# Utilizing Deep Learning to Automatically Measure Radiographic Parameters for Individuals with Distal Radius Fractures

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INTRODUCTION: Accurate assessment and treatment of distal radius fractures relies, in part, on measurement of radiographic parameters such as radial inclination, volar tilt, and ulnar variance. Traditionally, these measurements require manual identification of anatomic landmarks, which can be time-consuming and subject to interobserver variability. Recent advances in artificial intelligence (AI), particularly deep learning-based segmentation, offer the potential to automate this process by identifying relevant anatomy directly from wrist radiographs. Leveraging such tools could streamline clinical workflows, improve consistency in measurement, and enable large-scale radiographic analyses for research and quality improvement.

METHODS: A convolutional neural network-based segmentation model built using a UNet architecture was developed and trained on radiographs of distal radius fractures. 1,096 patients were included and were split into training, validation, and test datasets using a 70-15-15 split. Segmentations and measurements for radial inclination, volar tilt, and ulnar variance were manually conducted on posteroanterior (PA) and lateral radiographs to compile a database for training the deep learning model and evaluating its accuracy. Following segmentation, an automated pipeline employing contour analysis, skeletonization, and morphological processing was used to extract three radiographic parameters: radial inclination, volar tilt, and ulnar variance.

RESULTS: The segmentation model achieved a dice score of 0.98 for PA radius segmentation, 0.98 for PA ulnar segmentation, and 0.95 for lateral radius segmentation. Automated measurement for radial inclination achieved a mean absolute error (MAE) of 3.35, a median absolute error of 1.91, and a root mean squared error (RMSE) of 5.89. Benchmarks for volar tilt were 8.60, 2.97, and 21.9 and ulnar variance were 2.60, 0.834, and 8.42 for the same metrics, respectively. Excluding outliers (<10 samples) where the initial image segmentation model did not fully capture the necessary anatomical landmarks, leading to inordinate measurements, the automated radial inclination measurement achieved an MAE of 2.75 and RMSE of 4.32, volar tilt measurement achieved MAE of 3.92 and RMSE of 5.6, and ulnar variance measurement achieved MAE of 1.36 and RMSE of 2.53.

DISCUSSION AND CONCLUSION:
This study demonstrates the feasibility of automating the extraction of key radiographic parameters in distal radius fracture assessment using artificial intelligence. A segmentation model was successfully developed to isolate the radius and ulna on wrist radiographs, enabling automated calculation of radial inclination, volar tilt, and ulnar variance. These parameters are essential for evaluating fracture alignment and guiding treatment decisions. The findings support the potential role of AI-based tools in facilitating efficient, standardized radiographic assessment and enabling large-scale research by minimizing the need for manual measurements. Future directions include expanding the system to incorporate additional radiographic features for a more comprehensive evaluation of fracture stability.
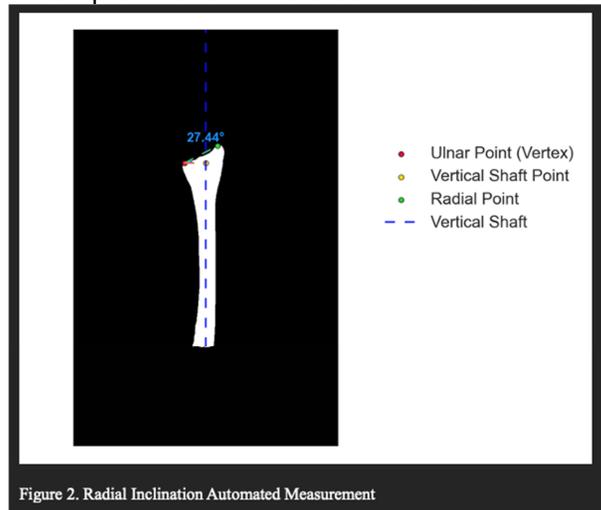


Figure 1. Automated Segmentation Overlayed on Original Image



Figure 2. Radial Inclination Automated Measurement