Multi-view-enabled Deep Learning for Automated Radiographic View Classification and Fracture Detection for Elbow

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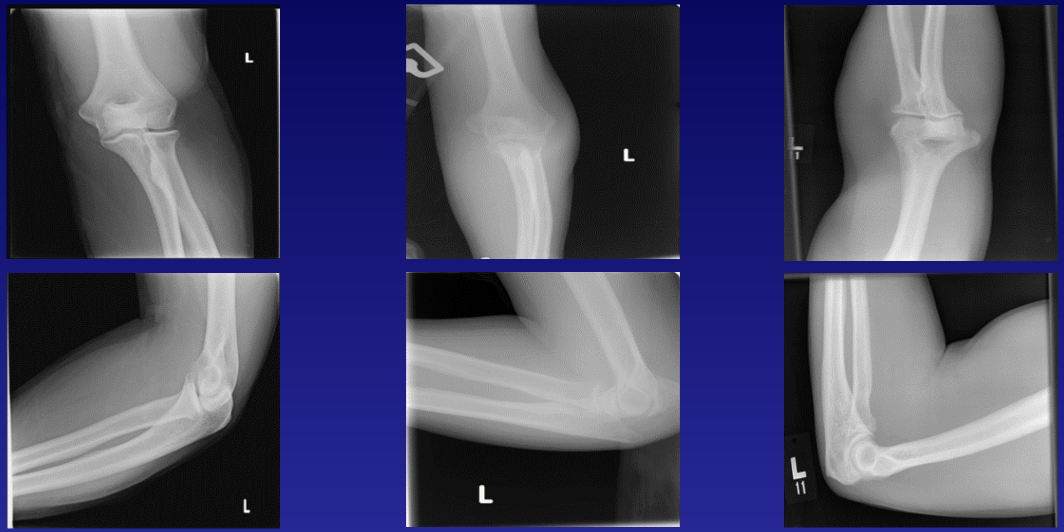
Background

- Elbow fracture is one of the fracture types that happens most frequently among people across all ages
  - Needs timely diagnosis and treatment since it could cause neurovascular damage
  - X-ray helps assessment by visualization
  - Patients often take frontal and lateral view radiographies of elbow
  - View not always labeled accurately



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- Deep learning
  - Thrives in recent years
  - Have potential benefits to reduce treatment lead-time
  - Comparable performance to human experts'

Objective

- Two-step deep learning method
  - Step 1: Develop a deep learning model that can predict view labels (frontal or lateral) given the image.
  - Step 2: Develop a multi-view deep learning method for elbow fracture classification

Method and Materials

- Method
  - View labeling (frontal/lateral)
    - Review the collected images by a board-certified radiologist
    - Correct the labels of mislabeled images
    - Train a CNN deep learning model on a binary classification task (frontal against lateral)
    - Reassign labels to images

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    - Reassign labels to images
  - Multi-view-enabled elbow fracture classification.
    - Pair the frontal and lateral view images of the same patient
    - Feed the pairs into the model for feature extraction with Inception-Resnet-V2
    - Fuse the features for classification of elbow fracture
    - Evaluate the multi-view-enabled model as well as the single view model

Method and Materials

- Materials
  - This is an IRB approved retrospective study
  - 4,740 cases
  - Average patient age: 50.44, standard deviation: 20.42
  - Each with a frontal and a lateral view elbow X-ray image (9,480 in total)
  - 1,598 images (631 frontal and 967 lateral) were mislabeled on the header
  - 682 fractured cases, 4,058 non-fracture (normal) cases
  - 90% data for training, 10% for testing
  - Evaluation metrics: accuracy, AUC

Results

- View labeling
  - 97% accuracy

- Fracture classification
  - Single view model
    - AUC: 0.94
    - Accuracy: 89%
  - multi-view model
    - AUC: 0.96
    - Accuracy: 97%

Discussion

- We developed a two-step method to first assign correct view labels (frontal vs. lateral) to images, and then use both views to detect fractures.

- Our model is highly accurate in automatically categorizing elbow radiographic views and detecting elbow fractures.

- This kind of AI models can be helpful to assist radiologist assess multi-view images and automatically triage elbow radiographs to reduce treatment lead-time.

- Our study is a single-center study and further evaluation of the models are required.

Medical Knowledge-Guided Deep Curriculum Learning for Elbow Fracture Diagnosis from X-Ray Images

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Method

- Scoring of different fracture subtypes
  - Fracture images: 6 subtypes
  - Assign scores from human expert's knowledge

Table 2. Difficultness scoring of the normal cases and six subtype fractures of the elbow (1 – hardest; 100 – easiest).

	(normal)	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*
Score	30	30	30	70	40	90	10

Figure 1. Six Subtypes of elbow fractures: (a) Ulnar fracture; (b) Radial fracture; (c) Humeral fracture; (d) Dislocation; (e) Complex fracture/multi-type fracture; (f) Coronoid process fracture.

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Thank you!

Questions?

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