CONGENITAL KYPHOSIS AND KYPHOSCOLIOSIS: THE NATURAL HISTORY AND RESULTS AFTER SURGERY

HARWANT SINGH

FPSK (P) 2000 1
DEDICATION

This thesis is dedicated to my parents, to whom I owe everything; and to my wife, who put up with my nuances while I was doing this study.

It is also dedicated to the late Professor N. Subramaniam of the University of Malaya, and the late Professor Q.M. Iqbal of Universiti Kebangsaan Malaysia; who were the pioneers of scoliosis surgery in Malaysia, and who taught me that treating children’s spinal deformities is a life long passion and not just a vocation.

Lastly, but by no means least; this is also dedicated to all the spinal deformity patients who have given me the opportunity to treat them, and who have taught me so much more than any book, conference or meeting; and have given me valuable insight into what spinal deformity is.
Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy.

CONGENITAL KYPHOSIS AND KYPHOSCOLIOSIS: THE NATURAL HISTORY AND RESULTS AFTER SURGERY

By

HARWANT SINGH

October 2000

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Congenital kyphosis and kyphoscoliosis are due to vertebral anomalies that are present at birth. These vertebral anomalies cause a deformity of the spine in the sagittal plane. If allowed to progress, this deformity can produce neural dysfunction due to bowstringing of the cord over the apex of the deformity. The goals of this study were to document the natural history of congenital kyphosis and kyphoscoliosis and to determine the stage at which the natural history should be interrupted by treatment. This was done by reviewing the medical records and radiographs of the spine of 112 consecutive patients. Sixty eight patients had a type-I kyphosis due to anterior failure of vertebral-body formation, twenty-four had a type-II kyphosis due to anterior failure of vertebral-body segmentation, and twelve had a type-III kyphosis due to a combination of anomalies. The deformities of the remaining eight patients could not be classified. The apex of kyphosis was seen at all
levels but was most frequent between the tenth thoracic and the first lumbar level (seventy-four patients; 66%). Progression of the curve was most rapid during the adolescent growth spurt and only stopped at skeletal maturity. Progression was most rapid and the magnitude of the curve was the greatest in the type-III kyphosis (twelve patients) followed by type-I kyphosis due to posterolateral quadrant vertebra (thirty-nine patients), a posterior hemivertebra (eight patients), a butterfly vertebra (fifteen patients), and a wedge vertebra (six patients). A kyphosis due to two adjacent type-I vertebral anomalies progressed more rapidly and produced a more severe deformity than a single similar anomaly. The prognosis for type-II kyphosis was variable and was much more severe when an anterolateral unsegmented bar had produced a kyphoscoliosis (nine patients) than when a midline anterior bar had produced a pure kyphosis (fifteen patients), which usually progressed slowly. Sixty-five patients had surgical treatment. The stability of the sagittal curve at maturity was dependent on vertebral anomaly causing sagittal deformity, type of arthrodesis procedure performed, age of patient at arthrodesis and size of sagittal curve at arthrodesis, however only the first two were statistically significant.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KYPHOSIS DAN KYPHOSCOLIOSIS KONGENITAL: RIWAYAT SEMULAJADI DAN KESIMPULAN SURGERI

Oleh

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Enam puluh lima pesakit telah menjalankan rawatan pembedahan. Stabiliti deformiti pada waktu baligh adalah bergantung kepada jenis anomali vertebra yang menyebabkan deformiti sagital, jenis artrodesis yang dijalankan, umur pesakit pada waktu pembedahan dijalankan dan saiz deformiti pada masa pembedahan; tetapi hanya faktor pertama dan kedua adalah signifikan.
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I certify that an Examination Committee met on 30 October 2000 to conduct the final examination of Harwant Singh on his Doctor of Philosophy thesis entitled “Congenital Kyphosis and Kyphoscoliosis: The Natural History And Results After Surgery” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

Harwant Singh,

Date: 12 November 2000
TABLE OF CONTENTS

DEDICATION ii
ABSTRACT iii
ABSTRAK v
ACKNOWLEDGEMENTS vii
APPROVAL SHEETS ix
DECLARATION FORM xi
LIST OF TABLES xvi
LIST OF FIGURES xvii
GLOSSARY OF TERMS xx

CHAPTER

1 INTRODUCTION

1.1 General 1
1.2 Historical Perspective 3
1.3 Prevalence of Congenital Kyphosis and Kyphoscoliosis and its Significance 5
1.4 Hypothesis and Research Objectives 11
2 LITERATURE REVIEW

2.1 Embryology and Classification of the Vertebral Defect Causing Kyphosis and Kyphoscoliosis 13
2.2 Previous Natural History Studies 17
2.3 Previous Treatment Studies 19
2.4 The Problem of Respiratory Capacity in Severe Spinal Deformity 21
2.5 Neurological Deficit in Congenital Kyphosis and the Relationship of Sagittal Plane Deformity to Neural Structures 25
2.6 Methods of Quantifying Sagittal Plane Deformities and their Inadequacies 30
2.7 Animal Models in Congenital Kyphosis 31
2.8 Other Anomalies Associated with Congenital Kyphosis 32
2.9 Genetics of Congenital Kyphosis 34

3 MATERIALS AND METHODS

3.1 Overview of Methodology 35
3.2 Measuring Technique for Cobb and Modified Cobb Method 38
3.3 The Radius of Curvature Method 39
3.4 Data Recording and Statistical Analysis 42
3.5 Validation of the Methodology 43
## RESULTS

### A: NATURAL HISTORY

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Epidemiology</td>
<td>44</td>
</tr>
<tr>
<td>4.2 Classification of Vertebral Anomalies</td>
<td>47</td>
</tr>
<tr>
<td>4.3 Rib Patterns</td>
<td>51</td>
</tr>
<tr>
<td>4.4 Neurology</td>
<td>53</td>
</tr>
<tr>
<td>4.5 Ventilatory Capacity</td>
<td>57</td>
</tr>
<tr>
<td>4.6 Cardiovascular Abnormalities</td>
<td>59</td>
</tr>
<tr>
<td>4.7 Renal Abnormalities</td>
<td>60</td>
</tr>
<tr>
<td>4.8 Skin and Subcutaneous Stigmata</td>
<td>61</td>
</tr>
<tr>
<td>4.9 Other Vertebral and Axial Skeletal Abnormalities</td>
<td>62</td>
</tr>
<tr>
<td>4.10 Appendicular Skeletal and Other Visceral Abnormalities</td>
<td>64</td>
</tr>
<tr>
<td>4.11 Influence of Family History</td>
<td>66</td>
</tr>
</tbody>
</table>

### B: CURVE CHARACTERISTICS AND PROGRESSION

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.12 Anatomical Description in Relation to Curve Characteristics</td>
<td>67</td>
</tr>
<tr>
<td>4.13 The Apical Qualities in Congenital Kyphosis and Kyphoscoliosis</td>
<td>84</td>
</tr>
<tr>
<td>4.14 Progression of Untreated Curves</td>
<td>87</td>
</tr>
<tr>
<td>4.15 Neurological Deficit During Natural Progression of Curve</td>
<td>117</td>
</tr>
<tr>
<td>4.16 Comparison between Cobb Method and Radius of Curvature Method in Severe Sagittal Plane Deformities</td>
<td>118</td>
</tr>
</tbody>
</table>
C: SURGERY

4.17 Introduction 127
4.18 Types of Surgery Performed and Results 130
4.19 The Effect of Vertebral Type Undergoing Arthrodesis and Stability at Maturity 144
4.20 The Effect of Type of Arthrodesis Procedure and Stability at Maturity 146
4.21 The Effect of Age at Arthrodesis and Stability at Maturity 148
4.22 The Effect of Size at Arthrodesis and Stability at Maturity 150
4.23 The Results of Surgery in Neurologically Compromised Patients 152
4.24 Level of Fusion Performed 154
4.25 Complications of Surgery 154
4.26 Biomechanics of Surgical Procedures 155

5 DISCUSSION

5.1 Natural history 164
5.2 Neurological Symptoms 173
5.3 Intraspinal Anomalies 175
5.4 Surgery for Congenital Kyphosis and Kyphoscoliosis 177

6 CONCLUSIONS AND RECOMMENDATIONS 185

BIBLIOGRAPHY 190
BIODATA OF AUTHOR 226
LIST OF TABLES

Table 1: Data on the untreated patients who had spontaneous neurological deficit 56
Table 2: Respiratory data 58
Table 3: Number of vertebrae in relation to vertebral-body anomaly 63
Table 4: Rate of progression of untreated curves 116
Table 5: Cobb’s angle and radius of curvature in patients with no neurological deficit 123
Table 6: Cobb’s angle and radius of curvature in patients with neurological deficits 124
Table 7: The level of apices and type of vertebral anomaly in patients with neurology 126
Table 8: Immediate correction achieved after surgery in the different types of procedures 143
Table 9: The effect of vertebral type undergoing arthrodesis and stability at maturity 145
Table 10: The effect of type of arthrodesis procedure and stability at maturity 147
Table 11: The effect of age at arthrodesis and stability at maturity 149
Table 12: The effect of curve size at arthrodesis and stability at maturity 151
Table 13: Results of surgery in neurologically compromised patients 153
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kyphosis at thoraco-lumbar level</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Deformity in sagittal and coronal planes of spine, ribs removed to show spinal column</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Deformity in axial plane viewed easily from the back of a patient who is bending forwards</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Sagittal cut through kyphosis specimen and sagittal MRI cut illustrating the apex compressing on anterior spinal cord</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Severe curvature of spine with reduced thoracic space causing restriction in lung expansion</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>Severe spinal deformity causing restriction of lung expansion</td>
<td>23</td>
</tr>
<tr>
<td>7</td>
<td>Crowding of ribs in kyphoscoliosis</td>
<td>24</td>
</tr>
<tr>
<td>8</td>
<td>Sagittal cut through specimen with kyphosis</td>
<td>27</td>
</tr>
<tr>
<td>9</td>
<td>Ribs removed to show sharp angular kyphosis at thoraco-lumbar junction</td>
<td>28</td>
</tr>
<tr>
<td>10</td>
<td>Schematic diagram of hemivertebra at apex</td>
<td>29</td>
</tr>
<tr>
<td>11</td>
<td>The kyphosis template, and points of reference for template</td>
<td>40</td>
</tr>
<tr>
<td>12</td>
<td>The template used on the reference points on the radiograph</td>
<td>41</td>
</tr>
<tr>
<td>13</td>
<td>Schematic outline of study design</td>
<td>46</td>
</tr>
<tr>
<td>14</td>
<td>TYPE I: Anterior failure of vertebral-body formation</td>
<td>48</td>
</tr>
<tr>
<td>15</td>
<td>TYPE II: Anterior failure of vertebral-body segmentation</td>
<td>49</td>
</tr>
<tr>
<td>16</td>
<td>TYPE III: Mixed</td>
<td>50</td>
</tr>
<tr>
<td>17</td>
<td>Rib patterns</td>
<td>52</td>
</tr>
<tr>
<td>18</td>
<td>Histogram showing level of apex and number of patients who had spontaneous neurological deficit</td>
<td>55</td>
</tr>
<tr>
<td>19</td>
<td>TYPE I posterolateral quadrant hemivertebra causing kyphoscoliosis</td>
<td>70</td>
</tr>
<tr>
<td>20</td>
<td>TYPE I: Butterfly (Sagittal cleft) vertebra</td>
<td>73</td>
</tr>
<tr>
<td>21</td>
<td>TYPE I: Anterolateral wedged vertebra causing kyphoscoliosis</td>
<td>75</td>
</tr>
<tr>
<td>22</td>
<td>TYPE II: Anterior failure of segmentation with kyphosis</td>
<td>77</td>
</tr>
</tbody>
</table>
Figure 23: TYPE II: Anterior failure of segmentation. The relationship between disc space and severity of deformity 78
Figure 24: TYPE III: Mixed type 81
Figure 25: Graph showing the different types of vertebral defects, their apical location, as well as the number of vertebral levels 83
Figure 26: Cord compresion in congenital kyphosis and its relationship to the radius of curvature 86
Figure 27: TYPE I: Posterolateral quadrant hemivertebra with myelogram showing compression in anterior cord by apex 89
Figure 28: TYPE I: Posterolateral quadrant hemivertebra with myelogram showing high compression and paraparesis 90
Figure 29: TYPE I: Posterolateral quadrant hemivertebra causing kyphoscoliosis. Incarcerated hemivertebra. 91
Figure 30: TYPE I: Sagittal cleft (Butterfly) vertebra 96
Figure 31: TYPE I: Sagittal cleft (Butterfly) vertebra 97
Figure 32: TYPE I: Sagittal cleft (Butterfly) vertebra 98
Figure 33: TYPE I: Wedge Vertebra 100
Figure 34: TYPE I: Wedge Vertebra 101
Figure 35: TYPE I: Wedge Vertebra 102
Figure 36: TYPE II: Anterior failure of segmentation 105
Figure 37: TYPE II: Anterior failure of segmentation 106
Figure 38: TYPE II: Anterior failure of segmentation 107
Figure 39: TYPE II: Anterolateral failure of segmentation with kyphoscoliosis 109
Figure 40: TYPE III 111
Figure 41: TYPE III. Vertebral body defect 112
Figure 42: Unclassified 114
Figure 43: Unclassified 115
Figure 44: MRI of kyphosis showing possible vertebral anomaly 122
Figure 45: Relationship of sagittal vertebral anomalies and radius of curvature 125
Figure 46: TYPE I: Posterior hemivertebra causing kyphosis 136
Figure 47: TYPE III: Progression of curve 141
Figure 48: TYPE III: Progression of curve 142
Figure 49: Sagittal weight bearing axis of spine and the forces that act to maintain equilibrium of the spinal column 158
Figure 50: Congenital vertebral anomalies and the direction of vertebral growth causing kyphosis 159
Figure 51: Relationship of moments acting on grafts in front of the spinal column 160
Figure 52: Relationship of levels of posterior fusions and the moments acting on the apex 161
Figure 53: Relationship of curve severity to moments acting on the apex 162
Figure 54: Summary of key biomechanical factors in kyphosis correction 163
Figure 55: The relationship between various vertebral anomalies and the radius of curvature 189
GLOSSARY

ABBREVIATIONS

MRI – Magnetic Resonance Imaging
FVC – Forced Vital Capacity
FEV1 – Forced Expiration in 1 second
CT – Computerized Axial Tomogram

BIOMECHANICS

Bending – Angular deformation of a structure, caused by a bending moment.

Bending Moment – The moment that tends to bend a structure. It is usually the sum of the moments due to several forces.

Centre of Gravity – The point in a body in which the body mass is centred.

Compression Force – A force that tends to shorten a structure or material.

Compressive Stress – A normal stress that tends to shorten material.

Force – An action that causes a body to displace or deform (Newtons – N).

Moment – The sum of the forces applied to a structure multiplied by their perpendicular distance from a reference point or axis (Newton meters – Nm).

Tension Force – A force that tends to elongate a structure or material.

Tensile Stress – A normal stress that tends to elongate material.

Viscoelasticity – Material behaviour in which the resistance to deformation depends on the amount of deformation (elastic) and the rate of deformation (viscous).
CLINICAL

Apical disc – The disc most deviated from the vertical axis of the patient.

Apical vertebra – The vertebra most deviated in the vertical axis of the patient.

Congenital scoliosis – Scoliosis due to congenitally anomalous vertebral development.

End vertebra – The most cephalad vertebra of a curve, whose superior surface or transverse axis, and the most caudal vertebra, whose inferior surface of transverse axis, tilts maximally towards the concavity of the curve.

Iliac apophysis – The apophysis along the crest of the ilium.

Kyphosis – A posterior convex angulation of the spine.

Kyphoscoliosis – A non idiopathic scoliosis associated with an area of hyperkyphosis.

Neuromuscular scoliosis – A scoliosis due to either a muscular or neurologic disorder.

Risser sign – In the frontal plane of the pelvis, the state of ossification of the iliac apophysis is used to denote the degree of skeletal maturity.

Sagittal balance – Alignment of C7 to the posterior superior aspect of the sacrum on an upright long cassette radiograph of the spine.

Scoliosis – A lateral curvature of the spine.

Skeletal age – The age obtained by comparing PA radiographs of the left wrist and hand with standards of the Gruelich and Pyle atlas.

Vertebral tilt – Angulation in the coronal plane, measured from the lower endplate to the horizontal.
CHAPTER 1

INTRODUCTION

1.1 General

*Congenital Kyphosis*, by definition, is an anatomical vertebral anomaly which is present at birth. This anatomical vertebral anomaly forms in utero and may manifest at birth, or soon after birth. There may be other congenital abnormalities associated with it. The early occurrence of the curve results in a potentially progressive curve, as the child will have progression during the physiological growth spurts.

These curves are usually rigid, resistant to correction by external bracing; and require surgery usually to arrest their progression. If the early curves are missed at birth or in early life, severe curves develop (Figure 1). It is more difficult to treat a severe rigid curve, than a minor curve. Therefore a proper and thorough understanding of the natural history of these curves is essential, to decide the appropriate time of treatment.
Figure 1: Kyphosis at the thoraco-lumbar level.
1.2 Historical Perspective

Spinal problems have been recognised in written history as far as 4500 years ago (Hughes 1988). Kyphosis, as a distinct pathological condition of the spine had been described by Hippocrates (Adams 1849, 1888), more than 2000 years ago; and surgical intervention as treatment for spinal disorders had been prescribed in early Indian surgical texts (Cumston 1926) approximately 1500 years ago. Although the clinical condition of kyphosis was recognised since early times, these descriptions could not determine the cause of the deformities. The anatomical works De Dissectione Partium Corporis Humani of Charles Estienne in 1539 and De Humani Corporis Fabrica Libri Jeptum by Andreas Versalius in 1543 contain the first modern and accurate anatomical descriptions of the human spine (Ball 1928). These works were the beginnings of serious study. However, there was no distinction between infective and non-infective causes of the kyphosis deformity of the spine.

The first description of congenital kyphosis as a separate entity causing spinal kyphosis was in German by Von Rokitansky in 1844. MacEwen first reported the association of untreated spinal deformity and neurological deficit in 1888. The development of radiography in 1895 enabled spinal deformities to be