

Contents

Preface: Spinal Deformity Surgery xiii

Christopher P. Ames, Brian Jian, and Christopher I. Shaffrey

Clinical and Radiographic Evaluation of the Adult Spinal Deformity Patient 143

Justin S. Smith, Christopher I. Shaffrey, Kai-Ming G. Fu, Justin K. Scheer, Shay Bess, Virginie Lafage, Frank Schwab, and Christopher P. Ames

Among the prevalent forms of adult spinal deformity are residual adolescent idiopathic and degenerative scoliosis, kyphotic deformity, and spondylolisthesis. Clinical evaluation should include a thorough history, discussion of concerns, and a review of comorbidities. Physical examination should include assessment of the deformity and a neurologic examination. Imaging studies should include full-length standing posteroanterior and lateral spine radiographs, and measurement of pelvic parameters. Advanced imaging studies are frequently indicated to assess for neurologic compromise and for surgical planning. This article focuses on clinical and radiographic evaluation of spinal deformity in the adult population, particularly scoliosis and kyphotic deformities.

Sagittal Spinal Pelvic Alignment 157

Eric Klineberg, Frank Schwab, Justin S. Smith, Munish Gupta, Virginie Lafage, and Shay Bess

The goal of any ambulatory patient is to maintain a horizontal gaze with the least amount of energy expenditure. With progressive deformity, and in particular sagittal malalignment, significant compensatory mechanisms must be used to achieve this goal. Each pelvis dictates the amount of lumbar lordosis required through its morphometric parameter pelvic incidence. The pelvis may compensate for decreasing lumbar lordosis (eg, age, flat back deformity) by retroverting and increasing pelvic tilt and decreasing the sacral slope. Underappreciation for these spinopelvic compensatory mechanisms leads to surgical under-correction, iatrogenic flat back and poor clinical outcomes.

Use of Surgimap Spine in Sagittal Plane Analysis, Osteotomy Planning, and Correction Calculation 163

Michael Akbar, Jamie Terran, Christopher P. Ames, Virginie Lafage, and Frank Schwab

Over the past 3 decades the sagittal plane has received increasing attention from the scientific community and spine surgeons alike. There remains a lack of clear and concise methods for incorporating surgical techniques and radiographic parameters to achieve the best possible outcome on a patient-specific level. This article proposes a new method for a treatment approach to sagittal malalignment by incorporating new digital tools for surgical planning. This technique offers a consistent approach to adult spinal deformity with sagittal-plane components, and can permit optimization in consistently achieving proper postoperative spinopelvic alignment.

Adolescent Scoliosis Classification and Treatment 173

Jane S. Hoashi, Patrick J. Cahill, James T. Bennett, and Amer F. Samdani

Adolescent idiopathic scoliosis (AIS) affects up to 3% of the population. It can be stratified by curve type according to the Lenke classification. This classification

system incorporates curve magnitude, flexibility, the lumbar modifier, and the sagittal plane. The Lenke classification serves as a guide for selection of levels for surgical treatment of AIS. Surgical treatment of AIS includes anterior and posterior approaches; most AIS is treated through a posterior approach. Surgical goals include maximizing correction in the coronal, sagittal, and axial planes.

Classifications for Adult Spinal Deformity and Use of the Scoliosis Research Society–Schwab Adult Spinal Deformity Classification

185

Shay Bess, Frank Schwab, Virginie Lafage, Christopher I. Shaffrey, and Christopher P. Ames

Adult spinal deformity (ASD) is a complex disease state that pathologically alters standing upright posture and is associated with substantial pain and disability. This article provides an overview of classification systems for spinal deformity, clarifies the need to differentiate between pediatric and adult classifications, and provides an explanation on the use of the Scoliosis Research Society-Schwab Adult Spinal Deformity Classification (SRS-Schwab ASD Classification). This information allows surgeons, researchers, and health care providers to (1) identify sources of pain and disability in patients with ASD and (2) accurately use the SRS-Schwab ASD Classification to evaluate patients with ASD.

Coronal Realignment and Reduction Techniques and Complication Avoidance

195

Kai-Ming G. Fu, Justin S. Smith, Christopher I. Shaffrey, Christopher P. Ames, and Shay Bess

Scoliosis is a broad term encompassing multiple pathologies with different etiologies. Patients may range from the infant with congenital deformity, to the adolescent with idiopathic scoliosis, to the elderly patient with severe degenerative scoliosis. Treatment must be tailored to individual circumstances and the pathoanatomy of each deformity. Various coronal reduction techniques have been described and will be discussed within this article. While scoliosis is generally considered a deformity in the coronal plane, often deformity is present in the sagittal and axial planes also. Treatment of these deformities can require osteotomies or vertebral column resections, techniques further discussed in accompanying articles.

Spinal Osteotomies for Rigid Deformities

203

Munish C. Gupta, Khalid Kebaish, Benjamin Blondel, and Eric Klineberg

Various osteotomies are useful in making a rigid deformity flexible enough for realignment in coronal and sagittal plane. This article defines the osteotomies and their usefulness in treatment of specific rigid deformities. The pedicle subtraction osteotomy and vertebral column resection used in treating rigid deformities are described in detail.

Proximal Junctional Kyphosis and Proximal Junctional Failure

213

Robert Hart, Ian McCarthy, Christopher P. Ames, Christopher I. Shaffrey, David Kojo Hamilton, and Richard Hostin

Proximal junctional failure (PJF) should be distinguished from proximal junctional kyphosis, which is a recurrent deformity with limited clinical impact. PJF includes mechanical failure, and is a significant complication following adult spinal deformity surgery with potential for neurologic injury and increased need for surgical revision. Risk factors for PJF include age, severity of sagittal plane deformity, and extent of

operative sagittal plane realignment. Techniques for avoiding PJF will likely require refinements in both perioperative and surgical strategies.

Treatment Algorithms and Protocol Practice in High-Risk Spine Surgery 219

Patrick A. Sugrue, Ryan J. Halpin, and Tyler R. Koski

The practice of appropriate evidence-based medicine should be a goal for all physicians. By using protocols in areas where strong evidence-based medicine exists, physicians have reliably shown they can improve patient outcomes while reducing complications, cost, and hospital stay. Evidence-based protocols in complex spinal care are rare. At Northwestern University the authors have developed a multidisciplinary protocol for the preoperative, intraoperative, and postoperative workup and care of complex spine patients. The rationale and use of the High-Risk Spine Protocol is discussed.

The Role of Minimally Invasive Techniques in the Treatment of Adult Spinal Deformity 231

Praveen V. Mummaneni, Tsung-Hsi Tu, John E. Ziewacz, Olaolu C. Akinbo, Vedat Deviren, and Gregory M. Mundis

Many surgeons use minimally invasive surgery (MIS) approaches for treatment of patients with adult degenerative spinal deformity. The feasibility and efficacy of these techniques in the treatment of certain subtypes of degenerative deformities have been reported. In this article, several MIS techniques are discussed and an established 6-level treatment algorithm (MiSLAT) is presented, to help guide spinal surgeons in the use of MIS techniques for the treatment of patients with degenerative deformity. MIS treatment of MiSLAT level I to IV deformities is recommended, whereas level V and VI deformities require more traditional open approaches for adequate deformity correction.

Assessment and Treatment of Cervical Deformity 249

Justin K. Scheer, Christopher P. Ames, and Vedat Deviren

Cervical deformity is disruption of normal cervical alignment. This article focuses on the varying etiology of cervical deformity, normative data, and evaluation and examination of deformity, and presents various treatment options for the proper management of these debilitating conditions. Surgical treatment may be indicated in patients with severe mechanical neck pain, neurologic compromise, and progressive deformity causing significant disability, such as dysphagia or loss of horizontal gaze.

Management of High-Grade Spondylolisthesis 275

Manish K. Kasliwal, Justin S. Smith, Adam Kanter, Ching-Jen Chen, Praveen V. Mummaneni, Robert A. Hart, and Christopher I. Shaffrey

Management of high-grade spondylolisthesis (HGS) remains challenging and is associated with significant controversies. The best surgical procedure remains debatable. Although the need for instrumentation is generally agreed upon, significant controversies still surround the role of reduction and anterior column support in the surgical management of HGS. Complications with operative management of HGS can be significant and often dictate the selection of surgical approach. This review highlights the pathophysiology, classification, clinical presentation, and management controversies of HGS, in light of recent advances in our

understanding of the importance of sagittal spinopelvic alignment and technologic advancements.

Health Economic Analysis of Adult Deformity Surgery **293**

Ian McCarthy, Richard Hostin, Michael O’Brien, Rajiv Saigal, and Christopher P. Ames

Given the substantial growth in frequency and expense of spine deformity surgery, and the general economic landscape of the health care system, health economics research has an important role in the literature on adult spinal deformity (ASD). The purpose of this article is to provide an update on the current state of health economics studies in the ASD literature and to introduce areas in which health economics might play some additional role in future research on ASD.

Index **305**