Chapter

1

Preoperative assessment of the adult patient

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Key points

- Tests should be ordered only as indicated.
- History and physical examination should precede laboratory studies.
- Variability of spinal anatomy and physiology dictate that cases involving spine surgery should be considered on an individual basis.
- General "cardiac clearance" is rarely useful.
- Many diseases and comorbidities involve the spine and must be considered separately.

Introduction

Procedures on the spine vary in complexity from simple discectomy to multi level reconstruction and fusion with instrumentation. Moreover, the level of surgery from the cervical area to the coccyx further impacts planning for anesthetic management. Procedures may be planned for months or occur emergently as part of multiple trauma. Thus many factors determine appropriate preoperative anesthetic assessment.

General guidelines

In 2002 the American Society of Anesthesiologists developed a practice advisory to assist in decision making regarding appropriate preanesthetic assessment and care.[1] The advisory is the synthesis of opinions from experts, open forums, public sources, and literature review. It is to be applied to all anesthesiologists and those who provide care under the direction of an anesthesiologist including residents, certified registered nurse anesthetists (CRNA) or students. It applies to all age groups and all types of anesthesia and deep sedation for both surgical and nonsurgical situations. The advisory does not address emergency situations.

Preanesthetic evaluation is the process of clinical assessment preceding the delivery of anesthesia. It is the responsibility of the anesthesiologist or CRNA practicing alone. The process must consider information from multiple sources including, among others, the patient, surgical and medical records, nurse evaluations, and laboratory tests and other tests. As appropriate, consultations may be sought and preoperative tests ordered as indicated. In some departments of anesthesia, informed consent is obtained separately from surgical consent; in others consent is signed as part of general hospital consent. In either case, the preanesthetic record must note that the anesthetic options, risks and benefits of anesthesia have been explained to the patient, and he/she has agreed and accepted the plan.

Obtaining a history and physically examining the patient should precede the ordering or performance of preanesthesia tests. Such a process includes evaluation of pertinent medical records, patient interview, assessment of the risk/benefit for different anesthetic techniques and a plan for postoperative pain management, which is especially important for the patient scheduled to undergo complex lower spine surgery. The timing of the evaluation depends on the degree of surgical invasiveness, where highly invasive procedures should be done prior to the day of surgery (multilevel laminectomies with instrumentation) and medium or low risk surgery (minimally invasive single-level laminectomy) may be done on the day before or day of surgery. Analysis of the Practice Advisory of the ASA provides a good indication of minimal standard of care in the United States. Airway assessment and documentation was considered essential by 100% of consultants and 100% of ASA members. Pulmonary and cardiovascular examination was cited by 81–88% of respondents as required. In addition, the health care system should provide appropriate assessment of the severity of the patient's medical condition and the invasiveness of surgery. In other words, the diagnosis and planned surgery should be identified prior to operation.

Routine testing implies tests that are performed without clinical indication and include such items as hemoglobin, urinalysis, chest radiograph (CXR), electrocardiogram, coagulation profile and basic metabolic panel. The reasons for ordering these tests as a "shotgun" approach are varied and include such arguments as:

1. The approach represents good screening (although for what, is not specified).
2. It may save an annual physical examination (although mammography, colonoscopy, and prostatic screening are usually recommended in annual physical examinations, these results do not impact anesthetic management).
3. Preoperative testing is medicolegally sound (but tests may cause more harm than good, may produce false positives or may not be reviewed, thus resulting in even more adverse situations).
4. Testing is required (most hospital do not have mandated tests written into the policies and procedures).
5. Multiple testing provides income for hospitals and laboratories (true).

A study done 20 years ago showed that routine testing cost >$60 billion annually and >60% of tests were not indicated. Approximately 0.2% revealed pertinent abnormalities, that is, a finding that might change the anesthetic or surgical plan.[2] There has been little change in many areas.

Site of surgery

Pathology, usually resulting in pain may occur throughout the cervical spine due to trauma, degenerative changes, tumors, lytic lesions, and compression. Levels for surgery may be upper cervical (C1–2), middle and lower cervical, thoracic, lumbar and, more rarely, sacral/coccygeal. The approaches at each level are shown in Tables 1.1–1.3. Anterior upper cervical approaches are used to relieve compression at the cervicomedullary junction and stabilize odontoid fractures. They may also be indicated in resection of tumors such as clival chordomas. Posterior approaches are used to correct atlantoaxial or occipitalatlanto instability, odontoid and spinal fractures, and cervical instability.

Supine approach to the middle lower cervical spine is indicated in the removal of osteophytes or herniated discs. Fusion and/or instrumentation allow the disc space height to be maintained. The posterior approach

Table 1.1 Upper cervical approaches

Anterior	Posterior
Transoral	Craniocervical fusion/fixation
Transpalatal	Atlantoaxial fusion
Transmandibular	C1–C2 wiring/plating
Anterior retropharyngeal	C1–C2 transarticular screw fixation

Table 1.2 Middle and lower cervical approaches

Supine	Prone
Anterior cervical discectomy	Laminectomy, foraminotomy, laminotomy
Cloward procedure, includes insertion of autologous or bank bone or methylmethacrylate	Wiring: interspinous, sublaminar
	Plating, pedicle screws

Table 1.3 Other levels and approaches

Anterior cervicothoracic
Anterior thoracic: thorascopic techniques
Posterior thoracic
Anterior lumbar/lumbosacral
Posterior lumbar
Combined anterior posterior
Minimally invasive and microdiscectomies

is used in cases of cervical radiculopathy due to degenerative disease and in cases of cervical canal stenosis or removal of intraspinal masses such as ependymomas. Multiple levels may be involved.

Lumbar fusion is performed to relieve pain due to intervertebral movement. Segmental instability, spondylolisthesis, and iatrogenic instability are other indications. Pedicle screw stabilization involves creation of a rigid three-column spinal fixation. Posterolateral fusions include laminectomy, discectomy, and grafted bone to decorticated bone. Posterior lumbar interbody fusion includes bilateral laminectomies with removal of the inferior and part of the superior facets, discectomies, autologous or banked bone placement or cages to the disc spaces. Combined anterior posterior approaches are indicated for correction of multilevel collapse, unstable three-column injury, severe kyphosis, scoliosis, or infective or neoplastic conditions. Surgery involves complete circumferential decompression, rigid short segment fixation, and maximal correction of deformities.

It is clear that preanesthetic assessment varies depending on the approach required, the pathology involved, the invasiveness of the procedure, and the presence of other comorbidities, which may be part of the spinal disease. Assessment also varies depending on whether the surgery is elective or emergent

Cervical and elective surgery

Upper levels

High cervical cord tumors such as chordomas or ependymomas may be resected through the mouth – an approach rarely used today. Many of these patients are young and relatively healthy and require little preoperative testing. However, psychological preparation includes the awareness that a tracheostomy is usually placed prior to surgery. The approach requires bisection of the tongue and mandible allowing direct access to the back of the mouth. Surgery necessitates the cooperation of several specialties and is generally very long, lasting 24 hours or more. Decannulation of the trachea can usually be accomplished within 72 hours as swelling subsides in the upper airway. Blood loss is minimal.

Indicated tests: Complete radiographic series to determine the extent of the pathology.

Trisomy 21 is one of the most common chromosomal abnormalities in humans, occurring in 1:6–800 live births in the United States. The anomaly affects many organ systems with implications that require close preanesthetic assessment (Table 1.4). As life expectancy of these patients has improved, the number of adult patients with Down's syndrome presenting for surgery is increasing. Muscle hypotonia and ligamentous laxity with atlantoaxial instability occur frequently and patients may present for stabilization with plating, wiring, or some other means of fusion of C1–2.

Approximately 15% of patients with Down's syndrome have atlantoaxial instability and the majority of them are asymptomatic.[3] However, they are predisposed to subluxation and cervical cord compression especially during endoscopy and intubation. Specific history and physical examination are important to seek out such symptoms as gait abnormalities, clumsiness and increased fatigue when walking. Other findings include abnormal neck motion (very mobile), upper and lower motor neuron signs such as spasticity, hyperreflexia, extensor plantar reflexes, loss of bowel or bladder control, and neck posturing (torticollis).[4] The Sharp and Purser test may also be applied. With the patient in a sitting position, and the neck flexed, backward pressure is applied against the forehead while the spinous process of the axis is palpated. A gliding motion may be felt as subluxation is reduced. The test is positive in about 50% of patients with atlantoaxial instability. Posterior stabilization is recommended for patients with subluxation prior to any other elective surgery. Intubation should be performed with head stabilization including two-point pin fixation.

Approximately 40% of Down's syndrome patients have some form of congenital heart disease, the most prevalent of which is endocardial cushion defect. Other anomalies include ventricular and atrial septal defects. All three of these lesions may result in pulmonary hypertension. Adults appear to have a higher incidence of aortic insufficiency and mitral valve prolapse. Those with previously repaired congenital heart disease may have conduction defects, usually left anterior hemiblock and right bundle branch block. Cardiology consultation may be indicated.

There is a general predisposition towards hypoxia. Respiratory tract infections secondary to airway anomalies, immunologic deficiencies and institutional living are contributing factors. Hypotonia and sleep apnea with both mechanical and central nervous

Table 1.4 Trisomy 21. Perianesthetic considerations

Anatomic	Short stature, obesity, small mouth, large tongue, high arched palate, small mandible and maxilla, short neck
Musculoskeletal	Hypotonia, lax joints, unstable atlantoaxial joint, temporomandibular joint disease
Cardiac	Congenital defects, aortic insufficiency, mitral valve prolapse
Respiratory	Frequent infections, pulmonary hypertension, sleep apnea, atelectasis, airway obstruction
Immune system	Altered response, infections, hepatitis B, lymphocytic leukemia increased incidence
Neurologic	Mental retardation, seizures, early onset presenile dementia, perioperative agitation
Gastrointestinal system	Gastroesophageal reflux
Hematologic	Polycythemia
Endocrine	Thyroid anomalies, especially in adults; decreased central and peripheral sympathetic activity

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system factors add to hypoventilation and hypoxia. Preoperative assessment should include blood gas analyses, pulmonary function testing, and training in basic respiratory therapeutic maneuvers.

Patients of all ages with Down's syndrome tend to have lower blood pressures than normal and mentally handicapped controls, perhaps related to a decrease in central and peripheral sympathetic activity. Resting and stress levels of dopamine beta-hydroxylase, which converts dopamine to norepinephrine, are decreased. Excretion of epinephrine is decreased, which may be due to decreased adrenal production even though plasma epinephrine levels are normal.

Indicated tests: Chest radiography to exclude aspiration or atelectasis, complete blood count to assess polycythemia and leukocytosis indicating infection, room air oxygen saturation, electrocardiogram to assess conduction defects, thyroid function tests, neck radiography, blood glucose to exclude diabetes.

Syringomyelia is the development of a fluid-filled cyst (syrinx) within the spinal cord (Fig. 1.1). Over time, the cyst may enlarge, damaging the spinal cord and causing pain, weakness, and stiffness, among other symptoms. If left untreated, symptoms may worsen and require surgery. There are several possible causes. The majority of syringomyelia cases are associated with Arnold–Chiari malformation, a condition in which brain tissue protrudes into the spinal canal. The malformation consists of a downward displacement of the cerebellar tonsils through the foramen magnum, sometimes causing noncommunicating hydrocephalus as a result of obstruction of cerebrospinal fluid (CSF) outflow. The cerebrospinal fluid outflow is caused by phase differences in outflow and influx of blood in the vasculature of the brain. Any obstruction can cause headaches, fatigue, muscle weakness in the head and face, difficulty swallowing, dizziness, nausea, impaired coordination, and, in severe cases, paralysis. While the Chiari malformation may be present at birth, symptoms are often delayed until the 2nd–4th decade. Often symptoms may appear to be triggered by a fall or minor trauma. Other causes of syringomyelia include spinal cord tumors, spinal cord injuries such as tethered cord syndrome, and meningitis. Early signs and symptoms of syringomyelia may affect the back of the neck, shoulders, arms, and hands and include:

- Muscle weakness and wasting (atrophy)
- Loss of reflexes
- Loss of sensitivity to pain and temperature

Later signs and symptoms of syringomyelia are:
- Stiffness in the back, shoulders, arms, and legs
- Pain in the neck, arms, and back
- Bowel and bladder function problems
- Muscle weakness and spasms in the legs
- Facial pain or numbness
- On neck flexion, a tingling sensation rapidly spreading down the trunk and into the legs (Lhermitte's sign)

Syringomyelia can become a progressive disorder and lead to complications such as scoliosis, Horner's syndrome, and chronic pain. In other cases, there may be no associated symptoms and no intervention is necessary. Typically, surgery for syringomyelia, usually in the upper cervical spine with a posterior and prone approach (especially for Chiari malformations) includes one or more of the following:

- Treatment of a Chiari malformation. A suboccipital craniectomy is performed and a dural graft may be added around C1–2 to enlarge the opening of the foramen magnum and restore the flow of cerebrospinal fluid.

Figure 1.1 Syringomyelia. The thin gray curved line indicates extravasated cerebrospinal fluid.

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- Draining of the syrinx. A shunt may be inserted from the syrinx to the abdomen or chest (syringoperitoneal or syringopleural shunt). Less commonly, the syrinx can be drained at surgery.
- Removal of the obstruction. If there is blockage within the cord such as might be caused by adhesions or a tumor, surgical removal of the obstruction may restore the normal flow and allow fluid to drain from the syrinx.
- Correction of an abnormality. If a spinal abnormality is hindering the normal flow of cerebrospinal fluid, surgery to correct it – such as releasing a tethered spinal cord – may be corrective.

Preanesthetic assessment centers on history and physical examination. Duration and amount of symptoms as well as drug ingestion including narcotics and antidepressants should be documented. All nonsteroidal analgesics should be discontinued 1–2 weeks before surgery if possible. Frequently the diagnosis of syringomyelia is delayed and the patient may have received multiple consultations and many therapies. Neurologic examination should include a review of any preexisting deficits. Muscle and nerve assessments and electromyelography may be indicated to gauge the extent of paresthesias or numbness. Range of motion of the neck may indicate a sharp increase in symptoms during flexion. Nausea, vomiting, and difficulty swallowing should be assessed and prophylactic therapy given as indicated.

Indicated tests: MRI of the syrinx, CXR if a shunt is to placed in the thorax, complete blood count, and coagulation profile if the patient has received analgesic medications.

Middle and lower levels; elective surgery

Anterior cervical discectomy is commonly performed in the treatment of nerve root or spinal cord compression. By decompressing the spinal cord and nerve roots of the cervical spine the corresponding vertebrae can be stabilized and pain and paresthesias relieved. This procedure is used when other nonsurgical treatments have failed.

The nucleus pulposus of the herniated disc bulges out through the annulus and presses on the nerve root next to it (Fig. 1.2). This nerve root becomes inflamed and causes pain. The problem can also be caused by degenerative disc disease (spondylosis). The disc consists of about 80% water and with age dries out and shrinks, causing small tears in the annulus and inflammation of the nerve root. At surgery, the disc is completely removed as well as any arthritic bone spurs. To prevent the vertebrae from collapsing and to increase stability, the open space is filled with bone graft, taken from the pelvis or cadaveric bone or methylmethacrylate. Occasionally a titanium plate is screwed on the vertebrae to increase stability during fusion, especially when there is more than one disc involved.

Recently, endoscopic anterior cervical discectomy under epidurogram guidance has been described.[5] Contrast dye through a cervical discectomy is used to generate an epidurogram. Using fluoroscopy, endoscopic instruments are advanced to the epidural space and both soft and hard discs can be removed.

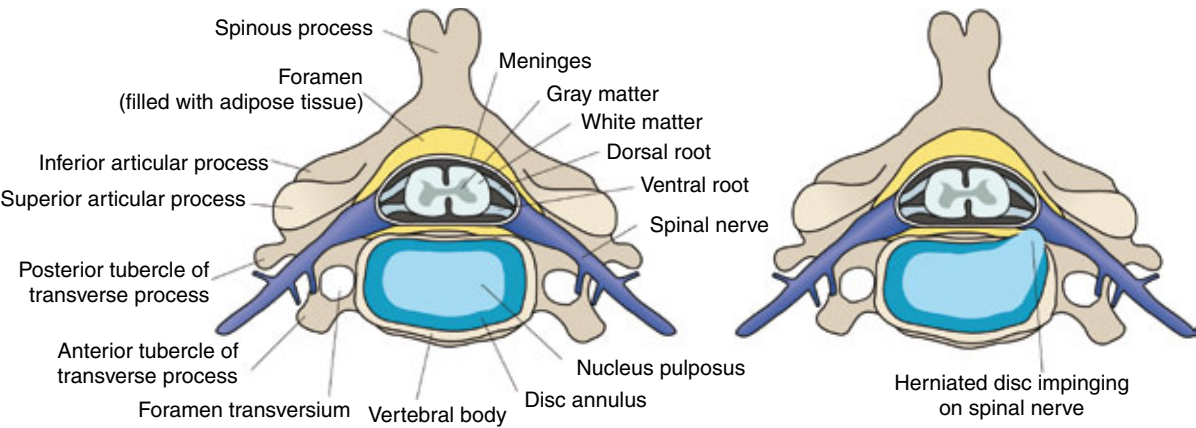As with other surgery on the spine, ingestion of all nonsteroidal anti-inflammatory medicines (Advil,

Figure 1.2 Vertebra and disc: normal (left) and herniated situation (right) (from http://en.wikipedia.org/wiki/Anterior_cervical_disectomy and fusion).

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Section 1: General considerations

Motrin, Nuprin, Aleve, etc.) and anticoagulants (Coumadin, clopidogrel, aspirin) should be stopped 1 to 2 weeks before surgery. In some instances, as for example recent placement of a drug eluding stent, discontinuing of clopidogrel may be ill advised. The cardiologist and surgeon should be consulted and the preferred therapy determined. Ingestion of herbs that can interfere with coagulation should also be stopped. For example, garlic decreases platelet aggregation, ginger inhibits thromboxane synthetase, gingko inhibits platelet activating factor, ginseng interacts with all the anticoagulants to increase their effectiveness, and feverfew inhibits serotonin release from platelets. Additionally, the patient should be advised to stop smoking (pipes and cigarettes), inhaling snuff, and chewing tobacco at least 1 week before and 2 weeks after surgery (although complete cessation is preferable) as these activities can cause bleeding problems. Also, nicotine interferes with bone metabolism through induced calcitonin resistance and decreased osteoblastic formation. Patients who smoked had failed fusions in up to 40% of cases, compared with only 8% among nonsmokers.[6] Smoking also retards wound healing and increases the risk of infection.[7]

Because risk of damage to the recurrent laryngeal nerve is a complication of this surgery, its function should be ascertained preoperatively. Many patients with spinal disc disease are smokers and may have other causes of hoarseness. The recurrent laryngeal nerve is a branch of the vagus nerve that supplies motor function and sensation to the larynx. It is referred to as "recurrent" because the branches of the nerve innervate the laryngeal muscles in the neck through a rather circuitous route: it descends into the thorax before rising up between the trachea and esophagus to reach the neck. The left laryngeal nerve branches from the vagus nerve to loop under the arch of the aorta, posterior to the ligamentum arteriosum before ascending. The right branch loops around the right subclavian artery. Both nerves give off several cardiac filaments to the deep part of the cardiac plexus. As they ascend in the neck, branches – more numerous on the left than on the right side – are given off to the mucous membrane and muscular coat of the esophagus; branches also supply the mucous membrane and muscular fibers of the trachea, and some pharyngeal filaments go to the superior pharyngeal constrictor muscle. The nerve splits into anterior and posterior rami before supplying muscles in larynx and supplies all laryngeal muscles except for the cricothyroid, which is innervated by the

external branch of the superior laryngeal nerve. The recurrent laryngeal nerve enters the pharynx, along with the inferior laryngeal artery, below the inferior constrictor muscle to innervate the intrinsic muscles of the larynx responsible for controlling the movements of the vocal folds.

Unilateral damage may cause hoarseness. Although the right recurrent laryngeal nerve is more susceptible to damage due to its relatively medial location, surgery is generally performed on the right side more for convenience of the right-handed surgeon. Indeed, the total rate of persisting recurrent laryngeal nerve damage using a right-sided approach approximates 13%, a number that can be reduced to 6.5% with a left-sided incision.[8] The complication can be further reduced by controlling endotracheal tube (ETT) cuff pressure to <20 mmHg.[9] Noting that cuff pressures are often much higher than realized and may increase intraoperatively, proper control by manometer reduced ETT related postprocedural respiratory complications, even in procedures of short duration. Problems such as cough and sore throat were significantly reduced.[10] However, the significance of reducing and controlling cuff pressure in reducing the incidence of vocal cord immobility has been questioned by one study.[11] Laryngeal damage may also relate to excessive pressures of the retractors on the esophagus. The patient should be advised preoperatively that while a short period of soreness in the throat is not unusual, should it be accompanied by hoarseness or last longer than 2–3 days then further consultation should be sought.

A preoperative plan for pain control should be in place. To this end it is important to know whether autologous bone grafting is intended. Acute postoperative pain and nerve injuries after anterior iliac crest bone graft can lead to neuropathic chronic pain. A small study evaluated the efficacy of preoperative placement of transversus abdominis plane (TAP) block under ultrasound-guided technology.[12] The authors considered TAP to be an appropriate technique for postoperative analgesia after bone harvest as about 80% of patients had no pain at 18 months. Whatever the approach, a plan for pain relief must be detailed as the discomfort experience from the hip is significantly greater than that felt in the neck. Other techniques include local infiltration, patient-controlled analgesia, and opioid or nonsteroidal injections.

Blood loss during this procedure is minimal, although there are rare instances of delayed bleeding from vessel damage and retropharygeal hematomas.

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Indicated tests: Coagulation profile to ensure no adverse effects of medications or herbs; cervical radiologic studies to assess the extent of the disease; type and screen to check for antibodies; complete blood count to ensure adequate hemoglobin levels for optimal wound healing.

Thoracic levels: elective surgery

Scoliosis (from Greek: skoliōsis, "crooked") is an abnormal lateral curvature of the spine. It is a complex three-dimensional deformity that is typically classified as either congenital (caused by vertebral anomalies present at birth), idiopathic (cause unknown, subclassified as infantile, juvenile, adolescent, or adult according to when onset occurred), or neuromuscular (having developed as a secondary symptom of another condition, such as spina bifida, cerebral palsy, spinal muscular atrophy, or physical trauma). The condition affects approximately 20 million people in the United States.[13] Although surgery is more often performed in children in whom growth retardation is a significant problem as the disease progresses, a significant number of adults also undergo the operation. Scoliosis may be associated with other conditions such as Ehlers–Danlos syndrome (hyperflexibility, "floppy baby" syndrome, and other variants including a high incidence of mitral valve prolapse), Charcot–Marie–Tooth, Prader–Willi syndrome, kyphosis, cerebral palsy, spinal muscular atrophy, muscular dystrophy, familial dysautonomia, CHARGE syndrome (coloboma, heart abnormalities, atresia of the nasal choanae, growth retardation, genital and urinary anomalies, ear deformities, and deafness), Friedreich's ataxia, proteus syndrome, spina bifida, Marfan's syndrome, neurofibromatosis, connective tissue disorders, congenital diaphragmatic hernia, hemihypertrophy, and craniospinal axis disorders (e.g., syringomyelia, Arnold–Chiari malformation).

Depending on the existence of comorbidities that may be present in >50% of patients, preanesthetic assessment may be complex.[14] Of most importance is the assessment of ventilatory function, which may be considerably compromised if the curvature exceeds 40°. Several comorbidities such as Duchenne muscular dystrophy and spinal muscular atrophy are often associated with poor pulmonary function tests and the simultaneous development of scoliosis will further aggravate the situation. However, at least one study showed that despite preoperative forced vital capacity of <30% and further slight decreases postoperatively, there were no major pulmonary complications

postoperatively and functional ability improved markedly.[15] Nevertheless, lung function should be assessed preoperatively to allow a program of respiratory therapy to be instituted.

Cardiac assessment is also critical as many of these patients may have other problems that affect cardiac function such as Marfan's syndrome. Also, severe curvatures affect heart rhythm by altering the position of the heart within the chest. Echocardiographic and stress tests as far as the patient can manage are indicated. It is doubtful whether the patient can be made into any better condition based on results of these tests except that pulmonary infection or aspiration might be identified and corrected.

As with iliac crest grafting, pain control becomes a major problem postoperatively. Thoracic epidural–general analgesia has been shown to be effective.[14]

Typically the surgery, performed in a prone position and with instrumentation, involves many levels and lasts some 6–8 h. Blood loss may be considerable. Occasionally patients predonate which may make them relatively anemic preoperatively. As a complementary surgical procedure a thoracoplasty (or costoplasty) may be performed to reduce the rib hump that affects most scoliosis patients with a thoracic curve. Thoracoplasty may also be performed to obtain bone grafts from the ribs instead of the pelvis, regardless of whether a rib hump is present. Thoracoplasty can be performed as part of a spinal fusion or as a separate surgery and involves the resection of typically four to six segments of adjacent ribs that protrude. Each segment is 2.5–5 cm long, (the ribs grow back, straight). The most common complication of thoracoplasty is increased pain in the rib area during recovery. Another complication is temporarily reduced pulmonary function (10–15% is typical) following surgery. This impairment can last anywhere from a few months to 2 years. Hemothorax and pneumothorax may also occur. Because thoracoplasty may lengthen the duration of surgery, patients may also lose more blood or develop complications from the prolonged anesthesia.

Indicated tests: Type and crossmatch blood, which will almost certainly be required; coagulation profile if the patient has been receiving analgesics; complete blood count, especially if predonation has taken place; CXR to rule out infection, pulmonary function tests as a baseline of ventilatory function; cardiology consult for other (often rare) comorbidities; assessment of Cobb and pelvic angles.

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Section 1: General considerations

Tumors may metastasize to the thoracic spine. Other pathologies that arise in the thoracic area and require surgery include infection such as tuberculosis, and hemangiomas. Pott's disease (named after Percivall Pott, 1714–1788, a London surgeon) is a presentation of extrapulmonary tuberculosis that affects the intervertebral joints. It is most commonly localized in the thoracic portion of the spine. Pott's disease results from hematogenous spread of tuberculosis from other sites, often pulmonary. The infection then spreads from two adjacent vertebrae into the adjoining intervertebral disc space. If only one vertebra is affected, the disc is normal, but if two are involved the disc, which is avascular, cannot receive nutrients and collapses to be broken down by caseation, leading to vertebral narrowing and eventually to vertebral collapse and spinal damage. A soft tissue mass may form.

Spinal metastasis is common in patients with cancer. The spine is the third most common site for cancer cells to metastasize, following the lung and the liver. Approximately 60–70% of patients with systemic cancer develop spinal metastasis of which only 10% are symptomatic and 94–98% have epidural and/or vertebral involvement.[16]

Spread from primary tumors is mainly by the arterial route. Retrograde spread through the Batson plexus during Valsalva maneuver is postulated. Direct invasion through the intervertebral foramina also can occur. Besides mass effect, an epidural mass can cause cord distortion, resulting in demyelination or axonal destruction. Vascular compromise produces venous congestion and vasogenic edema of the spinal cord, resulting in venous infarction and hemorrhage.

About 70% of symptomatic lesions are found in the thoracic region of the spine, particularly at the level of T4–T7. Of the remainder, 20% are found in the lumbar region and 10% are found in the cervical spine. More than 50% of patients with spinal metastasis have several levels of involvement. About 10–38% of patients have involvement of several noncontiguous segments. Intramural and intramedullary metastases are not as common as those of the vertebral body and the epidural space. Isolated epidural involvement accounts for less than 10% of cases; it is particularly common in lymphoma and renal cell carcinoma. Most of the lesions are localized at the anterior portion of the vertebral body (60%). Rarely is there disease in both posterior and anterior parts of the spine.

Primary sources for spinal metastatic disease are as follows:

- Lung 31%
- Breast 24%
- GI tract 9%
- Prostate 8%
- Lymphoma 6%
- Melanoma 4%
- Unknown 2%
- Kidney 1%
- Others, including multiple myeloma, 13%

Preanesthetic assessment depends on the cause. Often surgery for the primary tumor has been undertaken, but if vertebral collapse and pain have become the prominent feature then attempts may be undertaken to stabilize the thoracic spine. The approach is usually prone and may be prolonged with considerable blood loss. Many patients have already undergone chemotherapy or radiation therapy and may be debilitated.

Indicated tests: Identification of primary tumor; complete blood count and metabolic panel for cancer patients; CXR to rule out infection or metastasis; cardiac evaluation for patient with general debility.

Vertebroplasty is a minimally invasive procedure performed in the thoracic area in which a filler material (traditionally polymethylmethacrylate, PMMA) is injected percutaneously into a vertebral body for treatment of vertebral fractures associated with osteoporosis, malignant conditions, hemangiomas, and acute trauma.[17]

Osteoporosis, or porous bone, is a disease characterized by low bone mass and structural deterioration of bone tissue. The resulting bone fragility increases fractures of all bones, especially the hip, spine, and wrist, (especially the spine). These fragility fractures cause both acute and chronic pain and are a major source of morbidity and mortality. One in every two women and one in four men over 50 years of age will have an osteoporosis-related fracture in their lifetime. The demographics of this population are predominantly whites and females of Asian descent, many with the comorbidities of the geriatric group. Other risk factors include poor nutritional status, a history of a primary relative with bone fragility, inactive lifestyle, early menopause, smoking, steroid use, and alcohol use. Diagnosis depends on a bone mineral density test and a dual-energy X-ray absorptiometry (DEXA) test.

In vertebroplasty, the PMMA is injected directly into the bone, whereas in kyphoplasty it is injected after establishment of a cavity by inflation of a balloon tamp.

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As the ability of the procedure to dramatically decrease pain has been repeatedly demonstrated, it has been applied to many more and sicker patients. It is used as a palliative treatment for osteoporotic and malignant vertebral lesions, which weaken vertebrae and cause chronic pain.

Preanesthetic assessment is critical in these patients as many of them have significant comorbidities. Some of the considerations include:

1. Cardiac disease
2. Pulmonary compromise
3. Urinary tract infection
4. Multiple medications and interactions, including herbal therapies
5. Metastatic disease
6. Poor nutritional status
7. Narcotic dependency
8. Limited mobility
9. Communication difficulties

As age increases so do cardiovascular and pulmonary comorbidities. The decrease in pulmonary function associated with osteoporotic vertebral fracture may be clinically significant in a patient with already reduced pulmonary and cardiovascular reserve. Previously pulmonary function in the osteoporotic patient was described as normal, perhaps because height at age 25 years and not current height was used in pulmonary function test calculations.[18] On adjusting for this change, a statistically significant decrease in vital capacity and FEV_1 suggesting restrictive lung pattern may be identified. Also, the mortality rate from pulmonary disease (not lung cancer) is increased with osteoporotic vertebral fractures. Significant improvement in pulmonary function has been shown after vertebroplasty and kyphoplasty, improvement that might increase for up to 3 months.[19] Metastatic lesions may cause vertebral fractures. The primary source may or may not have been identified. In addition to the effects upon the pulmonary system, vertebral fractures also affect the gastrointestinal system. Loss of vertebral height decreases abdominal space and compromises gastrointestinal function. Prophylactic antacid therapy is indicated. Long-term opioid use causes constipation and decreases nutrient absorption. Insomnia and depressive effects of chronic pain adversely affect psychological well-being and many patients are also maintained with antidepressants, especially such herbal preparations as St. John's Wort.

Indicated tests: Cardiac evaluation in an elderly debilitated patient; assessment of volume status; complete blood count to exclude anemia; basic metabolic panel to exclude renal and hepatic disease; CXR to exclude pneumonia and aspiration; assessment of multiple medications for drug interactions especially narcotic patches; urine analysis to exclude urinary tract infection; availability of an interpreter as many patients are of Asian descent

Lumbar level: elective surgery

Many surgical procedures are performed on the lumbar spine ranging from a simple minimally invasive and endoscopic discectomy to multilevel reconstructive procedure with complex instrumentation. Similarly, anesthetic management varies from little more than local anesthesia with some sedation to general anesthesia. Recently there has been resurgence in the use of regional anesthesia, especially for single-level discectomies. Advantages for this approach are decreased blood loss, better pain management (especially if epidural clonidine is added to the technique), less nausea and vomiting, and a decreased incidence of deep venous thrombosis.[20] Endoscopy may be used posteriorly for discectomy and anteriorly for instrumentation.

Spinal stenosis is the single most common diagnosis leading to any type of spine surgery, and laminectomy is a basic part of the surgical treatment. The lamina of the vertebra, which itself is not damaged, is removed to widen the spinal canal and create more space for the spinal nerves and thecal sac. Surgical treatment that includes laminectomy is the most effective remedy for severe spinal stenosis; however, most cases of spinal stenosis are not severe and respond to bed rest, nonsteroidal anti-inflammatory agents, and steroids. Should symptoms include numbness, loss of function, and neurogenic claudication, laminectomy is generally indicated. If the spinal column is unstable then fusion with instrumentation is required.

Spondylolisthesis describes the anterior displacement of a vertebra or the vertebral column in relation to the vertebrae below (Fig. 1.3). This pathology occurs most commonly in the lumbar spine. A hangman's fracture is a specific type of spondylolisthesis where the C1 vertebra is displaced anteriorly relative to the C2 vertebra due to fractures of the C2 vertebra's pedicles.

Patients presenting for major spinal surgery are more likely to be male with truncal obesity and frequently have multisystem disease. Some of the more typical findings are shown in Table 1.5.

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Table 1.5 The patient for major spine surgery often has many comorbidities

Findings and symptoms	Anesthetic implications
Hypertension	Well controlled? Medications? Effects of general anesthesia?
Smoking	Respiratory function? Wound healing? Postoperative care?
Obesity	Obstructive sleep apnea? Airway difficulties? Pulmonary hypertension?
Diabetes mellitus	Perioperative glucose control?
Multiple pain managements	Drug interactions?
Renal disease	Diuretic therapy? Coronary artery disease?
Hematologic anomalies	Anemia? polycythemia?

Figure 1.3 Spondylolisthesis. The body of L5 can be seen slipped over the sacrum.

Spinal fusion and instrumentation is major surgery that is generally planned for many months. Thus patients have often undergone extensive evaluation before they are even seen in a preanesthetic assessment clinic. However, in consultations key questions should be identified to ensure that all of the perioperative caregivers are considered when providing a response.[21]

Several studies suggest that such an approach is not always taken. A multiple-choice survey regarding the purposes and utility of cardiology consultations was sent to randomly selected New York metropolitan area anesthesiologists, surgeons, and cardiologists.[22] There was disagreement on the importance and purposes of a cardiology consultation on topics such as intraoperative monitoring, "clearing the patient for surgery," and advising as to the safest type of anesthesia and avoidance of hypoxia and hypotension. This advice was regarded as important by most cardiologists and surgeons but as unimportant by anesthesiologists. Also, the charts of 55 consecutive patients aged more than 50 years who received preoperative cardiology consultations were examined to determine the stated purpose of the consultation, recommendations made, and concordance by surgeons and anesthesiologists with the recommendations. Of the cardiology consultations, 40% contained no recommendations other than "proceed with case," "cleared for surgery," or "continue current medications." A review of 146 medical consultations suggested that the majority of such consultations give little advice that impacted either perioperative management or outcome of surgery.[23] In only 5 consultations (3.4%) did the consultant identify a new finding; 62 consultations (42.5%) contained no recommendations. Therefore, careful history taking and physical evaluation by the anesthesiologist is essential as not only can situations change over a few weeks but factors that are critical in anesthetic management may appear of less significance to the cardiologist.

The history should seek to identify cardiac conditions that have been shown to impact perioperative morbidity and mortality such as unstable coronary syndromes, prior angina, recent or past myocardial infarction, decompensated heart failure, significant dysrhythmias, and severe valvular disease.[21] A prior history of placement of a pacemaker or implantable cardioverter defibrillator (ICD) or a history of orthostatic intolerance is important. Modifiable risk factors for coronary heart disease (CHD) should be recorded, along with evidence of associated diseases, such as peripheral vascular disease, cerebrovascular disease, diabetes mellitus, renal impairment, and chronic pulmonary disease. In patients with established cardiac disease, any recent change in symptoms must be ascertained. Accurate recordings of current medications used, including herbal and other nutritional supplements, and dosages are essential. Alcohol and tobacco use and ingestion of over-the-counter and illicit drugs

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