HKU to Join International Collaborative Research Team and Develop a New Predictive Model for Progression of Adolescent Idiopathic Scoliosis

Press Conference
January 14, 2016
Speakers

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3 yrs
9 yrs
14 yrs
46 yrs
Idiopathic scoliosis

• Female : Male = 4:1
• Age 11-14
• Growth spurt
Prevalence

3.0% > 10°

0.5% > 20°

0.2% > 30°

0.1% > 40°

Willner 1984
Lonstein 1982
Ohtsuka 1988
Incidence in Hong Kong

- Affects around 2 – 3% adolescents (Department of Health, 2012)
- About 400,000 cases screened in School Screening Programme from 1995 to 2000
  - Scoliosis was detected in 10,160 patients
  - 4,412 patients required close observation or bracing
  - 573 required surgery
- In 2015 at DKCH
  - 1,500 new cases were seen
  - 5,000 cases were followed-up for observation, bracing or postoperative
Untreated scoliosis

• Cardiopulmonary compromise
• Back pain
• Truncal imbalance
• Cosmetic problem
Mortality

- Mainly affects infantile & juvenile
- Increased mortality in severe curves (> 70°)

Pehrsson et al. Spine 1992
Cosmesis
Indications for Bracing

• Early diagnosis
• Mild curve (< 30°)
• Skeletally immature
Underarm brace

• Cosmetically more acceptable
Effects of Bracing in Adolescents with Idiopathic Scoliosis

Stuart L. Weinstein, M.D., Lori A. Dolan, Ph.D., James G. Wright, M.D., M.P.H., and Matthew B. Dobbs, M.D.

ABSTRACT

RESULTS
The trial was stopped early owing to the efficacy of bracing. In an analysis that included both the randomized and preference cohorts, the rate of treatment success was 72% after bracing, as compared with 48% after observation (propensity-score–adjusted odds ratio for treatment success, 1.93; 95% confidence interval [CI], 1.08 to 3.46). In the intention-to-treat analysis, the rate of treatment success was 75% among patients randomly assigned to bracing, as compared with 42% among those randomly assigned to observation (odds ratio, 4.11; 95% CI, 1.85 to 9.16). There was a significant positive association between hours of brace wear and rate of treatment success (P<0.001).

CONCLUSIONS
Bracing significantly decreased the progression of high-risk curves to the threshold for surgery in patients with adolescent idiopathic scoliosis. The benefit increased with longer hours of brace wear. (Funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases and others; BRAIST ClinicalTrials.gov number, NCT00448448.)
Indications for surgery

- Late diagnosis
- Severe curves (>45°)
- Imbalance
- Failed brace treatment
17 yo recent curve progression
Postoperative results (7 days)
The use of 3D Spinal parameters to differentiate between progressive and non-progressive AIS curves at the first visit
Introduction

First Visit

• Prediction of scoliosis progression remains challenging in Adolescent Idiopathic Scoliosis

Consequences

• Multiple clinical visits
• Serial radiographs
• Psychological stress
Known Predictive factors for curve progression

- Type of curve
- Age
- Maturity
- Severity of deformity at presentation
Why 3D?
3D reconstructions with EOS system
Why is EOS so different?

• Only method to acquire simultaneous radiographs
• Calibrated environment
  – Possible to know exactly where the patient is in space
• Rapid 3D reconstruction
• 3D parameters calculated specifically for each patient
Risk Factors

Initial Cobb Angle

Type of deformity

Bone age assessment

Predictive model of Cobb angle at skeletal maturity

3D parameters of the spine
The objective of this study was to develop a predictive model of the final deformity in adolescent idiopathic scoliosis based on 3D spine parameters.

Prediction based on patient-specific parameters.

Ultimately, how can we better predict which patients will progress and which will not.
Predictive model - Methods

- Prospective cohort – Single center
- Statistical model
- Outcome: Final deformity at the end of growth
- Complete model:
  - 3D spine parameters as predictors
  - Skeletal maturity
  - Type of curve
  - Initial Cobb angle
Results

- Prospective Cohort
- 194 enrolled
- 158 analyzed \( \rightarrow 81\% \)
- Mean duration of study: 37.4 months
Predictive model

• Predictive model includes:
  – Skeletal maturity system
  – Type of curvature
  – Initial deformity severity
  – Angle of the plane of maximal curvature
  – 3D wedging of two specific disk levels
  – Apical intervertebral rotation

• $R^2 = 0.702$
Plane of Maximal deformity
Apical Vertebral Rotation

$\theta_{AXIAL}$
Peri-apical disk wedging
Risk Factors

Initial Cobb Angle

Type of deformity

Bone age assessment

Predictive model of Cobb angle at skeletal maturity

$R^2 = 0.488$
Risk Factors

Initial Cobb Angle

Type of deformity

Bone age assessment

3D parameters of the spine

Predictive model of Cobb angle at skeletal maturity
Risk Factors

- Initial Cobb Angle
- Type of deformity
- Bone age assessment

Predictive model of Cobb angle at skeletal maturity

$R^2 = 0.702$

3D parameters of the spine
Does it work?

Patient no 1

Model Prediction: 29°

Patient no 2

Model Prediction: 50°
Does it work?

Patient no 1

Model Prediction: 29°

Patient no 2

Model Prediction: 50°
Conclusion

• This study supports the use of 3D reconstructions of the spine in the initial evaluation of AIS to help predict the outcome
Conclusion

• The results of this study could help optimize treatment decision-making at the first visit by identifying patients at high or low risk of progression.

• This could mean better identification of patients at higher risk of progression or patients that would benefit from earlier bracing or even earlier surgery.
Next steps

• Validate the model in a multicenter cohort with 8 international sites
  – Hong Kong (Professor Kenneth Cheung)
  – Singapore
  – Nagoya
  – Paris
  – San Diego
  – Miami
  – Delaware
  – Montreal

• Larger number of patients (≈ 1200 patients)
Acknowledgements

CHU Sainte-Justine Research Center
Mother and Child
University Hospital Center

Université de Montréal

IRSC CIHR
Instituts de recherche en santé du Canada
Canadian Institutes of Health Research

MENTOR

Department of Orthopaedics and Traumatology, The University of Hong Kong
香港大學矯形及創傷外科學系

Fonds de recherche Santé
Québec
X-rays in Scoliosis

• Assessment and follow-up of Scoliosis requires X-rays checks every 6 months
• Accumulation of radiation dosage may have negative effects on children
EOS Imaging System

- Nobel prize winning technology from French physicist Dr George Charpak
- Captures 2 perpendicular X-rays from 2 detectors at the same time
Advantages

- Low dose radiation
  - 65-95% dose reduction compared with normal X-rays
  - 0.1% - 0.2% of CT scan
Advantages

• Only machine that allows 3D reconstructions of the spine without further radiation exposure
• HKU joins this international effort to look for a new predictive model for the progression of adolescent idiopathic scoliosis
Publications in international top-quality peer reviewed journals

Assessment of Scoliosis Correction in Relation to Flexibility Using the Fulcrum Bending Correction Index
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Kuen-Chu M. C. Cheung, FRCS, FHKAM (Orth), D. S. Lu, MD, MPH,
and John C. Y. Leong, OBE, FRCS, FRACS, FRACS, FHKAM (Orth, JP)

Prediction of Scoliosis Correction With Thoracic Segmental Pedicle Screw Constructs Using Fulcrum Bending Radiographs
Wai Yuen Cheung, FRCS, FHKAM,* Lawrence G. Lenke, MD,†
and Keith D. K. Luk, FRCS, FHKAM*

A Prospective Comparison of the Coronal Deformity Correction in Thoracic Scoliosis Using Four Different Instrumentations and the Fulcrum-Bending Radiograph
K. K. Luk, FRCS, FHKAM (Orth), D. S. Lu, MD, PhD, K. M. C. Cheung, FRCS, FHKAM (Orth),
and Y. W. Wong, FRCS, FHKAM (Orth)

Coupling Between Sagittal and Frontal Plane Deformity Correction in Idiopathic Thoracic Scoliosis and Its Relationship With Postoperative Sagittal Alignment
Keith D. K. Luk, MCh Orth, FRCS, FRC Orth, FHKAM(Orth),
Sudha Vasavada, MCh Orth, Dr(Orth), FRC Orth, Shm Sungi, D. S. Lu, MD, PhD,
Y. Y. Wai, FRCS, FHKAM(Orth), W. Y. Cheung, FRCS, FHKAM(Orth),
and Kenneth M. C. Cheung, MD, FRCS, FHKAM(Orth)

Selection of Fusion Levels in Adolescent Idiopathic Scoliosis Using Fulcrum Bending Prediction
A Prospective Study
Keith D. K. Luk, MCh Orth, FRCS, FHKAM, FHK COS, Angus S. Don, FRACS,
Chee S. Chong, MBBS, MS(Orth), Yat W. Wong, FRCS, FHKAM, FHK COS,
and Kenneth M. C. Cheung, FRCS, FHKAM, FHK COS
Clinical Effectiveness of School Screening for Adolescent Idiopathic Scoliosis
A Large Population-Based Retrospective Cohort Study

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Jack C. Y. Cheng, MD,‡ Bobby K. W. Ng, MD,§ T. P. Lam, MD,‡ K. H. Mak, MSc PH,‡
Paul S. F. Yip, PhD,∥ and Daniel Y. T. Fong, PhD†

A Meta-Analysis of the Clinical Effectiveness of School Scoliosis Screening

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Jack Chun Yiu Cheng, MD,‡ Bobby Kin Wah Ng, MD,§ Tsz Ping Lam, MD,‡
Kwok Hang Mak, MSc, PH,¶ Paul Siu Fai Yip, PhD,∥ and Keith Dip Kei Luk, MCh Orth ‡

Costs of School Scoliosis Screening
A Large, Population-Based Study

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Referral Criteria for School Scoliosis Screening
Assessment and Recommendations Based on a Large Longitudinally Followed Cohort

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Paul S. F. Yip, PhD,∥ and Keith D. K. Luk, MCh Orth ‡
Research project in Hong Kong

• Aims to recruit 150 new patients diagnosed with AIS
• Eligible criteria:
  – 10 years old or above
  – No previous spinal disorders
  – Able to participate in follow-up
• Answer questionnaires, and perform X-rays using low dose EOS Imaging System
What we hope to achieve

• Predictive model
  – Doctors can advise the patient and the family the child’s individual risk for curve progression after the first X-rays taken at the first clinic visit
• More accurate information to make decision for bracing and surgery
• Personalised prediction and management
Patients’ Sharing
Q & A Session
Thank you!