# Using deep learning methods to automatically measure the angle of scoliosis. Bridging the gap between theory and clinical application.

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## Introduction

Scoliosis is one of the most common spinal deformations. It is a rich field for technological applications. Automatic assessment of scoliosis angle is being studied for many years. Though deep learning (DL) of neural networks (NN) had shown a lot of promising results, the best method is until now not defined. Convolutional neural networks (CNN) show promising results in medical image analysis such as segmentation.

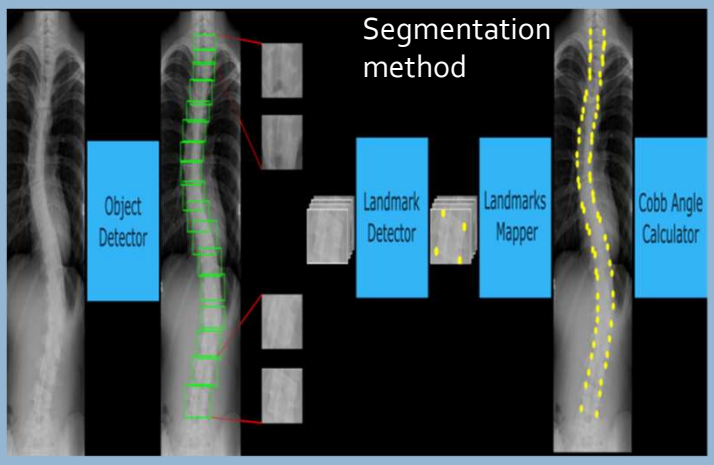
## METHODS

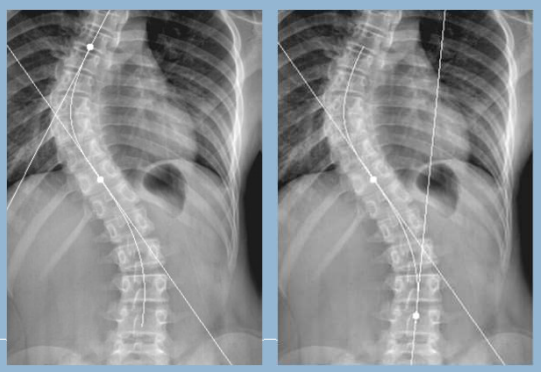
A review of 13 studies that used DL to measure cobb angle automatically was done, with the aim of evaluating their clinical applicability.

## FINDINGS AND DISCUSSION

Reviewed studies have similar broad lines in their approaches for measuring Cobb angle. Use of a certain data set to teach a proposed network, to detect and segment vertebrae, certain vertebral landmarks or the whole spine, and then measure the angle of inclination automatically.

Results were structured to represent certain features of the proposed method and compare them. Those features are (type of NN, measurement principle, number of data set and the results).



Direct method

## AUTOMATIC MEASUREMENT METHODS

1- Segmentation-based methods (use vertebral segmentation for angle calculation).**Draw back:** Accurate segmentation of vertebrae is difficult owing to an unclear vertebral boundary in radiographs.

2- Direct estimation methods ( using certain landmarks without vertebral segmentation). **Draw back:** Small errors in landmarking can cause serious errors in angle measurement.

## TYPE OF NN

All the reviewed studies used networks that were based on CNN with different compositions. The availability of many types of network and the possibility to change their architecture has made the choice of a gold standard method difficult.

## DATA SET

A major drawback in all the studies was its limited number, and also it did not represent all severity ranges of scoliosis equally.

## RESULTS

Direct quantitative comparison of the results was difficult due to differences in the nature of the reported results. Evaluation of such results by mean, for example, which has been seen in most of the studies, cannot be an accurate representative value for all the grades of scoliosis.

## Conclusions:

- ✓ There is a non neglectable gap between the theoretical method and its clinical application.
- ✓ It is important to involve a multidisciplinary team of both technical and medical specialists in all the steps of a study proposing a new method..
- ✓ When evaluating the effectivity of a new method, it is more accurate and clinically significant to represent each grade of scoliosis separately, rather than representing the whole data set by a single value (especially when the training set does not involve all the severity ranges equally). Otherwise, the results will be misleading.
- ✓ Prospective, comparative or case control like type of studies may be more beneficial to the active and successful integration of any new method into clinical practice.

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