Background: Artificial intelligence (AI) techniques including deep learning have been rapidly evolving and have yielded appreciable benefits in many fields in recent years. In rheumatoid arthritis, however, these techniques have not been used often.

Objectives: In an early phase of development of an AI-based automatic radiographic evaluation system for bone destruction, we aimed to develop learning-based models to automatically detect hand joint region, ankylosis and subluxation in radiographic images.

Methods: A total of 130 radiographic image sets of both hands were randomly obtained from rheumatoid arthritis patients who had visited our division at Keio University Hospital in 2015. Well-trained rheumatologists determined the boundaries of regions of MP and PIP/IP joint and evaluated the presence of ankylosis and subluxation of each joint in radiographs. These evaluations of hand joints were performed using our developed annotation software tool [1]. In learning phase, joint images were randomly divided into five sets for 5-fold cross validation. As deep learning models, we utilized Single Shot Multibox Detector (SSD) method [2] with ensemble learning for detecting ankylosis and subluxation of MP and PIP/IP joint regions.

Results: Our model showed 100% detection rate of MP and PIP/IP joint regions. As a performance of detecting hand joint ankylosis and subluxation, our model predicted precision values of 0.85 and 0.73, recall values of 0.94 and 0.79, and F-measure values of 0.90 and 0.76, respectively.

Conclusion: Deep learning-based models to automatically detect hand joint region, ankylosis and subluxation in radiographic images were developed with relatively small samples, which suggests that the predictive performance may increase by collecting more training dataset. Next, we are elaborating a plan for a deep learning-based evaluating system for erosion and joint space narrowing.