Complex spine surgery

Definition

Complex spine surgery refers to advanced surgical procedures performed on the spine to address severe spinal disorders, deformities, instability, or neurological compromise. These surgeries typically require specialized techniques, and extensive planning, and often involve multiple vertebral levels, instrumentation, or fusion procedures.

Indications for Complex Spine Surgery: - **Spinal deformities** (e.g., scoliosis, kyphosis) - **Severe degenerative spine disease** (e.g., advanced spondylosis, spinal stenosis with instability) - **Spinal tumors** (primary or metastatic) - **Traumatic spine injuries** (fractures, dislocations, instability) - **Revision spine surgery** (failed back surgery syndrome, pseudoarthrosis) - **Spinal infections** (osteomyelitis, discitis) - **Congenital spinal anomalies**

Common Complex Spine Procedures: - **Spinal fusion** (multi-level fusion, anterior/posterior fusion) - **Vertebral osteotomies** (e.g., pedicle subtraction osteotomy for deformity correction) - **Spinal instrumentation** (screws, rods, interbody cages) - **Tumor resection and reconstruction** - **Minimally invasive complex spinal procedures** (e.g., lateral interbody fusion with percutaneous instrumentation)

These surgeries are often performed by specialized spine surgeons, including neurosurgeons and orthopedic spine surgeons, in high-volume spine centers.

Complexity in spine surgery is a relative term, but it generally refers to surgical cases that involve one or more of the following:

Revision of prior back or neck spine surgery

Scoliosis

Surgery across more than three spinal segments (or levels)

Complex spinal surgery is the insertion of instruments to stabilize and fuse parts of the spine. This may be necessary for spinal fractures, metastatic spinal tumors, spinal instability, and sometimes for back pain. A relatively new development is minimally invasive spinal surgery, a type of 'key-hole' surgery.

These surgeries are typically performed by highly specialized spine surgeons and may be necessary for various spinal disorders or conditions that haven't responded to conservative treatments. Here are some aspects related to complex spinal surgery:

Conditions Requiring Complex Spinal Surgery:

Spinal Deformities: Conditions like scoliosis (abnormal curvature of the spine), kyphosis (excessive forward rounding of the back), or spondylolisthesis (vertebral slippage) may require complex surgical correction. Spinal Tumors: Surgical intervention may be necessary to remove tumors affecting the

spine or spinal cord. Spinal Trauma: Severe spinal injuries, fractures, or dislocations may necessitate complex surgical reconstruction. Degenerative Disc Disease: Advanced cases of degenerative disc disease, where multiple discs are affected, may require complex procedures such as spinal fusion or disc replacement at multiple levels. Procedures Involved in Complex Spinal Surgery:

Spinal Fusion: Joining two or more vertebrae together to stabilize the spine. Laminectomy: Removal of the lamina (bony arch) to relieve pressure on the spinal cord or nerves. Diskectomy: Removal of part or all of a spinal disc, often performed in conjunction with other procedures. Vertebrectomy: Removal of a vertebra, sometimes necessary in cases of severe deformity or tumor. Osteotomy: Surgical cutting or reshaping of bones to correct deformities. Instrumentation: The use of screws, rods, or other devices to stabilize the spine during fusion or other procedures. Minimally Invasive Techniques:

While complex spinal surgeries often involve traditional open procedures, advancements in technology have led to the development of minimally invasive techniques. These techniques use smaller incisions and specialized instruments, potentially reducing recovery times and complications. Risks and Complications:

Complex spinal surgery carries inherent risks, including infection, bleeding, nerve damage, and complications associated with anesthesia. The severity of these risks can vary depending on the specific procedure and the patient's overall health. Recovery and Rehabilitation:

Recovery from complex spinal surgery may involve a period of immobilization, physical therapy, and rehabilitation to regain strength and function. The duration of recovery varies based on the complexity of the surgery and the individual patient's response. Multidisciplinary Approach:

The management of complex spinal conditions often requires a multidisciplinary approach, involving collaboration between spine surgeons, neurosurgeons, orthopedic surgeons, pain specialists, and physical therapists. It's important for individuals considering or undergoing complex spinal surgery to have thorough discussions with their healthcare team to understand the potential benefits, risks, and expected outcomes. Patient education, careful preoperative planning, and postoperative rehabilitation play crucial roles in achieving successful outcomes in complex spinal surgery.

There have been substantial increases in the utilization of complex spinal surgery in the last 20 years. Spinal instrumented surgery is associated with high costs as well as significant variation in approach and care. The objective of this manuscript is to identify and review drivers of instrumented spine surgery costs and explain how surgeons can reduce costs without compromising outcomes.

Methods: A literature search was conducted using PubMed. The literature review returned 217 citations. 27 publications were found to meet the inclusion criteria. The relevant literature on drivers of spine instrumented surgery cost is reviewed.

Results: The drivers of cost in instrumented spine surgery are varied and include implant costs, complications, readmissions, facility-based costs, surgeon-driven preferences, and patient comorbidities. Each major cost driver represents an opportunity for potential reductions in cost. With high resource utilization and often uncertain outcomes, spinal surgery has been heavily scrutinized by payers and hospital systems, with efforts to reduce costs and standardize surgical approach and care pathways.

Conclusions: Education about cost and commitment to standardization would be useful strategies to reduce cost without compromising patient-reported outcomes after instrumented spinal fusion [1)]

Tendence

Major spinal surgery procedures have increased significantly [2) 3)] for three main reasons: the increased age demographic of the general population, the introduction of minimally invasive methods including percutaneous procedures, and improved outcomes including reduced hospital stay and return to desirable lifestyle. Lumbar and cervical fusion are the main reported procedures on the spine and these numbers seems to be significantly increase because of life style variations [4) 5)].

Although spine fusions are now considered minimally invasive techniques, the aggregate costs related to these surgeries has increased since the complexity of spinal involvement and number of levels to be fused have increased [6)].

A metaanalysis on the effectiveness of minimally invasive techniques for lumbar spinal stenosis has revealed that there was no difference in terms of improved outcome for the most commonly used surgical techniques [7)]. Other important factors to be considered in complex spinal surgeries include length of the procedure and anaesthesia time, prolonged prone positioning and blood loss which can contributors to postoperative adverse events.

One of the medical fields that has intensively utilized the most advanced technologies is complex spinal surgery. A multitude of novel types of instrumentation, implants, navigation and biologics have recently become available for the use in complex spine surgery [8)]. However, critics point out that technologically advanced treatments may offer little or no clinical benefit compared to traditional treatment strategies [9)].

Predictive clinical decision support is having an increasing impact in the field of risk stratification in complex spine surgery. Researchers are building accurate multivariate predictive models that can be applied to clinical practice in the form of decision support systems (DSS). Bekelis et al. created a statistical model to predict complications in spine surgery based on data from 13,660 patient cases. The model's outcome variables included 30-day postoperative risk of stroke, myocardial infarction (MI), wound infection, urinary tract infection (UTI), death, deep vein thrombosis (DVT), pulmonary embolism, and unplanned return to surgery. Predictors were preoperative patient characteristics. The model was able to successfully discriminate between cases that did and did not experience complications. Areas under the receiver operating characteristics curves for each of the outcome variables ranged from moderate to high [10)].

Case series

In a retrospective cohort analysis, we considered adults who had complex spine surgery between January 2005 and September 2014 at the Cleveland Clinic Main Campus. Our primary outcome was postoperative estimated glomerular filtration rate. Secondarily, we evaluated renal function using Acute Kidney Injury Network criteria. We obtained data for 1814 surgeries, including 689 patients (38%) who were given intraoperative vasopressors infusion for ≥30 minutes and 1125 patients (62%) who were not. Five hundred forty patients with and 540 patients without vasopressor infusions were well matched across 32 potential confounding variables.

In matched patients, vasopressor infusions lasted an average of 173 ± 100 minutes (SD) and were given a median dose (1st quintile, 3rd quintile) of 3.4-mg (1.5, 6.7 mg) phenylephrine equivalents. Mean arterial pressure and the amounts of hypotension were similar in each matched group. The postoperative difference in mean estimated glomerular filtration rate in patients with and without vasopressor infusions was only 0.8 mL/min/1.73 m (95% CI, -0.6 to 2.2 mL/min/1.73 m) (P = .28). Intraoperative vasopressor infusion was also not associated with increased odds of augmented acute kidney injury stage.

Clinicians should not avoid typical perioperative doses of vasopressors for fear of promoting kidney injury. Tolerating hypotension to avoid vasopressor use would probably be a poor strategy [11].

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