UTHealth Houston
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Digital Quantification of Cluster Features for Salivary Tissue Engineering

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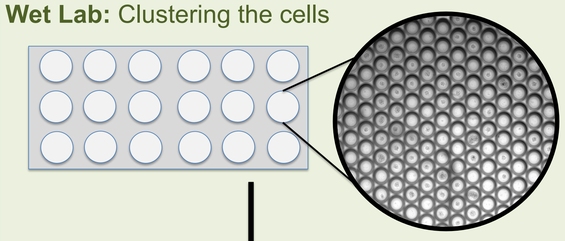
INTRODUCTION

- As a result of head and neck cancer radiation, individuals may suffer from xerostomia (dry mouth), resulting in a reduced quality of life
- There are no permanent and durable treatment options to restore salivary gland function currently
- At present, one approach is tissue engineering where salivary gland cells are encapsulated in hydrogels
- Pre-clustering may provide 3-D building blocks with greater survival potential and adaptation toward the development of larger tissues.
- Digital imaging tools with supervised machine learning (ML) software were used to quantitatively evaluate cell clustering methods, toward a goal of automated cluster optimization.

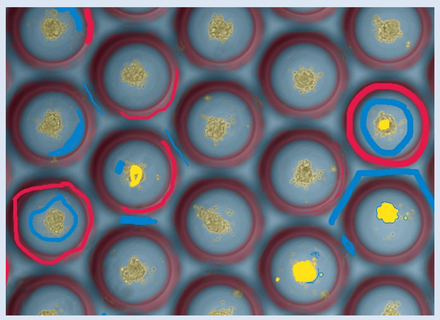
METHOD

Wet Lab: Clustering the cells

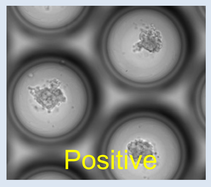


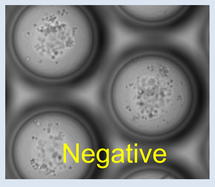
Human salivary stem/progenitor cells (hS/PCs) were seeded onto low-adhesion clustering plates
- Derived from 6 patient samples under IRB approval
- Imaged over time across hundreds of clustering wells

Ilastik (machine learning software for image segmentation and classification)

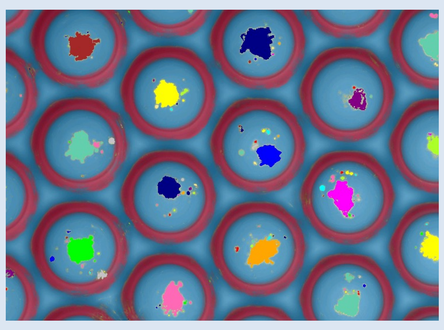


Pixel classification: Differentiation between cells and the wells in which they were contained
- Positive and negative control images were identified subjectively



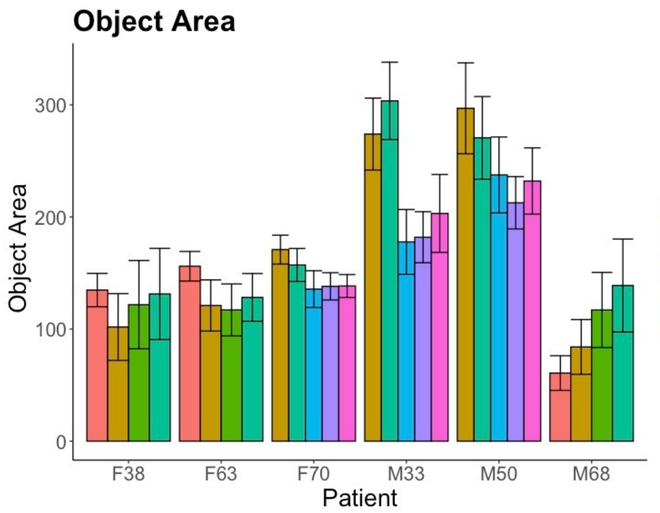


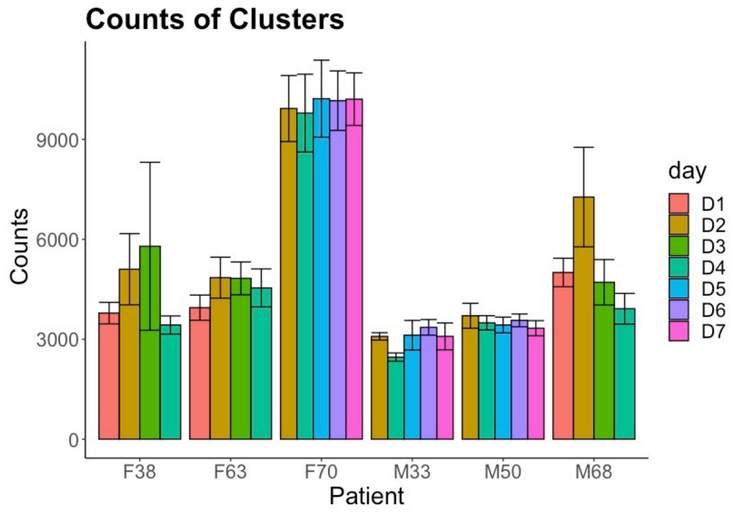
- User annotations used to train model (random forest classifier)

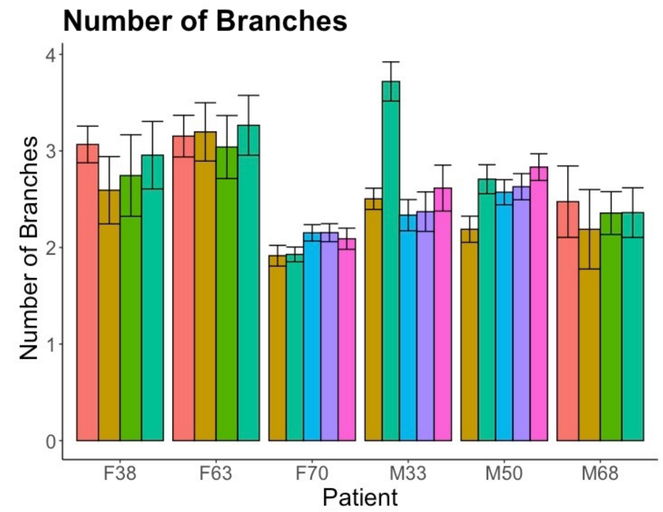


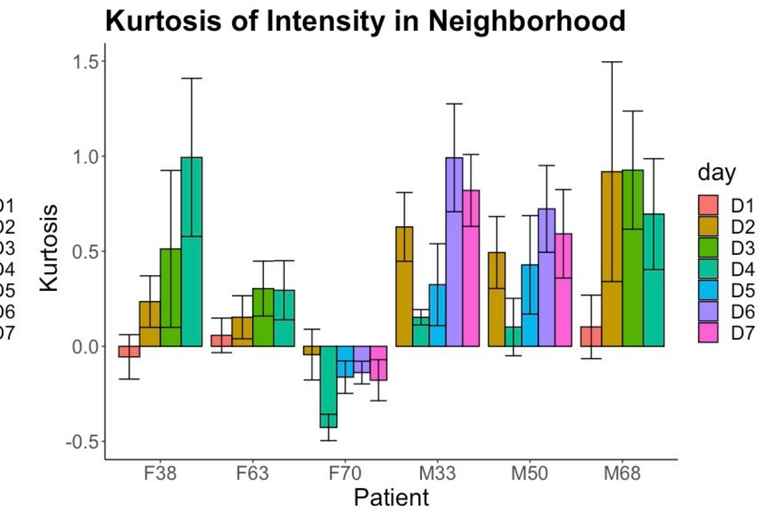
Object classification: identification of cluster regions to quantify features
- Used prediction maps from pixel classification
- Various cluster features were quantified
- Batch processing to analyze all images

RESULTS









- For each feature, averages were calculated for a single well, and for 6 replicates in each plate.
- Cluster perimeters were identified by ML algorithms, and separated from loosely-adherent neighboring cells, and poor clustering specimens were identified by deviations in multiple parameters.
- High cluster quality could not be correlated readily between single quantitative measures and standard subjective assessments.

CONCLUSION

- ML-based image analysis with Ilastik was useful in excluding patient samples with poor clustering potential, based on multiple individual measures.
- However, positive clustering behavior was more complex to confirm, and may require layered decision strategies to match subjective assessments.

ACKNOWLEDGMENTS

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