Predictive Dosimetry Using Machine Learning to Guide Dental Management and Extractions Prior to Head and Neck Radiotherapy

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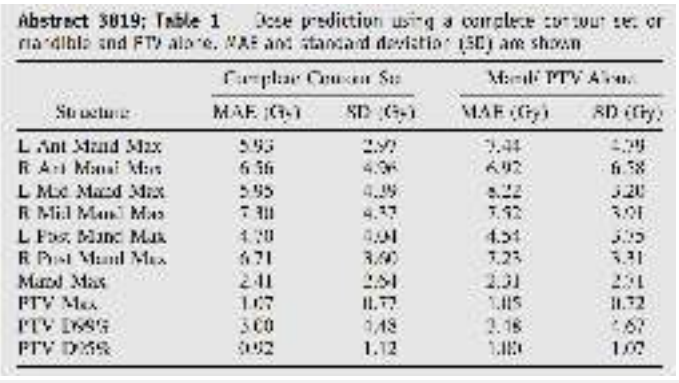
Purpose/Objective(s): Dental decay and osteoradionecrosis are major late sequelae of head and neck radiotherapy but there is little concrete basis to counsel patients about their individual risk. At our institution, dental oncologists may treat or extract teeth when the anticipated dose to the region is high, e.g. >50 Gy. We investigated the feasibility of dose prediction using either a complete or a limited contour set to determine if predictive accuracy could be maintained while preserving efficiency. We also investigated the feasibility of using diagnostic imaging to predict doses to the mandible.

Materials/Methods: A machine learning (ML) dose prediction model was trained using 86 oropharyngeal cancer radiation treatment plans delivered at a high-volume academic center. The model uses a boosting-based method, which forms a final strong classifier with respect to a distribution through iterative learning of weak classifiers. A test set of 14 treatment planning CTs was processed using a commercial ML decision support software with either a complete set of all targets and organs at risk (OARs) or a limited contour set comprised of the gross tumor planning target volume (PTV) and mandible aloneAll contours were manually delineated with the exception of mandible sub-structures, which were auto-segmented using commercial software. Predictive accuracy was defined as the mean absolute error (MAE) between delivered and predicted dose. The trained ML algorithm was then used to predict dosimetry for two patients using limited contour sets contoured on diagnostic CTs.

Results: Max doses could be predicted within MAE of 2.41 Gy for mandible and on average, within 6.19 Gy for mandible sub-structures using complete contour sets (Table 1). Although dose prediction for 8 out of 10 indices was improved using complete rather than limited contour sets, MAE on average improved by only 7.5%. As proof of principle, limited contour sets were delineated on diagnostic CTs for two patients for dose prediction prior to CT simulation. For these patients, while the MAE for 14 dental OARs was relatively high at 6.94 Gy, the errors were most pronounced below the 50 Gy threshold in regions far from the targets and OARs; only 1 of 14 (7%) total OARs was incorrectly predicted to receive a dose >50 Gy.

Table 1. Dose prediction using a complete contour set or mandible and PTV alone. MAE and standard deviation (SD) are shown.



Abstract 3819; Table 1 Dose prediction using a complete contour set or mandible and PTV alone. MAE and standard deviation (SD) are shown

	Complete Contour Set		Mandible/PTV Alone	
Structure	MAE (Gy)	SD (Gy)	MAE (Gy)	SD (Gy)
L Ant Mand Max	5.93	2.92	7.44	4.29
R Ant Mand Max	6.56	4.06	6.92	6.58
L Mid Mand Max	5.95	4.09	8.22	5.20
R Mid Mand Max	7.80	6.52	7.92	5.01
L Post Mand Max	4.20	0.94	4.54	5.05
R Post Mand Max	6.71	3.90	7.25	5.31
Mand Max	2.41	2.64	2.31	2.31
PTV Max	1.67	0.72	1.05	0.72
PTV D98%	3.00	0.48	2.16	1.67
PTV D95%	0.92	1.12	1.00	1.02

Conclusion: Diagnostic imaging can be used with minimal contouring for dose prediction of high-risk OARs using To our knowledge, this represents the first meaningful applied prospective use of ML-based clinical counseling prior to radiation treatment.