CBCT Analysis of Root Resorption in Orthodontic Patients with Short Root Anomaly

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BACKGROUND

The prevalence of short root anomaly (SRA) is estimated at 1.3%. SRA has a genetic background and is related to other dental anomalies, such as conoid teeth, agenesis, invaginated teeth, supernumerary teeth, pulp calculus, taurodontia, and microdontia (1). Short dental roots can affect the prognosis of teeth due to unfavorable root crown ratios. The proportion of healthy teeth is 1.63 for males, and 1.55 for females, but only ≤1.1 for teeth affected with SRA [2]. Therefore, it can complicate patient treatment in orthodontics and prosthodontics. There is a clinical belief that patients with SRA have more external apical root resorption (EARR) than normal patients [3-5]. However, there is a lack of studies validating this theory. For this reason, we aimed to assess if patients with SRA present more EARR at the final of the orthodontic treatment. Fig 1 - A is showing a panoramic image of a patient with SRA and 1-B is a control patient.

Fig. 1 – Panoramic image of SRA patient (A) and control patient (B).

OBJECTIVES

The objective of this study was to evaluate the amount of root resorption after orthodontic treatment in patients with Short Root Anomaly (SRA) in comparison with control patients using Cone Beam Computed Tomography (CBCT). We hypothesized that patients with SRA present more susceptibility to root resorption during orthodontic treatment when compared to the normal population.

MATERIAL AND METHODS

IRB APPROVAL: This study was approved by the IRB of the University of the Pacific (UoP), number: IRB2020-100

SAMPLE: 40 patients' sex-age matched were included and divided into two groups: SRA, n=20, and Control, n=20. CBCT scans were collected before (T1) and after the completion of orthodontic treatment (T2).

CBCT ASSESSMENT / Root analysis: Tooth volume and length were assessed. Segmentation of the 4 upper incisors was done using the software ITK-SNAP and the volume of each tooth was measured. After, the segmentations were exported as a 3D model to the 3D-Slicer where the tooth length was measured (Fig. 2 and 3).

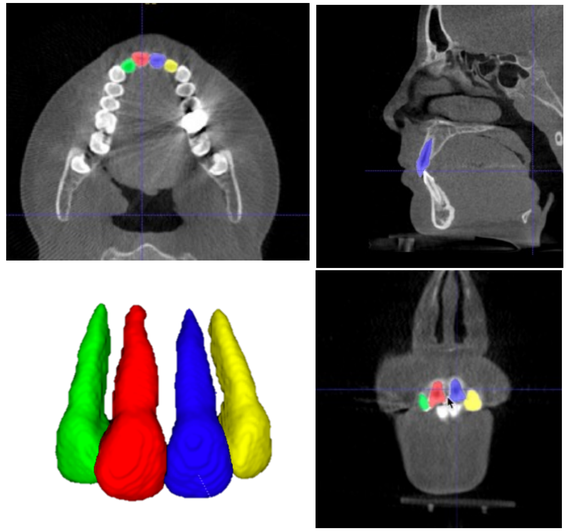

Fig. 2 ITK-SNAP segmentation. The four upper incisors were segmented in the ITK-SNAP software and their respective volume was individually measured.

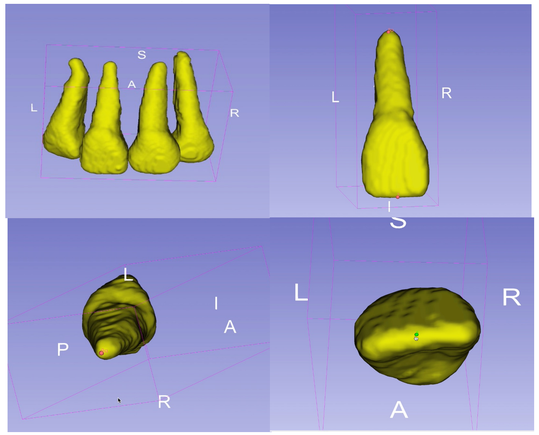

Fig.3 – 3D slicer length measurement. Each tooth had its length measured using the distance from the apex of the incisor to the incisal edge along the longitudinal axis (with the placement of landmarks).

RESULTS AND DISCUSSION

The paired t-test (T2-T1) showed a statistically significant reduction of length (mm) in both groups, with an average of 0.81 and 0.89 (left and right upper laterals) and 1.03, and 1.10 (left and right upper central) in the Control, and 0.70, 1.27, 0.66 and 0.51 in the SRA respectively. Treatment time was not significant in both groups. (Table 1)

Table 1- Paired t-test for the differences between groups

Control Group		Mean	Std. Dev.	Std. Error Mean	95% confidence interval of the difference Lower	Upper	t	df	Sig. (2 tailed)
Pair1	Seg. Vol. T1 UL2 – Seg. Vol. T2 UL2	10.61	45.01	10.06	-10.45	31.7	1.05	19	0.30
Pair1	Seg. Vol. T1 UL1 – Seg. Vol. T2 UL1	7.69	47.31	10.58	-14.45	29.8	0.73	19	0.47
Pair 3	Seg. Vol. T1 UR1 – Seg. Vol. T2 UR1	2.47	46.76	10.46	-19.41	24.3	0.24	19	0.81
Pair 4	Seg. Vol. T1 UR2 – Seg. Vol. T2 UR2	13.01	54.37	12.16	-12.44	38.4	1.07	19	0.29
Pair 5	3D Dist. T1 UL2 – 3D Dist. T2 UL2	0.81	1.28	0.28	0.21	1.41	2.84	19	0.01
Pair 6	3D Dist. T1 UL1 – 3D Dist. T2 UL1	1.03	1.04	0.23	0.54	1.51	4.43	19	0.00
Pair 7	3D Dist. T1 UR1 – 3D Dist. T2 UR1	1.1	1.04	0.23	0.61	1.58	4.73	19	0.00
Pair 8	3D Dist. T1 UR2 – 3D Dist. T2 UR2	0.89	1.14	0.25	0.35	1.42	3.48	19	0.002

SRA Group		Mean	Std. Dev.	Std. Error Mean	Lower	Upper	t	df	Sig. (2 tailed)
Pair1	Seg. Vol. T1 UL2 – Seg. Vol. T2 UL2	13.88	38.93	8.70	-4.33	32.10	1.59	19	0.12
Pair1	Seg. Vol. T1 UL1 – Seg. Vol. T2 UL1	4.50	47.89	10.70	-17.91	26.92	0.42	19	0.67
Pair 3	Seg. Vol. T1 UR1 – Seg. Vol. T2 UR1	-5.14	61.16	13.67	-33.71	23.48	-0.37	19	0.71
Pair 4	Seg. Vol. T1 UR2 – Seg. Vol. T2 UR2	43.76	68.67	15.35	11.61	75.90	2.85	19	0.01
Pair 5	3D Dist. T1 UL2 – 3D Dist. T2 UL2	0.71	1.44	0.32	0.02	1.38	2.17	19	0.04
Pair 6	3D Dist. T1 UL1 – 3D Dist. T2 UL1	0.66	1.16	0.25	0.11	1.20	2.54	19	0.02
Pair 7	3D Dist. T1 UR1 – 3D Dist. T2 UR1	0.51	1.00	0.22	0.04	0.98	2.29	19	0.03
Pair 8	3D Dist. T1 UR2 – 3D Dist. T2 UR2	1.27	1.50	0.33	0.57	1.97	3.79	19	0.001

The independent t-test showed no differences in the tooth length or volume in T2-T1 between both groups (Table 2)

Table 2- Independent t-test for the differences in volume and lengh between the groups

Independent Samples Test		Sig. (2 tailed)	Mean Difference	95% confidence interval of the difference Std. Error Difference	Lower	Upper
Pair1	Seg. Vol. T2T1 UL2	0.81	3.27	13.30	-23.67	30.21
Pair1	Seg. Vol. T2T1 UL1	0.83	3.18	15.05	-33.65	27.28
Pair 3	Seg. Vol. T2T1 UR1	0.66	7.62	17.21	-42.47	27.23
Pair 4	Seg. Vol. T2T1 UR2	0.12	30.75	19.58	-8.89	70.40
Pair 5	3D Dist. T2T1 UL2	0.77	-0.12	0.43	-1.00	0.75
Pair 6	3D Dist. T2T1 UL1	0.28	-0.37	0.34	-1.07	0.32
Pair 7	3D Dist. T2T1 UR1	0.7	-0.59	0.32	-1.25	0.06
Pair 8	3D Dist. T2T1 UR2	0.35	0.39	0.42	-0.46	1.25

When the upper laterals and centrals were analyzed together, we found a statistically significant reduction in the length in both groups and for the SRA the volume reduced also in the upper laterals (Table3)

Table 3- Paired t-test for the differences between groups with centrals and laterals grouped

Control Group	Mean	Std. Dev.	Std. Error Mean	95% confidence interval of the difference Lower	Upper	Sig. (2 tailed)
Seg. Vol. Upper Centrals T1– Seg. Vol. Upper Centrals T2	5.08	46.50	7.35	-9.79	19.95	0.494
Seg. Vol. Upper Laterals T1– Seg. Vol. Upper Laterals T2	11.81	49.28	7.79	-3.95	27.57	0.138
3D Dist. Upper Centrals T1– 3D Dist. Upper Centrals T2	1.07	1.01	0.16	0.75	1.39	0.00
3D Dist. Upper Centrals T1– 3D Dist. Upper Centrals T2	0.83	1.19	0.19	0.45	1.22	0.00

SRA Group	Mean	Std. Dev.	Std. Error Mean	Lower	Upper	Sig. (2 tailed)
Seg. Vol. Upper Centrals T1– Seg. Vol. Upper Centrals T2	-0.32	54.44	8.60	-17.73	17.09	0.971
Seg. Vol. Upper Laterals T1– Seg. Vol. Upper Laterals T2	28.82	57.14	9.03	10.54	47.09	0.003
3D Dist. Upper Centrals T1– 3D Dist. Upper Centrals T2	0.59	1.06	0.16	0.25	0.93	0.001
3D Dist. Upper Centrals T1– 3D Dist. Upper Centrals T2	0.98	1.49	0.23	0.50	1.45	0.000

CONCLUSION

Our study suggests that SRA patients are not more susceptible to root resorption than the control group, except for the upper laterals with a small magnitude in the volume. Both groups showed statistically significance before and after orthodontic treatment for tooth length and volume, suggesting that orthodontic treatment causes a certain amount of resorption in the root apex.

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ACKNOWLEDGMENTS

This study was partially funded by the Research Enhancement Award Activity 141 from the University of the Pacific, Arthur A. Dugoni School of Dentistry.