DEVELOPMENT OF A DEEP LEARNING METHOD FOR DISCRIMINATING ANTERIOR NASAL CAVITY DEGENERATIVE, REGENERATIVE, AND INFLAMMATORY LESIONS IN THE RAT

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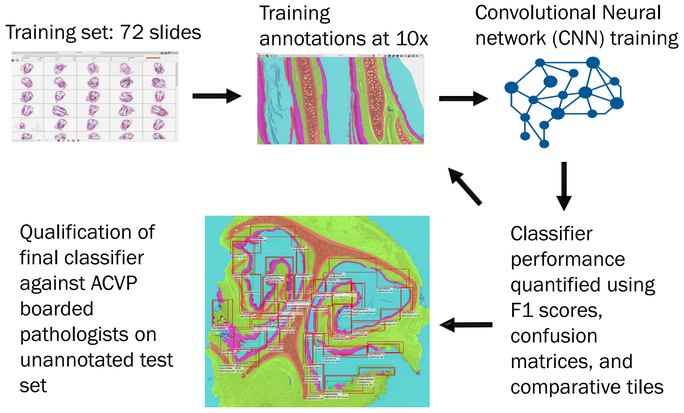
Background

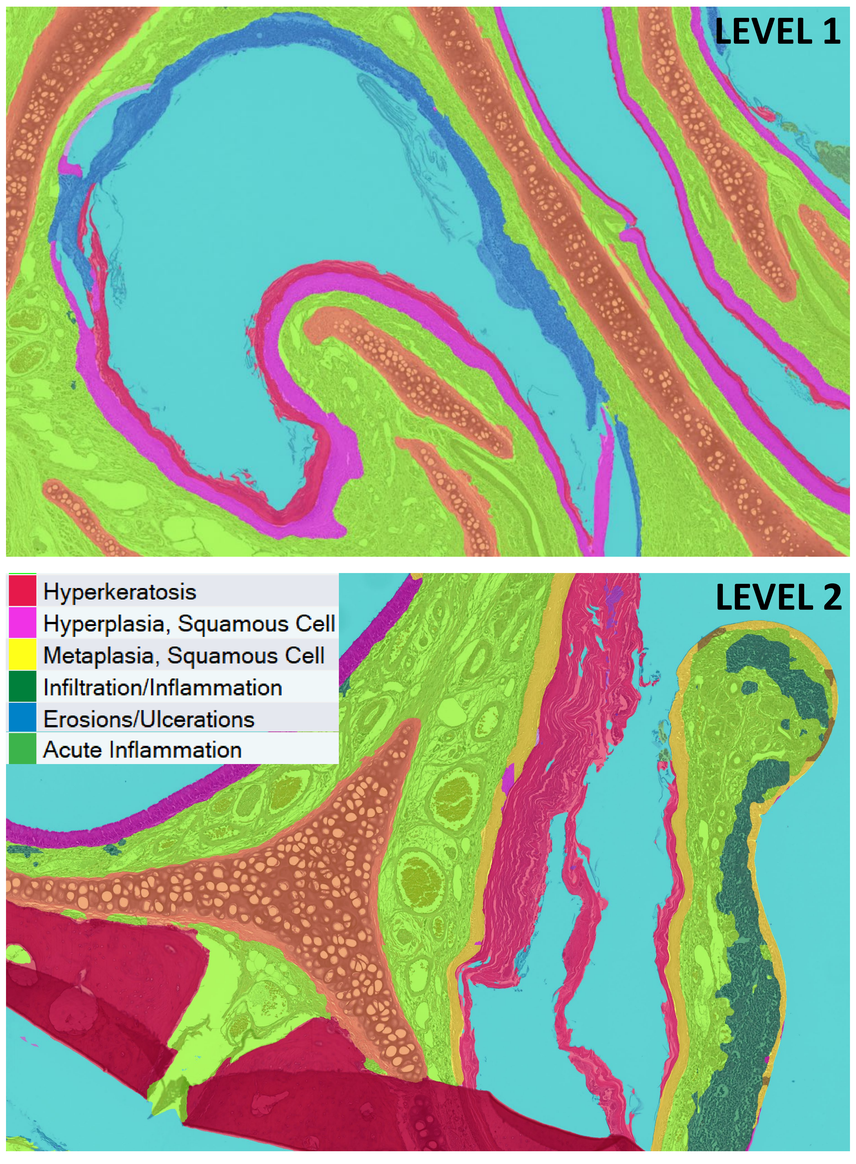
- Nasal cavity assessment is an essential activity for the pathologist in many toxicology studies
- Usually 6 (I-VI) distinct levels evaluated because of anatomic complexity
- Evaluation within studies is time consuming and diagnostic consistency across studies challenging

Methods

- Whole slide images of H&E stained nasal cavity levels I and II were scanned at 40x on a Leica AT2 scanner and uploaded to Deciphexs' Patholytix Preclinical Study Browser



Deep Learning AI Provides Decision Support For Pathologists Through Abnormality Detection in the Rat Anterior Nasal Cavity



Discussion

Conclusion

- The CNN algorithm detected nasal cavity pathology successfully for 5 common nasal cavity lesions
- The heat map provided by the algorithm masks helps the pathologist readily identify "abnormal" areas
- Using a CNN algorithm as a decision support tool for pathologists could facilitate standard nasal cavity evaluation

Challenges and Next Steps:

- Using only 2 "normal classes" initially slowed the computer learning process and prompted a change from 2 "normal classes" to 8
- The CNN model could not differentiate some changes (e.g. acute inflammation vs the debris from erosion and ulcerations) because context was insufficient at only one training magnification. Training was then done at multiple magnifications and using multi-magnification models such as Unet-MESD.
- CNN model identification of minimal or mild Infiltration/Inflammation is challenging and may be improved by higher magnification training
- The performance of this algorithm was excellent for the intended use. Additional studies are required to understand the impact of this type of tool on the pathologist's efficiency and consistency within and across studies

Results

Model Performance

Confusion Matrix

Actual \ Predicted	Hyperkeratosis	Hyperplasia, Squamous Cell	Metaplasia, Squamous Cell	Infiltration/ Inflammation	Erosions/ Ulcerations	Cartilage	Squamous Epithelium	Stroma	Lumen/ Background	Tooth	Bone	Respiratory Epithelium	Transitional Epithelium	Acute Inf.
Hyperkeratosis	67%	8%	1%	0%	3%	0%	3%	0%	18%	0%	0%	0%	0%	1%
Hyperplasia, Squamous Cell	3%	81%	0%	0%	2%	0%	4%	8%	0%	0%	0%	0%	0%	0%
Metaplasia, Squamous Cell	1%	0%	75%	0%	0%	0%	0%	13%	3%	0%	0%	1%	6%	1%
Infiltration/ Inflammation	0%	0%	0%	46%	1%	0%	0%	52%	0%	0%	0%	0%	0%	0%
Erosions/ Ulcerations	2%	0%	0%	0%	86%	0%	0%	3%	8%	0%	0%	0%	1%	0%
Cartilage	0%	0%	0%	0%	0%	97%	0%	3%	0%	0%	0%	0%	0%	0%
Squamous Epithelium	0%	0%	0%	0%	0%	0%	84%	9%	4%	0%	0%	1%	1%	0%
Stroma	0%	1%	0%	1%	0%	1%	0%	95%	1%	0%	1%	0%	0%	0%
Lumen/ Background	0%	0%	0%	0%	0%	0%	0%	1%	98%	0%	0%	0%	0%	0%
Tooth	0%	0%	0%	0%	0%	0%	0%	2%	0%	95%	3%	0%	0%	0%
Bone	0%	0%	0%	0%	0%	0%	0%	3%	0%	1%	96%	0%	0%	0%
Respiratory Epithelium	0%	0%	2%	0%	0%	0%	1%	4%	1%	0%	0%	90%	2%	0%
Transitional Epithelium	0%	0%	6%	1%	1%	0%	1%	14%	4%	0%	0%	5%	68%	0%
Acute Inflammation	0%	0%	1%	0%	19%	0%	0%	0%	7%	0%	0%	0%	0%	73%

F1 Scores

Class	Best Single Magnification Model	Unet-MESD
Bone	0.953	0.95
Cartilage	0.946	0.963
Lumen/background	0.967	0.976
Respiratory Epithelium	0.889	0.865
Squamous Epithelium	0.8	0.772
Stroma	0.931	0.942
Tooth	0.981	0.969
Transitional Epithelium	0.752	0.672
Acute Inflammation	0.169	0.692
Erosions/Ulcerations	0.846	0.856
Hyperkeratosis	0.777	0.7
Hyperplasia, Squamous Cell	0.766	0.777
Infiltration/Inflammation	0.496	0.48
Metaplasia, Squamous Cell	0.738	0.756
Binary	0.823	0.811

Qualification

Positive Detection: Were any lesion classes detected by the algorithm in the area annotated?

Total Number of Annotations	Number of Annotations with Positive Detections	% Positive Detections of Total
182	159	87.36
1298	1123	86.52
57	54	94.74

Class Match Detection: Were the specific lesion classes annotated detected by the algorithm?

Class	Total Number of Annotations	Detected	% Detected	Not Detected	% Not Detected
Hyperkeratosis	364	358	98.35	6	1.65
Hyperplasia, Squamous Cell	466	450	96.57	16	3.43
Metaplasia, Squamous Cell	128	126	98.44	2	1.56
Infiltration/Inflammation	652	172	26.38	480	73.62
Erosions/Ulcerations	58	52	89.66	6	10.34
Acute Inflammation	55	40	72.73	15	27.27

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