Classification Of Pediatric Radiographs for Scoliosis Etiology: Congenital, Idiopathic, Or Neurogenic Differentiation Via Artificial Intelligence

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INTRODUCTION:

We sought to develop a classifier for preoperative pediatric spine radiographs capable of differentiating between different scoliosis etiologies including adolescent idiopathic scoliosis (AIS), congenital scoliosis, or scoliosis from cord pathologies such as syrinx, tethered cord, or Chiari malformation. As scoliosis outcomes differ due to the underlying etiology, tools that can reliably and efficiently differentiate radiograph input would serve patients and their healthcare team.

Developing deep learning algorithms to interpret characteristics and curve patterns could create a resource for more accurate diagnoses, referrals, and care and limit unnecessary MRIs or the associated anesthesia in younger children. We hypothesize that the image classifier will have the greatest success in idiopathic and congenital radiographs, with potential challenges identifying cord pathologies.

METHODS:

This study included 1036 pediatric patients at a single institution with a confirmed scoliosis diagnosis and paired AP and Lateral images from the same visit. Patients were manually classified based on the etiology of their scoliosis from visit notes. The categories were AIS, congenital scoliosis, and scoliosis related to cord pathology.

Patient images were then randomized and assigned in an 80:10:10 split for training, validation, and testing. A deep learning classifier using the EfficientNet B4 architecture was trained on paired AP and lateral images. Performance metrics for the model were calculated on the testing set.

RESULTS:

The trained etiology classifier had an F1-Score of 0.97. AIS patients represented the highest number in the cohort (N=824), while cord pathologies represented the lowest number in the cohort (N=45). Model precision in identifying AIS was 0.98, 0.98 for congenital, and 0.82 for cord pathology groups.

Within the test set there were 29 incorrectly labeled images, representing 10 idiopathic, 6 congenital, and 13 cord pathology cases. Performance was higher on the more common classes in the dataset, with lower performance observed in the class with fewer images. Errors in both cord pathology and congenital images were mostly misidentified as AIS (N=12, N=6 respectively) by the model, while AIS was most misidentified as cord pathology (N=7).

DISCUSSION AND CONCLUSION:

A deep learning convolutional neural network classifier was trained to a high degree of accuracy to distinguish between three classes of etiologies for scoliosis on spine radiographs of pediatric patients. Observed performance was higher in the more prevalent categories, suggesting that additional data could improve the performance further. Developing tools to filter radiographs for patients with greater likelihood of underlying scoliosis pathologies has potential for improving diagnoses, referrals, costs, and efficiency of patient care.