account for the very low incidence of congenitally missing maxillary lateral incisors. Patients are more apt to seek treatment for conditions in the esthetic areas than they might otherwise for a congenitally missing premolar.

The present study can be considered a pilot study and exploratory in nature. The n value for the given database was fixed, as was the subset of scans showing evidence of a retained deciduous tooth. Further confounding the preliminary design and power analysis, no studies could be found examining the success rates of implants placed at included sites. A low n value for the given study precluded the role of advanced statistical analysis and hypothesis testing for the existing data set. Not only was the n value low, but data taken from patient charts was often inadequate or inconsistent between clinicians. Thus, the research team elected to forego more advanced statistical analysis of the current data set. Any statistically significant finding may be misleading given the small data set.

While the current sample population may be inappropriate for epidemiologic research on prevalence, the study population generally conforms to the reported data from prior studies. This study sought to determine the predictability of implants in these challenging situations, and not merely confirm the generalizability of the military population to the pre-existing literature. In that respect, the sample population provides an ideal data set to determine a critical question: what happened to adults with retained

deciduous teeth? Some of the patients may have been referred specifically for implant treatment, where others may have simply had retained deciduous teeth present as an incidental finding on a CBCT. An analysis of the history of these teeth with respect to implants warrants further discussion.

TREATMENT OPTIONS FOR RETAINED DECIDUOUS TEETH

The following provides discussion in regards to treatment options for retained deciduous teeth and important considerations when formulating treatment plans for these patients.

RETAINING DECIDUOUS TEETH

A reasonable treatment for retained deciduous teeth without permanent successors that do not have evidence of resorption, caries or occlusal plane discrepancies is to allow the teeth to remain as part of the dentition. Bjerklin et al. (2008) evaluated the survival of retained mandibular second primary molars from 12-13 years of age to adulthood. During the observation period, only 7 of the 99 primary molars in the study were lost due to root resorption, infraocclusion or caries. The authors concluded that long-term survival may be expected in more than 90 per cent of patients with retained primary second molars with agenesis of the permanent teeth.[12] Bjerklin and Bennett (2000) concluded that if primary molars are present at 20 years of age they appear to have a good prognosis for long-term survival.[5] Of the 33 deciduous teeth present in this study, only 3 existed without resorption, decay or occlusal plane discrepancies and were all primary

mandibular second molars. These teeth were left in place and patient ages were 24, 39, and 46.

With exception of the mandibular second molars, all remaining 20 deciduous teeth that were evaluated had resorption present (maxillary second molars, maxillary and mandibular canines, mandibular central incisors and maxillary lateral incisors), while resorption was present in only half of the mandibular second molars.

An important consideration when retaining a deciduous molar is the space allocation and bone support. Even if an implant restoration is planned in the long term, it is important to maintain the deciduous tooth in the absence of ankylosis and caries to maintain the space and bone. However, as previously discussed the space discrepancy between deciduous and permanent teeth differs significantly. In the case of the deciduous mandibular second molar, the retained tooth is too wide mesiodistally to have an ideal Class I molar occlusion, and results in a cusp to cusp, end on or half cusp Class II molar relationship despite a Class I canine occlusion.[13] Interproximal reduction of the 10 mm wide deciduous tooth to an appropriate width of 7 mm for a second premolar, in combination with orthodontic force, facilitates an ideal molar occlusion and maintains the bone for future implant placement.[9] In the case of the maxillary lateral incisor, the retained tooth is much smaller. The average mesio-distal crown diameter of permanent maxillary lateral incisors is 6.5 mm while the primary maxillary lateral incisor is 5.1mm.[3] The mean mesio-distal space discrepancy found for the 2 maxillary deciduous laterals in this study was 5.4 mm. This difference in width of 1 mm has esthetic implications for the final restoration, decreasing the width to length ratio and making the tooth appear longer. Magne et al. (2003) found that unworn laterals had an average width of 7.07 mm and

length of 9.75 mm making the width to length ratio 73%.[14] By decreasing this width to the 5.4 mm found in this study, the ratio would decrease to 55%, making the final restorations have compromised esthetics.

FIXED DENTAL PROSTHESIS

An option for replacement of a congenitally missing tooth is a fixed dental prosthesis. However, if the adjacent teeth do not have restorations or caries, preparing the teeth for full coverage restorations is destructive. Often times if the deciduous tooth was either infraoccluded or prematurely lost, the adjacent permanent teeth will begin tipping into this open space.[10] If a fixed dental prosthesis is being considered to close the space, the angulation of the abutment teeth may hinder its placement depending on the severity of the inclination. A parallel path of draw of the 2 abutment teeth may be unachievable, or cause over-reduction of the abutment teeth possibly leading to endodontic treatment. Additionally, ideal papilla fill in the pontic site will be difficult to achieve due to the tipping of the abutments. This is true of implants restorations in these sites as well.

ORTHODONTIC THERAPY

Patients with retained deciduous molars and congenitally missing second premolars may be able to be treated orthodontically to close the space after extraction of the retained deciduous tooth. These patients must be evaluated for an arch length deficiency to determine if their facial profile will be adversely affected by extraction and complete space closure. If the patient has adequate arch length and an acceptable profile, extraction of the retained teeth and space closure may be unfavorable. Other options such

as a fixed dental prosthesis, dental implant or retaining the deciduous tooth must be explored. Conversely, space closure may be indicated in cases with space deficiency, incisor proclination and full-lip profiles.[9]

EXTRACTION WITH IMMEDIATE IMPLANT

Retained primary second molars appear to present ideal situations for immediate implant placement. Mesiodistal space dimensions will naturally be met by the wider primary molar, and the short, wide root leaves adequate bone apical to the primary molar. Generally, an immediate implant requires at least 3 mm of bone apical to the extraction socket in order to ensure adequate primary stability. Retained primary molars maintain minimal root trunk and short roots. With the exception of the mental foramen, no limitations to apical placement exist in these cases.

In the current study, 12 of 19 retained second molars were treatment planned for implants. Of those 12 implants, 6 were attempted as immediate implants. Two immediate implants were aborted or removed for a lack of stability, and the majority of the remainder were placed with varying degrees of initial stability. These results suggest an important finding of the current study: immediate implant placement at the site of retained deciduous second molars appears to have a low success rate. Two of the 6 attempted immediate implants failed entirely.. In other words, resident clinicians perceived the flared roots and short root trunk to be beneficial attributes of the site, but apparently routinely encountered low bone density. Because the permanent tooth brings additional bone during its eruption process, we may postulate that the eruption of a permanent tooth may also improve the bone density of the surrounding ridge. Clinicians

should carefully weigh the costs and benefits of attempting an immediate implant at these sites, and should consider alternative techniques (such as aggressively pitched implants or underpreparing osteotomy sites) in order to ensure adequate placement.

EXTRACTION WITH DELAYED IMPLANT

Space discrepancies between deciduous and permanent teeth differ significantly. The average mesio-distal crown diameter of a permanent mandibular second premolar is 7 mm while the primary mandibular second molar is 9.9 mm[3]. The mean mesio-distal space discrepancy found for the 13 mandibular deciduous molars in this study was 10 mm which is consistent with the average reported values. This difference of 3mm in crown dimensions could lead to potential problems with prosthetic replacement of these teeth. With a mesio-distal space of 10 mm, it would be ideal to place a 5 mm diameter implant as opposed to a 4 mm platform to alleviate the severity of the implant platform to abutment angulation. However, if the mandibular second premolar is congenitally missing, the alveolar ridge width decreases approximately 25% over a 3 year period after extraction of the primary second molar. Ridge resorption slows over the next 4 years so that there is an additional 4% loss of ridge width. Additionally, the buccal surface of the ridge resorbs more than lingual, yet the posterior mandible often has a lingual concavity inferior to the alveolar ridge.[9] Excessive resorption in conjunction with a large lingual concavity may jeopardize placing a larger diameter implant, or possibly any implant at all. If ridge dimensions are inadequate for an appropriately sized implant corresponding to the final restorative treatment, the restoration will have compromised esthetics and

hygiene due to the smaller angulation of the abutment to platform interface and the corresponding restoration in the space available.

Two compromised situations involving vertical space have the potential to exist when implants are placed in sites where retained deciduous teeth were retained. Often times these teeth are ankylosed leading to the crest of bone being more apical to the adjacent teeth, or the ankylosis causes difficult extractions resulting in a loss of crestal bone. In this situation the implant platform is placed further apically than an ideal situation due to the inadequate vertical bone in the area of the former retained deciduous tooth. Prosthetically this leads to an increase in crown height and thus crown to implant ratio. In a systematic review, Blanes (2009) concluded that crown to implant ratio of implant supported restorations do not influence peri-implant crestal bone loss, however there was no data to evaluate the relationship between the crown to implant ratios and implant survival rates or the occurrence of technical complications of implant supported prostheses.[16] Due to the deeper platform, if a cement retained crown is being considered, the restoring dentist must be prudent with regards to custom abutment design and cement removal. Conversely, if adequate vertical bone height exists yet the former retained deciduous tooth was infraoccluded causing supraeruption of the opposing tooth, limited restorative space may be available. A minimum of 7-8 mm from the implant platform must be present for a cement retained restoration, which consists of 2 mm for occlusal material, 3-4 mm abutment height and 2-3 mm above the bone for the biologic width dimensions.[15] If less than 8 mm of space is available, than the restoring dentist must consider a screw retained restoration or alter the opposing occlusion. This may be

accomplished by adjusting the occlusal surface of the supraerupted tooth or a full coverage restoration to regain adequate space for the implant restoration.

CHAPTER 5: CONCLUSION

Retained deciduous teeth are present in a significant portion of the population. Often times these teeth continue to function for many years, however the long term survival is unpredictable and leads to complications in treatment planning. Since the present study was considered a pilot study and exploratory in nature, advanced statistical analysis and hypothesis testing for the existing data set was unable to be completed due to the low n value. In addition, data taken from patient charts was often inadequate or inconsistent between clinicians. Any statistically significant finding may be misleading given the small data set. Treatment options for managing retained deciduous teeth were discussed as well as periodontic and prosthodontic considerations when treatment planning these patients.

Table 1. Patient's age, gender and retained deciduous teeth

PATIENT #	AGE	GENDER	TOOTH
1	40	M	A
1	40	M	J
1	40	M	K
1	40	M	T
2	33	F	A
3	37	M	A
4	28	M	J
5	29	F	J
6	24	M	T
7	22	M	T
7	22	M	K
8	39	M	T
8	39	M	K
9	30	F	T
9	30	F	K
10	25	F	T
10	25	F	K
11	31	M	K
11	31	M	C
12	46	M	K
13	42	F	C
14	28	M	C
14	28	M	H
14	28	M	M
15	30	M	H
16	36	M	H
17	25	M	H
18	42	F	H
19	25	M	O
20	26	M	O
20	26	M	P
21	28	M	D
21	28	M	G

Table 2. Presence of resorption, decay and restorations in retained deciduous teeth.

TOOTH	RESORPTION	DECAY	RESTORATIONS
A	Y	N	N
A	Y	N	N
A	Y	N	N
J	Y	Y	N
J	Y	Y	N
J	Y	N	Y
T	N	N	N
T	Y	N	N
T	N	N	N
T	N	Y	Y
T	Y	N	N
T	Y	N	N
K	N	N	Y
K	Y	N	N
K	Y	N	N
K	N	Y	Y
K	N	N	N
K	N	N	Y
K	Y	Y	Y
C	Y	N	N
C	Y	N	N
C	Y	N	N
H	Y	N	N
H	Y	N	N
H	Y	N	N
H	Y	Y	N
H	Y	N	N
O	Y	N	N
O	Y	N	N
P	Y	N	N
M	Y	N	N
D	Y	N	N
G	Y	N	N
TOTAL	25 (79%)	6 (18%)	6 (18%)

Table 3. Measurements of dimensions associated with retained deciduous teeth in millimeters.

PATIENT	TOOTH	O PLANE DISCREP	CEJ DISCREP	M/D DISCREP	B/L WIDTH	M/D WIDTH	M ROOT ADJ TEETH	D ROOT ADJ TEETH	B PLATE
1	A	-1	0	8.89	10.27	9.37	2.54	1.61	
2	A	-4.29	-3.46	6.87	10.26	11.69	2.68	2.51	0.58
3	A	-1.86	0	11.9	11.49	10.88	3.52	1.11	0.99
4	J	-0.84	1.29	8.7	14.22	9.06	4.2	2.11	1.6
5	J	-1.83	-3.05	9	10.1	9.47	4.05	2.16	
1	J	0	1.25	8.19	8.63	9.26	2.11	0.93	
6	T	0	0	10.62	9.75	7.57	0.98	1.36	1.07
7	T	-1.48	0	9.95	9.16	12.55	2.55	1.46	1.58
8	T	0	0	10.95	10.82	13.72	1.86	0.53	0.48
9	T	0	-1.13	10.71	11.19	13.6	4.07	0.28	0.8
1	T	0	1.31	9.11	8.07	11.05	2.28	0.35	
10	T	0	1	10.06	8.81	10.9	2.17	0.93	1.48
11	K	-3.89	-3.46	8.32	11.71	12.17	2.89	1.51	1.17
10	K	0	0.73	10	8.63	11.03	2.82	0.19	1.58
1	K	-0.6	1.07	9.19	7.96	10.95	1.06	0.35	
9	K	-3.08	-2.81	10.31	11.51	14.32	5.33	0.43	1.75
8	K	0.91	1	11.27	9.55	14.93	2.25	0.9	
12	K	0	0	10.42	8.06	12.46	1.49	0.43	
7	K	-2.2		8.82	7.58	13.29			
11	C	-0.45	1.27	6.39	11.38	9.11	1.97	2.73	1.39
13	C				8.15		3.48		1.86
14	C	0	2.08	7.07	9.33	10.85		2.07	
15	H	0	2.23	7.87	8.57	10.34	4.88	2.73	1.63
16	H	-1.96	1.56	7.05	6.97	8.27	2.33	2	2.04
17	H	-1.84	0	6.83	7.85	8.87	2.29	2.04	2.58
18	H	0		5.45	7.76	7.9	2.39	1.86	2.18
14	H	0	2.45	7.12	9.01	9.93		2.68	
19	O	-2.88		4.55	4.4	5.75	1.2	2.16	0.72
20	O	-1.36		5.27	4.95	5.47		0.88	1.05
20	P	-1.76		5.27	4.71	5.47		1.76	0.88
14	M	0	1.6	6.17	9.03	7.78		1.92	0.79
21	D	-1.78	1.48	5.56	5.45	5.56	1.08	2.27	1.53
21	G	-2.29		5.24	4.79	6.09	1.16	0.96	0.82

Table 4. Means for each of the dimensions broken down by all teeth, second molars, maxillary second molars and mandibular second molars in millimeters.

	O PLANE DISCREP	CEJ DISCREP	M/D DISCREP	B/L WIDTH	M/D WIDTH	M ROOT ADJ TEETH	D ROOT ADJ TEETH	B PLATE
MEAN ALL TEETH	-1.08	0.25	8.22	8.79	9.99	2.58	1.46	1.33
MEAN 2nd MOLAR	-1.06	-0.35	9.65	9.88	11.49	2.71	1.06	1.19
MEANS MAX 2nd MOLAR	-1.64	-0.66	8.93	10.83	9.96	3.18	1.74	1.06
MEANS MAND 2nd MOLAR	-0.8	-0.19	9.98	9.45	12.2	2.48	0.73	1.24

Table 5. Additional information on retained deciduous teeth gathered from patient charts.

PATIENT #	TOOTH	EXTRACT?	ATTEMPT IMMEDIATE?	TORQUE	DELAYED?	TORQUE
1	A	Y	Y	15 Ncm (removed)	Y	45 Ncm
2	A	Y	N		N	
3	A	N				
4	J	N				
5	J	Y	Y	40 Ncm		
1	J	Y	Y	<15 Ncm (removed)	Y	>35 Ncm
6	T					
7	T	Y	Y	>50 Ncm		
8	T	N				
9	T	Y			Y	
1	T	Y	N		Y	45 Ncm
10	T	Y			Y	
11	K	Y	N		Y	50 Ncm
10	K	Y			Y	
1	K	Y	Y	25 Ncm		
9	K	Y			Y	
8	K	N				
12	K	N				
7	K	Y	Y	>50 Ncm		
11	C	N				
13	C	Y	N		Y	40 Ncm
14	C	Y (#6 present)				
15	H	Y (#11 present)				
16	H	Y (#11 present)				
17	H	Y (#11 present)				
18	H	Y	N			
14	H	Y (#11 present)				
19	O	Y	N		Y	
20	O	Y			Y	
20	P	Y			N	
14	M	Y (#22 present)				
21	D	Y	N		N	
21	G	Y	N		N	

Figure 1. Presence of resorption and decay on retained deciduous tooth

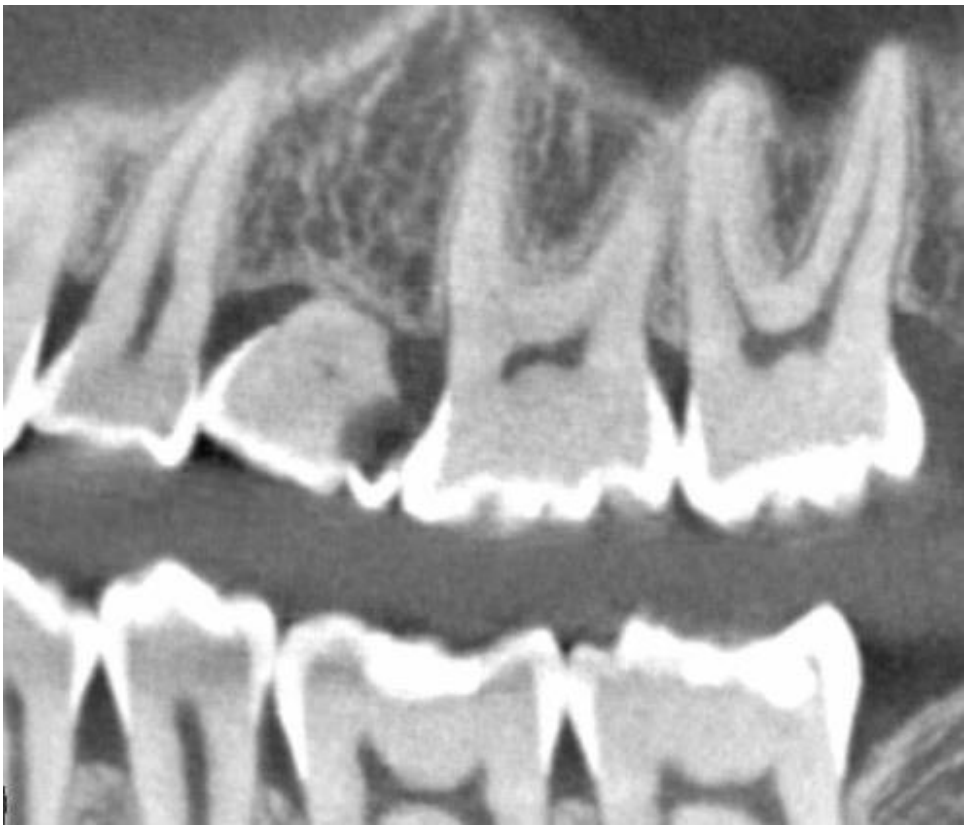


Figure 2. Presence of restoration on retained deciduous tooth

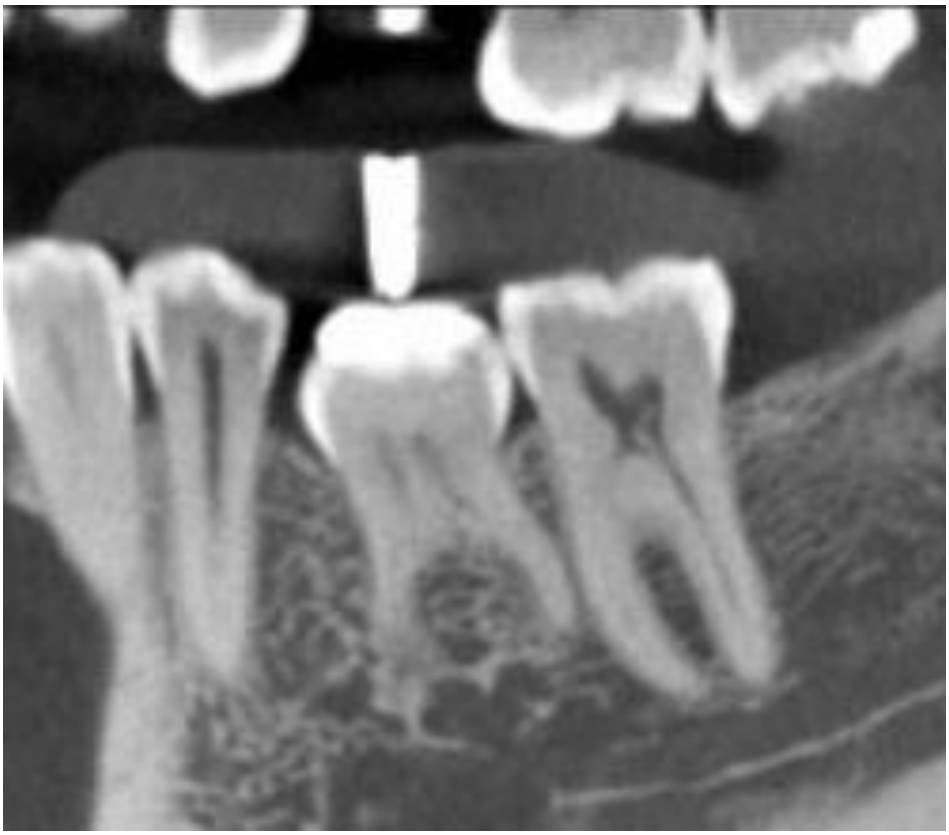
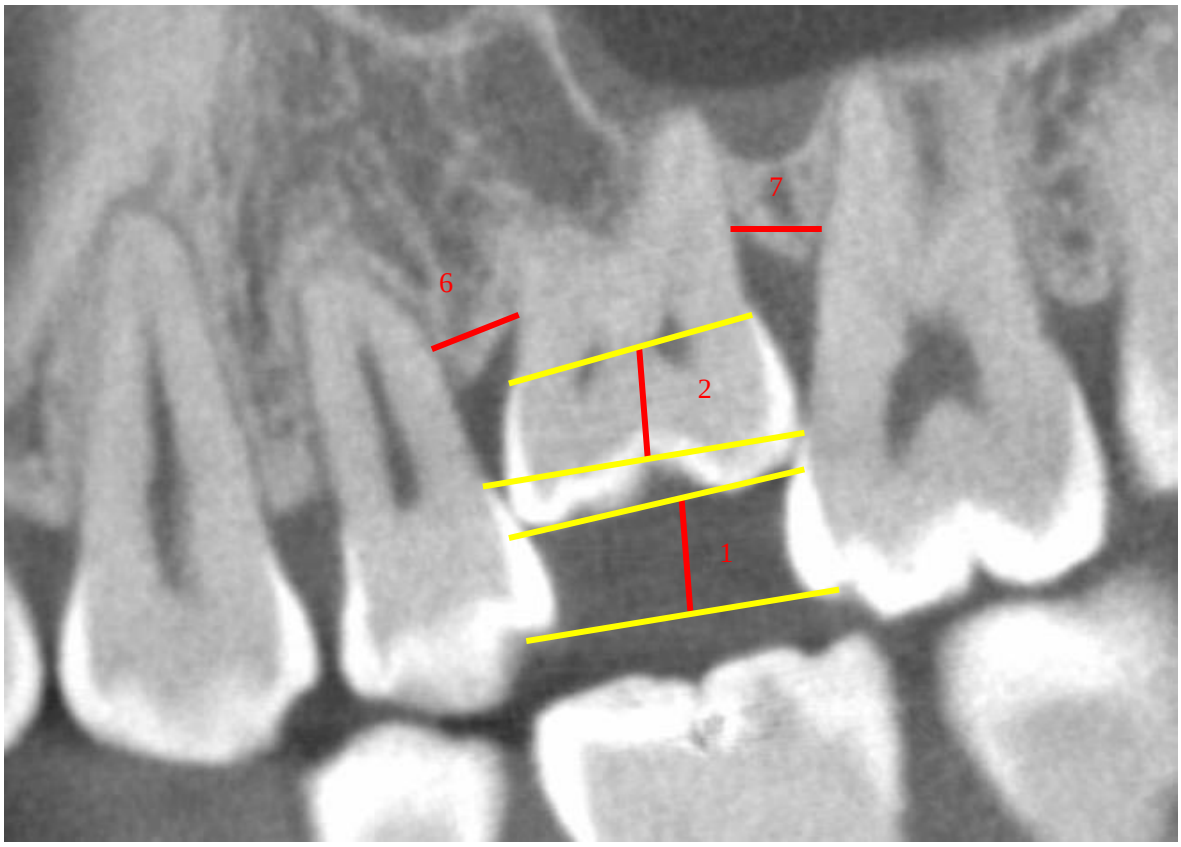


Figure 3. Example measurements of occlusal plane discrepancy, CEJ discrepancy, mesial root to adjacent tooth and distal root to adjacent tooth



1. Occlusal plane discrepancy
2. CEJ discrepancy
3. Mesio-distal space discrepancy
4. Mesio-distal ridge width
5. Bucco-lingual ridge width
6. Mesial root to adjacent tooth
7. Distal root to adjacent tooth
8. Buccal plate thickness

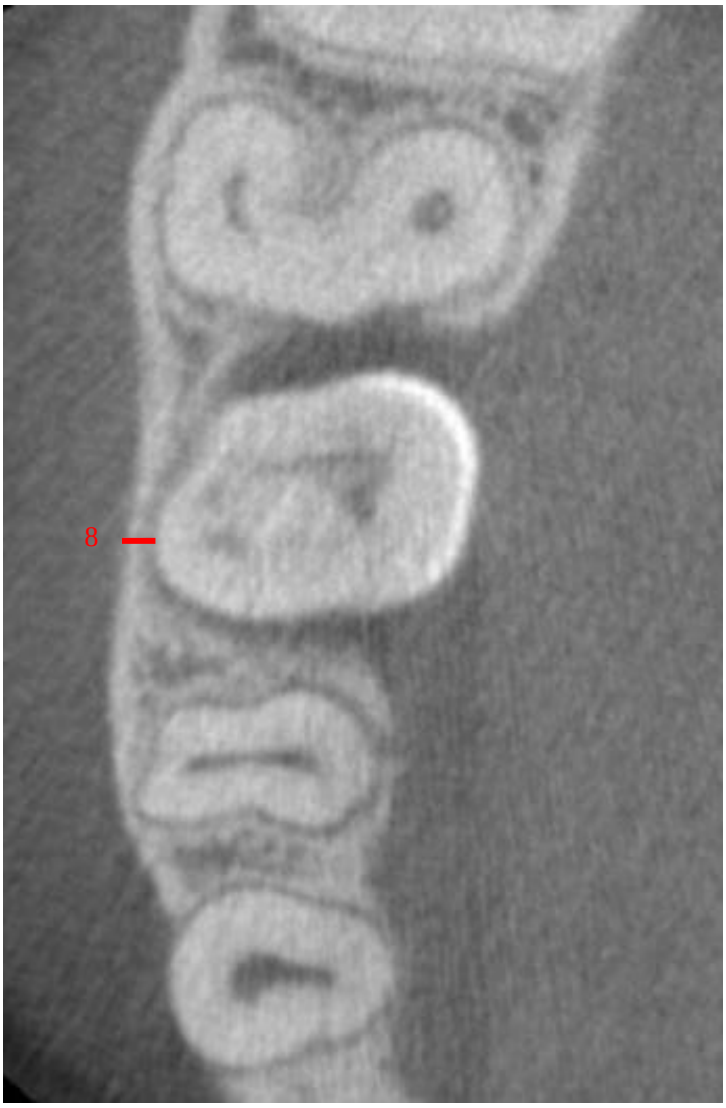
Figure 4. Example measurement of mesio-distal space discrepancy

1. Occlusal plane discrepancy
2. CEJ discrepancy
3. Mesio-distal space discrepancy
4. Mesio-distal ridge width
5. Bucco-lingual ridge width
6. Mesial root to adjacent tooth
7. Distal root to adjacent tooth
8. Buccal plate thickness

Figure 5. Example measurements of mesio-distal ridge width and bucco-lingual ridge width

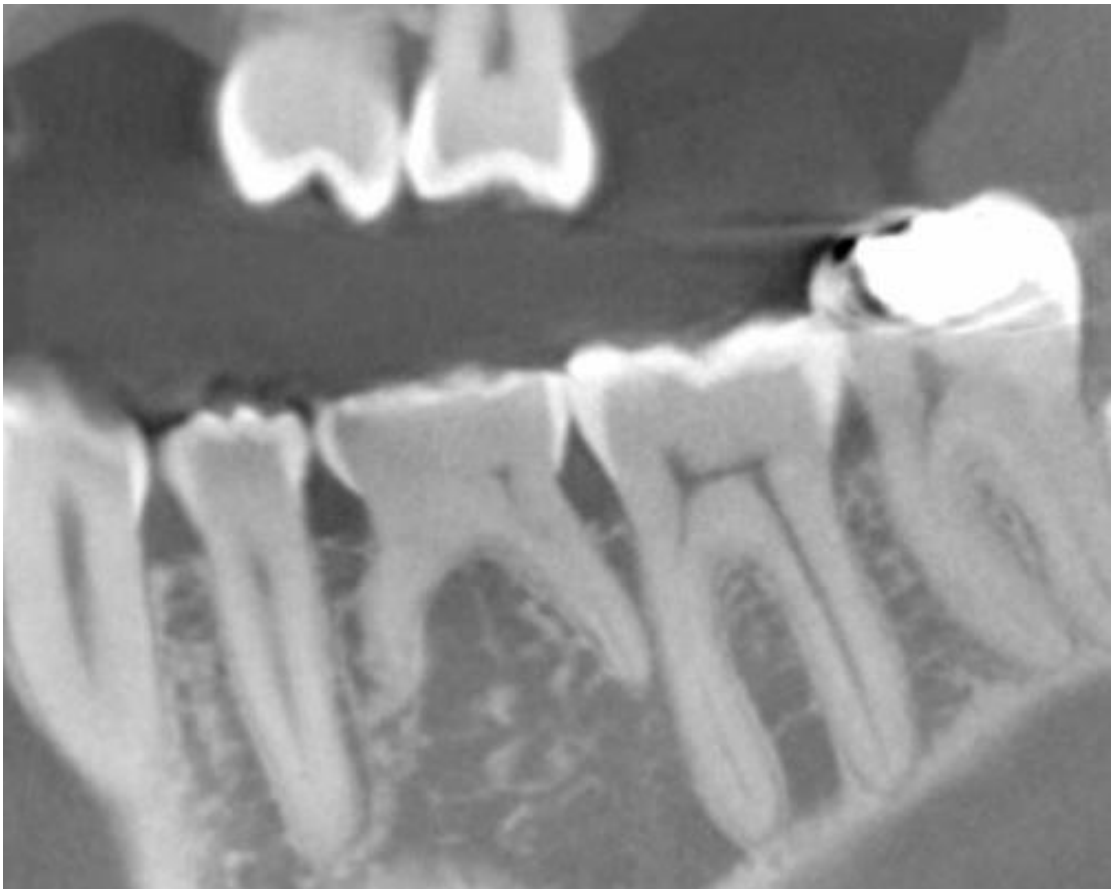
1. Occlusal plane discrepancy
2. CEJ discrepancy
3. Mesio-distal space discrepancy
4. Mesio-distal ridge width
5. Bucco-lingual ridge width
6. Mesial root to adjacent tooth
7. Distal root to adjacent tooth
8. Buccal plate thickness

Figure 6. Example measurement of buccal plate thickness



1. Occlusal plane discrepancy
2. CEJ discrepancy
3. Mesio-distal space discrepancy
4. Mesio-distal ridge width
5. Bucco-lingual ridge width
6. Mesial root to adjacent tooth
7. Distal root to adjacent tooth
8. Buccal plate thickness

Figure 7. Retained deciduous mandibular molar in a 39 year old male with no evidence of resorption, decay or restorations.



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