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ORIGINAL ARTICLE

Prediction of future curve angle using prior radiographs in previously untreated idiopathic scoliosis: natural history from age 6 to after the end of growth (SOSORT 2022 award winner)

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Abstract

Purpose Treatment selection for idiopathic scoliosis is informed by the risk of curve progression. Previous models predicting curve progression lacked validation, did not include the full growth/severity spectrum or included treated patients.
The objective was to develop and validate models to predict future curve angles using clinical data collected only at, or both at and prior to, an initial specialist consultation in idiopathic scoliosis.

Methods This is an analysis of 2317 patients with idiopathic scoliosis between 6 and 25 years old. Patients were previously untreated and provided at least one prior radiograph prospectively collected at first consult. Radiographs were re-measured blinded to the predicted outcome: the maximum Cobb angle on the last radiograph while untreated. Linear mixed-effect models were used to examine the effect of data from the first available visit (age, sex, maximum Cobb angle, Risser, and curve type) and from other visits while untreated (maximum Cobb angle) and time (from the first available radiograph to prediction) on the Cobb angle outcome. Interactions of the first available angle with time, of time with sex, and time with Risser were also tested.

Results We included 2317 patients (83% of females) with 3255 prior X-rays where 71% had 1, 21.1% had 2, and 7.5% had 3 or more. Mean age was 13.9 ± 2.2yrs and 81% had AIS. Curve types were: 50% double, 26% lumbar/thoracolumbar-lumbar, 16% thoracic, and 8% other. Cobb angle at the first available X-ray was 20 ± 10° (0–80) vs 29 ± 13° (6–122) at the outcome visit separated by 28 ± 22mths.
In the model using data at and prior to the specialist consult, larger values of the following variables predicted larger future curves: *first available Cobb angle, Cobb angle on other previous X-ray, and time* (*with Time^2 and Time^3*) *to the target prediction*. Larger values on the following variables predicted a smaller future Cobb angle: *Risser and age at the first available X-ray, time*Risser and time*female sex interactions.* Cross-validation found a median error of 4.5° with 84% predicted within 10°.
Similarly, the model using only data from the first specialist consult *had a* median error of 5.5° with 80% of cases within 10° and included: *maximum Cobb angle at first specialist consult, Time, Time^2, age, curve type, and both interactions.*

Conclusions The models can help clinicians predict how much curves would progress without treatment at future timepoints of their choice using simple variables. Predictions can inform treatment prescription or show families why no treatment is recommended. The nonlinear effects of time account for the rapid increase in curve angle at the beginning of growth and the slowed progression after maturity. These validated models predicted future Cobb angle with good accuracy in untreated idiopathic scoliosis over the full growth spectrum.

Keywords Scoliosis · Curve progression · Prediction · Natural history · Accuracy

Introduction

Scoliosis is characterised by a three-dimensional structural misalignment of the spine [1]. Scoliosis is defined as idiopathic (IS) after ruling out specific causes and accounts for

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