Three Dimensional Correction of Scoliosis

Thesis
Submitted For Partial fulfillment of M.D. Degree in
Orthopedic Surgery

Presented by Tamer Ibrahim Sherief

Under Supervision of:

Prof. Dr. Ahmad Zaki EL-Sobky

Head of Orthopedic Department Ain Shams University

Prof. Dr. Mamdouh Zaki Saad

Professor of Orthopedic Department Ain Shams University

Prof. Dr. Sherif Fathi Abd El-Hamid

Ass. Prof. of Orthopedic Surgery Ain Shams University

Prof. Dr. Tarek Mohammad Samy

Ass. Prof. of Orthopedic Surgery Ain Shams University

1999



malle lleadile

Acknowledgement

I wish to express my deepest gratitude to my supervisors in this thesis: Prof. Dr. Ahmad El Sobky, Head of Orthopedic Department, Ain Shams University, Prof. Dr. Mandouh Zaki, Professor of Orthopedic Surgery, Ain Shams University, Prof. Dr. Sherif Fathy, Ass. Professor of Orthopedic Surgery, Ain Shams University, Prof. Dr. Tarek Samy, Ass. Professor of Orthopedic Surgery, Ain Shams University for their continuous encouragement and help throughout this work, and for their invaluable guidance to make this work appear in its final picture.

I would also like to sincerely thank all my professors and colleagues, in our department who saved no effort to support me

all the way through.

T.SHERIEF



Index

List of Contents

Introduction	
Aim of the work	4
Review of literature:	
Glossary of scoliosis terms	5
 Anatomy and clinical biomechanics 	9
 Classification of scoliosis 	33
 Etiologic theories of idiopathic scoliosis 	41
 Pathologic changes in idiopathic scoliosis 	45
Spinal growth	49
 Natural history of idiopathic scoliosis 	57
 Clinical and radiologic approach to scoliosis patient 	67
 Decision making in scoliosis treatment 	97
 Biology and techniques of spinal fusion 	122
Posterior derotation systems	129
 Intraoperative spinal cord monitoring 	133
Material and methods	138
Results	233
Complications	255
Discussion	258
Summary and conclusions	268
Case presentation	
References	

Index II

List of Figures

	Fig.1	The normal sagittal profile of the spine	10
	Fig.2	The central co-ordinate system	15
	Fig.3	Vertebral deformity in scoliosis	18
î	Fig.4	Pathomechanics of structural scoliosis	20
	Fig.5	The vertebral transverse plane geometry	21
	Fig.6	The effect of transverse plane geometry on vertebral rotation	21
	Fig.7	Creep in scoliosis	24
	Fig.8	Axial load study on a spinal model	25
	Fig.9	Transverse load study on a spinal model	26
	Fig.10	Combined load study on a spinal model	26
	Fig.11	Load-deformation curve	27
	Fig.12	Inflection point	28
	Fig.13	Growth charts for boys and girls	49
	Fig.14	Sitting height	50
	Fig.15	Vertebral growth centers	52
	Fig.16	Duval-Beaupere's curve	53
	Fig.17	Peak growth velocity correlated to development parameters	54
	Fig.18	Curve progression correlated to age	59
	Fig.19	Curve progression correlated to Risser sign	60
	Fig.20	Curve progression correlated to curve magnitude	61
	Fig.21	The bell curve for predicting the risk of curve progression	64
	Fig.22	Tanner stages	70
	Fig.23	Clinical examination	72-3
	Fig.24	Radiographic evaluation	75
	Fig.25	Stagnara view	77
	Fig.26	King-Moe curve patterns	82-3
	Fig.27	Cobb and Ferguson method	86
	Fig.28	Methods of measurement of vertebral rotation	88-9
	Fig.29	Mehta's staging of infantile idiopathic scoliosis & RVAD	90
	Fig.30	Risser grades	92
	Fig.31	The stable zone of Harrington	105
	Fig.32	The central sacral line and the stable vertebra	106

Index III

Fig.33	Moe's method of facet joint fusion	124
Fig.34	Hall's method of facet joint fusion	125
Fig.35	Lumbar flat back syndrome	130
Fig.36	Effect of distraction across the thoracolumbar junction	132
Fig.37	Sex distribution	147
Fig.38	Age distribution	148
Fig.39	Patient's complaints	150
Fig.40	Menarchal state in female patients	151
Fig.41	Curve patterns	156
Fig.42	Risser grade distribution among patients	169
Fig.43	Patient's positioning for anterior release	175
Fig.44	Transthoracic approach	178
Fig.45	Thoracotomy approach (photos)	178-9
Fig.46	Technique of anterior spinal release	179
Fig.47	Transthoracic retroperitoneal approach	181-2
Fig.48	Patient positioning for the posterior procedure	184
Fig.49	Surgical exposure for the posterior procedure	185
Fig.50	Facet joint fusion	186
Fig.51	Decortication of the posterior elements and bone grafting	187
Fig.52	Steps of the posterior procedure (photos)	188-9
Fig.53	Thoracoplasty and prominent parts of the ribs	190
Fig.54	Posts	192
Fig.55	Screws	193
Fig.56	Hooks	195
Fig.57	Wires	196
Fig.58	Longitudinal members	197
Fig.59	Slotted connectors	199
Fig.60	Transverse connectors	200
Fig.61	Tandem connectors	200
Fig.62	Accessories	201
Fig.63	Instrument set	202
Fig.64	Instrument set (cont.)	203
Fig.65	Instrument set (cont.)	204
Fig.66	Instrument set (cont.)	205

Index IV

Fig.67	Pedicle screws (application)	206
Fig.68	Hooks (application)	207
Fig.69	Sublaminar wires (application)	208
Fig.70	Rod length measurement	209
Fig.71	Rod contouring and bending	209
Fig.72	Transverse connectors (application)	209
Fig.73	Instrumentation of King I and II curve patterns	210-5
Fig.74	Instrumentation of double major curve pattern	216-21
Fig.75	Instrumentation of King V curve pattern	222-4
Fig.76	Instrumentation of TL/L curve pattern	225-7
Fig.77	Pain compared to preoperative	234
Fig.78	Cosmetic satisfaction	235
Fig.79	Coronal plane evaluation (clinical)	237
Fig.80	Sagittal plane compared to preoperative	238
Fig.81	Average percentage of correction of thoracic prominences	239
Fig.82	Correction of lumbar prominences	240
Fig.83	Rotational prominences average values	241
Fig.84	Average correction for thoracic & lumbar curves	243
Fig.85	Postoperative correction for instrumented curves	245
Fig.86	Final followup correction for instrumented curves	245
Fig.87	Average values for sagittal Cobb's angles	253
Fig.88	Changes in rotation in various curve types	254
Fig.89	Case No.2	274-7
Fig.90	Case No.3	280-4
Fig.91	Case No.7	287-91
_	Case No.8	294-7
Fig.93	Case No.9	299-301
Fig.94	Case No.13	305-7
Fig.95	Case No.17	310-2
Fig.96	Case No.24	315-8
Fig.97	Case No.26	320-2
Fig.98	Case No.29	325-7

Index

List of Tables

Table 1	Growth velocity	51
Table 2	Prevalence of idiopathic scoliosis	57
Table 3	Incidence of progression in different studies	58
Table 4	Relationship between incidence of progression, age	62
	and curve magnitude	
Table 5	Relationship between incidence of progression,	62
	magnitude of the curve and Risser sign	
Table 6	Tanner's stages	69
Table 7	Average values for Lenke's ratios in King I and II patterns	85
Table 8	Pseudarthrosis rate with different techniques	127
Table 9	Age groups	148
Table10	Menarchal state in female patients	150
Table11	Tanner stages for female patients	151
Table12	Tanner stages for male patients	152
Table13	Rotational prominences	154
Table14	Strategic vertebrae	157
Table15	Curve magnitudes in King I and II curve patterns	158
Table16	Average Cobb's angle for curve types	159
Table17	Average AVT for curve types	160
Table18	Average AVT values for King I and II curve patterns	160
Table19	Flexibility of double major curves	162
Table20	Flexibility of King II curves	163
Table21	Flexibility of King III curves	163
Table22	Flexibility of King V curves	164
Table23	Flexibility of TL/L curves	164
Table24	The average percentage of flexibility and residual	164
	angle for various curve patterns	
Table25	The average percentage of flexibility and residual	165
	angle for thoracic and lumbar curves	
Table26	Average FI for King I and II (without and without	166
	applying Lenke's criteria)	
Table27	Preoperative lateral Cobb's angle	166

Index VI

Table28	Sagittal contour description	167
Table29	Average AVR for various curve types	168
Table30	Average AVR values for King I and II curve patterns	168
Table31	Risser grade distribution	169
Table32	Pain at final followup compared to preoperative	233
Table33	Cosmetic satisfaction compared to preoperative	235
Table34	Average values for rotational prominences	240
Table35	Correction of thoracic and lumbar curves	242
Table36	Average correction for double major curve pattern	246
Table37	Average correction for King II curve pattern	247
Table38	Average correction for King III curve pattern	248
Table39	Average correction for King V curve pattern	248
Table40	Average correction for TL/L curve pattern	248
Table41	Relation between curve correction and preoperative	249
	curve flexibility	
Table42	Relation between curve correction and the procedure	249
	of anterior release	
Table43	Normal and abnormal sagittal Cobb's angle values	252
Table44	Changes in rotation in various curve types	254

Introduction