

Evaluating Baseline and Anatomically-Guided Preprocessing for Weakly Supervised Hip Osteophyte Classification

1. Introduction & Research Question

Background

- Osteophytes are important indicators of hip osteoarthritis.
- Weakly supervised datasets provide only image-level labels.
- Exact osteophyte locations are unavailable.
- Anatomical landmarks may help focus on clinically relevant regions [1].

Motivation

- Localized crops may focus the model on osteophyte-related structures.
- Broader crops preserve anatomical context that may also be informative [2].

Research Question

- *Does anatomically-guided preprocessing improve weakly supervised hip osteophyte classification compared to broad femoral head centered crops?*

Sub-Questions

Q1. Does anatomically-guided preprocessing improve classification performance compared to baseline femoral head centered crops?

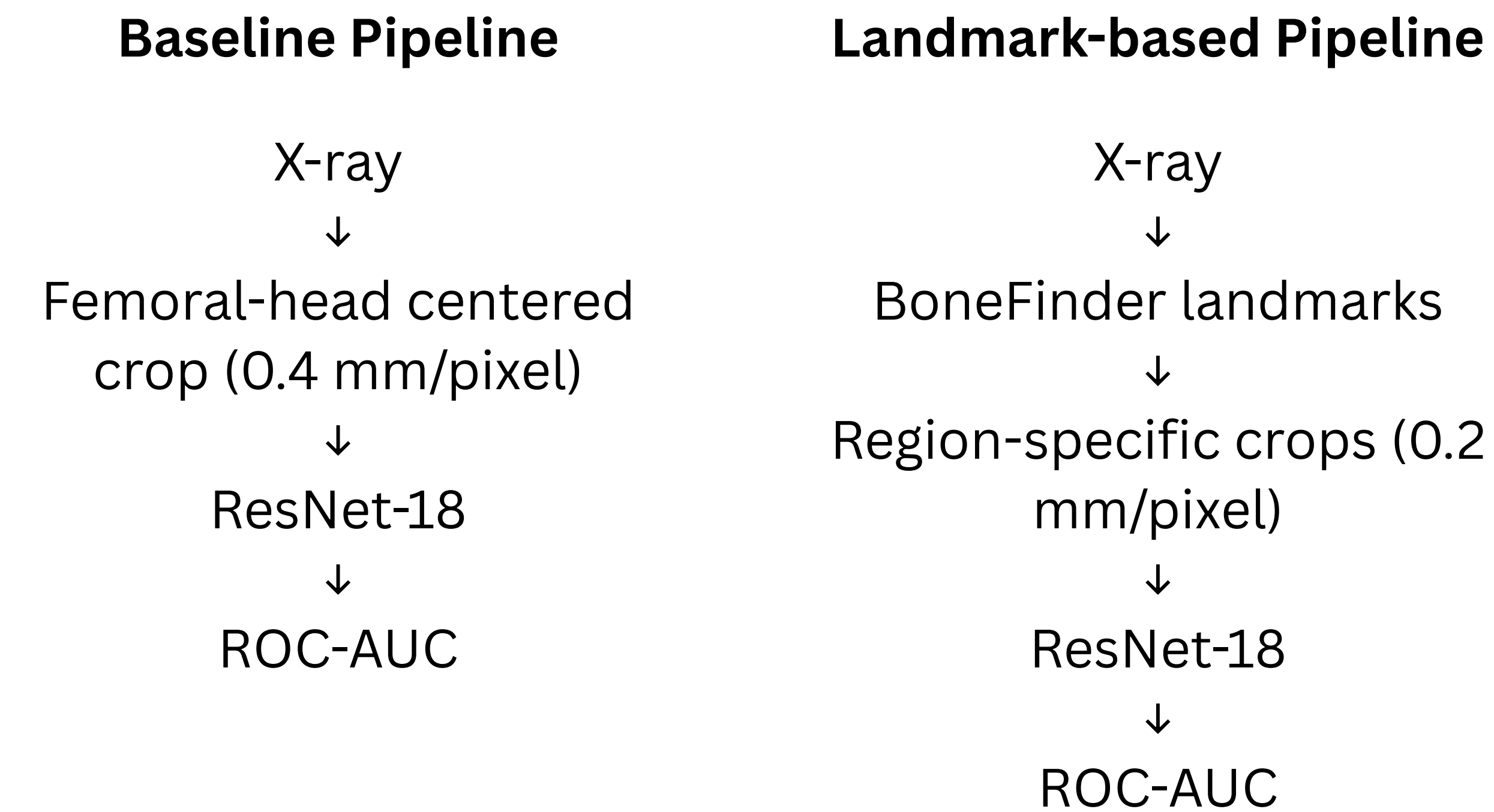
Q2. Which anatomical crop region provides the most useful information for osteophyte classification?

Q3. Does anatomically-guided preprocessing improve data efficiency when training data is limited?

References

- [1] Lindner et al. (2013). Fully automatic segmentation of the proximal femur using random forest regression voting
- [2] von Schacky et al. (2020). Development and validation of a multitask deep learning model for severity grading of hip osteoarthritis features on radiographs.
- [3] Osteoarthritis Initiative (OAI), 2024; Wesseling et al., CHECK Study, 2015.

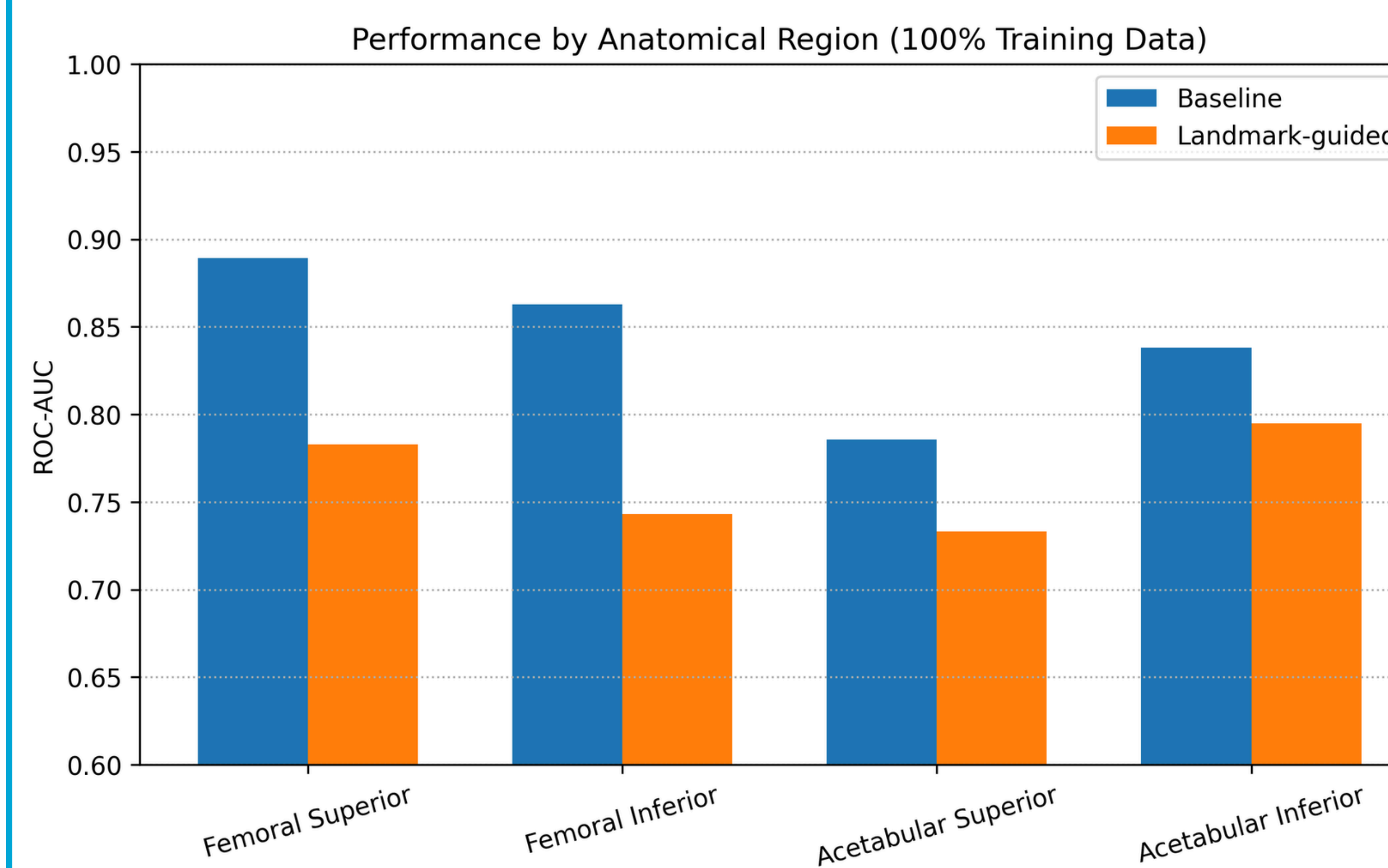
2. Methodology



Dataset

- OAI + CHECK [3]
- ~22,000 hip X-rays
- 70/15/15 split

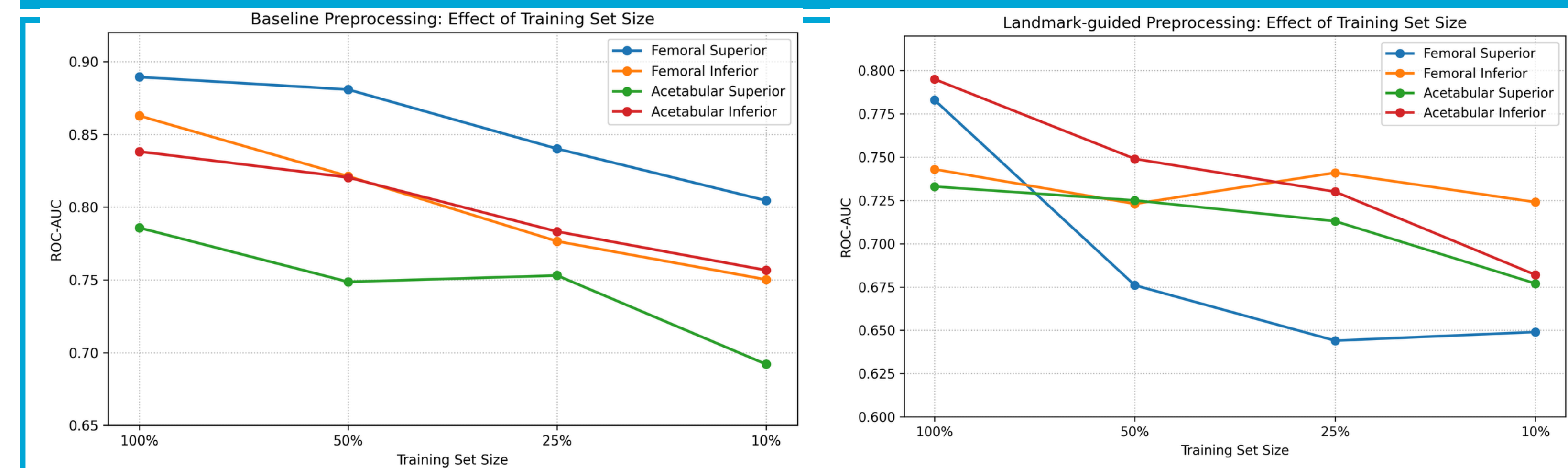
3. Results



Main Findings

- Baseline preprocessing achieved higher ROC-AUC scores in all anatomical regions.
- Best overall performance: Femoral Superior (ROC-AUC = 0.889)
- Best landmark-guided region: Acetabular Inferior (ROC-AUC = 0.795)
- Acetabular superior consistently achieved the lowest ROC-AUC scores.

4. Data Efficiency & Discussion



Experiments were repeated using 50%, 25%, and 10% of the training data. Performance decreased for both preprocessing strategies as the training set size was reduced.

Landmark-guided preprocessing did not provide a consistent advantage under limited training data, although some regions (e.g., femoral inferior) showed relatively stable performance.

Discussion

- Broader crops preserve anatomical context.
- Localized crops may remove informative features.
- Weakly supervised classification appears to benefit from surrounding anatomy.

5. Limitations

- Image-level labels only
- No precise osteophyte annotations
- Single CNN architecture
- Fixed anatomical crop regions

6. Future Work

- Multi-scale crop strategies
- Attention-based localization
- Segmentation-guided supervision
- Additional architectures

7. Conclusion

Broader anatomical context consistently outperformed localized landmark-guided crops.

Anatomically-guided preprocessing did not improve classification performance or data efficiency.

Preserving surrounding hip anatomy appears more beneficial than focusing on small localized regions.