Index

A
Adolescent idiopathic scoliosis (AIS), 10, 299
Anterior hemivertebra excision, 153, 162
Anterior release and posterior spinal instrumentation and fusion (APSIF), 291
Anterior vertebral body tethering (AVBT)
adquate single-lung ventilation, 127
anterior spinal growth modulation, 129
clinical course and outcome, 126, 127
diagnostic studies, 118
fusionless treatment methods, 128
Heuter-Volkmann principle, 128
history and physical examination, 117–118
intraoperative fluoroscopy, 127
irreversible growth cartilage or disc injury, 129
management options, 118–121
patient selection, 127
preoperative flexibility, 127
progressive adolescent idiopathic scoliosis, 127
rib head localization, 127
scoliosis porcine model, 129
screw trajectory, 127
segmental vessels, 127
skeletal maturity, 130
spine deformity, 129
surgical procedure
bronchial blocker, 121
chest tube placement, 125
with double-lumen intubation, 121
implant, 125
patient position, 121
pleura, 122
portal placement, 122, 123
retroperitoneal dissection, 123
standard fluoroscopy, 121
tension, 124
3D navigation, 121
vertebral staple insertion, 124
vertebral tap, 124
vs. VBS, 131
Apical derotation, 78
Apical fusion levels, 76–77
Apical segments, 76
Autofusion, 44, 69, 309, 315, 318
AVBT, see Anterior vertebral body tethering (AVBT)

B
Beal’s syndrome, 1

C
Cardiopulmonary function, 186
Center for Thoracic Insufficiency (CTIS), 169
C-EOS, see Classification of early-onset scoliosis (C-EOS)
Cerebral palsy
contracture and stiffness, 212
distraction procedures, 215
dual growing rods, 218
growing rod constructs, 217
growing rod distraction, 214
growing rod insertion, 213
halo-gravity traction, 212, 213
history and physical examination, 211
intraoperative neural monitoring, 217
lengthening procedures, 217
pelvic fixation, 217
pelvic obliquity, 215, 217
radiographic evaluation, 212
surgical procedure, 216
thoracolumbar curve, 212
treatment, 215
Chiari malformation, 308, 310
Chiari-associated scoliosis, 264
Classification of early-onset scoliosis (C-EOS), 265
age, 9–11
annual progression ratio, 11, 12
clubfoot deformity, 12
complications, 14
etiology, 9–11
history, 9
interobserver and intraobserver reliability, 12
multiple curve factors, 12
with nemaline myopathy, 12, 13
optimal care and prognosticate outcomes, 12
utility and validity, 12
Clubfoot deformity, 12
Complications, 253–259, 262, 267
axial plane deformity, 266
casting, 263
classification system, 263
clinical course and outcome, 259–261
clinical deformity, 247
diagnostic studies, 247–249, 265
with dual submuscular growing rods, 266
guided growth vs. distraction-based techniques, 265
idiopathic infantile scoliosis, 262
infection, 267
left trunk shift and thoracic prominence, 245
lengthening, 247
management, 249–253
postoperative radiographs, 247
proximal anchor failure, 264
psychological effects, 264
pulmonary function tests, 249
rib anchors vs. spine anchors, 265
risk of, 263
rod fracture, 262, 266
single concave VEPTR device, 245
stable proximal fixation, 262
surgical procedure
anterior release, 253–256
final fusion, 258, 259, 262, 267
growing rod distractions, 256–258

growing rod insertion with apical control, 253–256

halo-gravity traction application, 253, 262

rod revisions, 256–258

wound dehiscence, 247

Concave distraction, 188, 189, 191, 193

Congenital scoliosis definitive fusion, 188

with fused ribs, 170

bracing, 180

casting, 180

classification system, 178

convex hemiepiphysiodesis, 180

curve progression, 170, 179, 180

derotational casting, 180
developmental anomalies, 178

developmental disturbances, 179

evaluation, 169

fusionless growing constructs, 180

hemivertebra excision, 180

hemivertebrae and block vertebra, 171

management, 169

medical history, 167

MRI evaluation, spine, 179

opening thoracostomy, 180

radiographic evaluation, 168, 169

respiratory illnesses, 168

spinal deformity, 167

surgical intervention, 180

VEPTR insertion (see Vertical expandable prosthetic titanium rib (VEPTR))

vertebral formation, 178

wedge resection, 180

hemiepiphysiodesis, 183–195

posteroanterior radiograph, 185

Convex growth arrest (CGA), 188, 191–193

Corrective maneuvers, 77–79

Craniosynostosis, 307

D

Definitive fusion, 39–41, 313

Deformity correction, 77

DePuy Synthes, 112

Developmental delay, 211, 307

Distraction phase, 278, 280, 281

Double windlass mechanism spring traction system, 253

E

Early-onset deformity, 236

Elongation-derotation-(lateral) flexion casting (EDF)

clinical course and outcome, 28–30

diagnostic studies, 18, 19

history and physical assessment, 17

management, 19

progressive infantile scoliosis, 32

surgical procedure anesthesia, 20

application, 23

layer of Webril, 22

pelvic control, 21

preoperative preparation, 20

scoliosis, correction of, 23, 24

trimming, 24–28

External remote control (ERC), 92, 93
Index

F
Facetectomies, 38, 65, 293, 312
Femoral countertraction, 296
Flexibility films, 76
Flexible thoracolumbar kyphosis, 88
Forced vital capacity (FVC), 284
Fusionless treatment methods, 128

g
Gibbus deformity, 222–225, 227
Graduation phase, 278
Gross Motor Function
   Classification System (GMFCS), 211
Growth-friendly treatment
   advanced imaging studies, 319
   autofusion, 309, 313, 315, 318
   Chiari malformation, 308, 310
   clinical course and outcome, 314, 315
   history, 307
   lengthenings, 308
   lumbar hyperkyphosis, 308
   management, 308–309
   physical examination, 308
   posterior spinal fusion, 316–318
   preoperative advanced imaging, 315
   residual deformity, 315, 317–319
   rib-based anchors and pelvic anchors, 317
   skeletal maturity, 319
   spine-based distraction, 308
   surgical procedure, 310–314
   thoracic hypokyphosis, 308
   three-dimensional modeling, 319

dose recommendation, 298
efficacy, 298–299
perioperative, 296
technique and protocols, 297–298
Harrington rod placement technique, 98
Hemiepiphysiodesis, 153, 183–195
Hemivertebra excision
   anterior and posterior, 153
   brace treatment, 149, 152
deformity correction, 161
diagnosis, 151
epidural bleeding, 159
fixation, 155, 156
focal kyphosis, 150
hemivertebra cancellous bone, 159
laminar excision, 158
management, 152, 153
pedicle screw position, 156, 157
physical examination, 149
posterior-only approach, 153
radiographs, 164
skin incision, 154
stages, 157
supine bending x-rays, 152
transverse process, 159
Hemivertebrectomy, 188
Hemostasis, 312
Heuter-Volkmann principle, 128
Hybrid growing rod construct
   autofusion, 69
   clinical course and outcome, 67
   definitive fusion, 68
diagnostic studies, 61
distraction-based spinal
growth constructs, 68
EDF casting, 67
history and physical examination, 59–61
intraoperative positioning, 67
magnetically lengthening rods, 67

H
Halo-gravity traction (HGT)
   application, 253
Idiopathic early-onset scoliosis
anterior vertebral body stapling
  anterior procedure, 142
developmental history, 136
diagnostic studies, 137
fluoroscopy, 138
general anesthesia, 137
growth modulation treatment, 137
growth modulation with VBS, 135
intensive care unit, 139
intercostal blocks, 139
management, 137
MRI, 137
natural history, 143
neuromonitoring, 137
nighttime bracing, 143
physical examination, 136
posteroanterior and lateral radiographs, 136
preoperative measurement, 143
surgical procedure, 137–139
treatment, 143
bending radiographs, 36
bilateral rods, 43
clinical course and outcome, 41, 42
complication rates, 41
definition, 68
delaying TGR/MCGR, 41
with hybrid growing rod construct
autofusion, 69
clinical course and outcome, 67
definitive fusion, 68
diagnostic studies, 61
distraction-based spinal growth constructs, 68
EDF casting, 67
history and physical examination, 59–61
intraoperative positioning, 67
magnetically lengthening rods, 67
management, 61–64
MCGR, 69
proximal rib hook anchors, 67, 69
rib hooks, 68
rib-based proximal anchors, 68
sagittal profile, 67
surgical procedure, 64–66
lengthening, 43
management, 36
medical history, 35
nonoperative management, 41
physical examination, 36
PJK, 44
plain radiographs, 36, 37
surgical procedure
  definitive fusion, 39–41
growing rod distraction, 38
intraoperative neuromonitoring, 36
postoperative PA and lateral standing radiographs, 38, 39
TGR fixation, 41
TGR instrumentation, 43
treatment options, 41, 68
two-incision technique, 43
Implantation phase, 276, 282
Infantile idiopathic scoliosis (IIS), 53–56
Instrumented spinal height gain, 114
Intraoperative skull-femoral traction (IOT), 296, 299, 300

K
Kyphoscoliosis, 231–233, 236, 241, 242
Kyphotic deformity, 153, 226

L
Low conus medullaris, 187
Lumbar hyperkyphosis, 308, 309

M
Magnetically controlled growing rods (MCGR), 43, 69, 90–94, 236
clinical course and outcome, 94–96
cost, 99
deformity control, 99
diagnostic studies, 88, 89
with growth-friendly spinal instrumentation, 88
Harrington rod placement technique, 98
history, 87
implantation, 207
multiple treatment strategies, 98
physical examination, 88
surgical management, 88–89
surgical procedure
Dimeglio’s work, 93
external remote control, 92, 93
fusion masses and instrumentation, 90
gentle distraction, 90
lengthening, 93
patient position, 90
pre- and post-lengthening, 93, 94
pre- and postoperative images, 90, 91
rod selection, 90
set screws placement, 90
subfascial tunnels, 90
vs. TGR, 99
Magnetically lengthening rods, 67
Microcephaly, 307
Modern Luque trolley
clinical course and outcome, 108, 109
complications, 110
curve progression, 110
description, 110
flexible curves and apical translation, 109
flexible left thoracolumbar curve, 104, 106
history and physical examination, 103–104
with hypotonic collapsing spinal deformities, 109
long-term clinical follow-up, 114
management, 104–105
meticulous preoperative planning and execution, 110
with new apical gliding spinal implant—trolley gliding vehicle, 114, 115
off-label modern spinal implants, 112
patient selection, 109
post technique, 108
progressive collapsing kyphoscoliotic deformity, 104, 105
surgical procedure, 106–108
trolley gliding vehicle, 112
Modern spinal implants, 111
Index

Myelomeningocele
  bracing, 226
  clinical course and outcome, 224
  diagnostic studies, 222–223
  fixation points, 226
  gibbus deformity, 222, 227
  history and physical examination, 221–222
  kyphotic deformity, 226
  low-profile fixation, 227
  management, 223
  nonambulatory patients, 227
  pelvic S-hooks, 226, 227
  preoperative assessment of comorbidities, 224
  shunt malfunction, 226
  spinal deformities, 226
  surgical procedure, 223–224
  wheelchair modifications, 226

N
Nemaline myopathy
  aggressive pain control, 206
  bilateral pelvis-to-rib growing rod construct, 200–203
  cardiac and pulmonary involvement, 205
  clinical severity, 197
  collapsing parasol effect, 200
  complications, 208
  diffuse hypotonia, 198
  dysarthric, 198
  Eiffel Tower construct, 207
  fusionless model, 206
  growing rod construct, 200
  growing rod distraction, 203
  growing rod insertion, 200
  incidence, 205
  instrumentation technique, 207
  intraoperative neuromonitoring, 204
  intrathecal treatment, 206
  lengthening procedures, 203
  management, 205
  muscle relaxants, 206
  pelvic obliquity, 203, 204
  progressive thoracolumbar scoliosis, 197
  pulmonary care, 203
  pulmonary complications, 206
  radiographic evaluation, 198
  respiratory therapy program, 206
  rib engagement, 203
  sensation, 198
  static muscle architecture, 205
  supine AP traction radiographs, 199
  surgical complications, 203
  surgical management, 199, 206, 208
  surgical morbidity and mortality, 206
  thoracolumbar curve, 198
  ventilator support, tracheostomy, 197
  VEPTR instrumentation, 207
  volatile inhalational anesthetics, 206
  Neuromuscular scoliosis, management, 208, 217, 218
  Noninvasive lengthening procedures, 96
  Normal human spinal growth neurocentral synchondrosis, 4
  and pulmonary function, 3
  with spinal deformity, 1, 3
  supine AP radiographs, 2
  thoracic and lumbar spine, 3–5
  VACTERL, 1

O
Off label modern spinal implants, 111
Opening wedge thoracostomy, 170, 172, 173, 177, 180, 181
P
Pediatric scoliosis, 154
Pedicle screw instrumentation, 188, 191
Pelvic obliquity, 199, 212, 215, 216
Posterior spinal instrumentation
and fusion (PSIF), 291
Posterior-only hemivertebra
excision, 153, 154
Prader-Willi syndrome, 87
Preoperative flexibility index, 298
Progressive adolescent idiopathic
scoliosis, 127
Progressive infantile scoliosis, 32
Proximal junctional kyphosis
(PJK), 44
Pulmonary function tests, 3, 249

R
Rib hooks, 68
Rib-based proximal anchors, 68

S
Sagittal spine length (SSL), 281, 282, 284
Scoliosis porcine model, 129
Scoliosis Research Society
Growing Spine
Committee, 274
Segmental vessel injury, 142
Self-growing rod construct, 104, 110, 112
Shilla growth guidance
technique, 76–78
clinical course and outcome, 79–81
deformity, 83
diagnostic studies, 74–76
vs. distraction-based growing
rod patients, 83
history, 73
patient criteria, 84
physical examination, 74
surgical procedure
apical derotation, 78
apical fusion levels, 76–77
apical segments, 76
deformity correction, 77
growing screws, 76, 77
treatment options, 76
SHILLA technique, 206
Shilla-guided growth system, 114
Skeletal dysplasia
clinical course and outcome, 238
clinical pearls and pitfalls, 238–240
diagnostic studies, 232–233
growth-friendly implants, 242
history and physical
examination, 231–232
lengthening, 242
management, 233–238
pedicle screw fixation, 242
surgical procedure, 236–238
SMD type I, 241
Spinal deformity, 1, 183
Spinal dysraphism, 88
Spinal traction, 296, 301
Spine growth assessment
anthropometric data, 286
biplanar radiographs, 286
delay tactic, 284
diagnostic studies, 273–274
Dimeglio’s data, 279
distraction phase, 278, 280, 282
expected growth rate,
279–281
FVC, 284
graduation phase, 278
growth-friendly treatment, 284
history, 271
implantation phase, 276, 282
law of diminishing returns, 284
management options, 274–275
measurements, 276
neurological examination, 272
pelvic inlet width, 283
reference data, 282
serial standing lateral
radiographs, 274
serial standing PA
radiographs, 273
spinal parameters, 276, 277, 279
SSL, 281, 282, 284
surgical course, 276
surgical procedure, 275
3D–TSL, 285, 286
Spine-based distraction, 200, 284, 308
Spine-based growing rods, 35, 217
Spondylometaphyseal dysplasia
(SMD), 241
Spondylometaphyseal dysplasia
Kozlowski type
(SMDK), 231, 241
Subperiosteal exposure, 38, 154, 188

T
Thoracic hypokyphosis, 308
Thoracic insufficiency syndrome
(TIS), 3, 178
Thoracolumbosacral orthosis
(TLSO), 48, 59, 189
Three-dimensional true spine
length (3D–TSL), 285
Traction, 296–299
advantages, 296
clinical course and outcome,
294–295
complications, 301, 304
diagnostic studies, 291
growth-friendly options, 292
HGT
efficacy, 298–299
perioperative, 296
recommended dose, 298
technique and protocols,
297–298
history and physical
examination, 289–291
intraoperative skull-femoral
traction, 299–300
management options, 291
skull traction options, 292
spinal traction, 296
surgical procedure, 293–294
triradiate cartilage, 293
Trolley gliding vehicle (TGV), 112
Two-stage growing rod strategy,
242

V
Vertebral body stapling (VBS)
complications, 144
detrimental effect, disc space,
145
growth modulation, 135, 137
indications, 146
posteroanterior and lateral
radiographs, 139
preoperative thoracic curve,
143
radiopaque trial instrument,
138
thoracic curves, 144
Vertical expandable prosthetic
titanium rib (VEPTR),
49–53, 206, 221–224,
226, 227
bone fusion, 172
clinical course and outcome,
52, 54
complication rates, 181
control of spinal deformity, 52
curvilinear incision, 171
device exchange, 175
diagnostic studies, 48, 49
distraction, 172
exchange of implants, 174
history and physical
examination, 47–48
IIS, 53
Vertical expandable prosthetic titanium rib (VEP TR) (cont.,)
in myelomeningocele bracing, 226
clinical course and outcome, 224
diagnostic Studies, 222–223
fixation points, 226
gibbus deformity, 222, 227
history and physical examination, 221–222
kyphotic deformity, 226
low-profile fixation, 227
management, 223
nonambulatory patients, 227
pelvic S-hooks, 226, 227
preoperative assessment of comorbidities, 224
shunt malfunction, 226
spinal deformities, 226
surgical procedure, 223–224
wheelchair modifications, 226

indications, 54
lengthening procedures, 174, 175
longitudinal incision, 174
management, 48
opening wedge thoracostomy, 173
paraspinal muscles, 171
pulmonary function, 176
reinsertion, 177
scoliotic deformity, 180
skin flaps, 173
spinal cord monitoring, 172
surgical lengthening, concave hemithorax, 180
surgical procedure exchange, 52, 53
insertion, 49–51
laminar hooks, 50
lengthening, 51, 52
postoperative images, 50
rib cradle, 50

W
Wheelchair modifications, 294