The UCSF Spine Center provides comprehensive treatment for all pathologies affecting the spine and peripheral nerves. Patients are treated by internationally recognized specialists in neurosurgery, orthopaedic surgery, neurology, and physiatry who work together to eliminate pain, restore function, and improve quality of life. The team also includes experts in cancer, pain management, physical therapy, radiation oncology, radiology, rheumatology, and nutrition. This team approach, from initial diagnosis through treatment and recovery, is one reason why US News and World Report has ranked the UCSF Neurosurgery and Orthopedics Departments among the best in the nation. We are committed to excellence in patient care, to the education and involvement of physicians who refer their patients to our Center, and to advancing new therapies for spinal disorders.
total spine care

Orthopaedic Surgery

Sigurd Berven, MD
Spinal deformity; Spinal tumors; Minimally invasive spinal reconstruction

Shane Burch, MD
Spinal deformity; Geriatric spine disease

Sibel Deviren, MD
Non-surgical treatments; Fluoroscopy-guided spinal injections

Vedat Deviren, MD
Spinal deformity; Minimally invasive spinal reconstruction; Spinal tumors

Serena S. Hu, MD
Spinal deformity; Spinal stenosis; Disc replacements

Aenor Sawyer, MD
Pediatric and adult bone health; Osteoporosis care and prevention

Bobby Tay, MD
Cervical and lumbar spinal disorders; Minimally invasive spine surgery

key collaborators

Anesthesia
Jeremy Lieberman, MD
Mark Rollins, MD, PhD

Intraoperative Neuromonitoring
Russ Lyons, MS, DABNM
Roger Noss, PhD

Neuroradiology
Cynthia Chin, MD
William Dillon, MD
Christopher Dowd, MD

Neurology
John Engstrom, MD

Orthopaedic Bioengineering
Jeffrey Lotz, PhD

Otolaryngology
Ivan El-Sayed, MD

Pediatric Spinal Surgery
Mohammad Diab, MD
Nalin Gupta, MD, PhD

Pathology
Tarik Tihan, MD

Radiation Oncology
Igor Barani, MD

Thoracic Oncology
Thierry Jahan, MD

Vascular & Endovascular Surgery
Charles Eichler, MD
Non-surgical treatments are applied simultaneously from the beginning of treatment and include:

- Medications
- Physical therapy
- Ergonomics
- Patient education
- Transforaminal epidural steroid injections
-Facet joint intra-articular injections
-Sacroiliac joint intra-articular injections
-Medial branch nerve blocks

- Selective nerve root blocks
- Sciatic nerve blocks
- Sympathetic nerve blocks with anesthetics or botox
- Piriformis anesthetic injections
- Radiofrequency ablations
- Embolization of spinal vascular malformations
- Spinal angiography
- Discography

Additional diagnostic evaluations and non-surgical treatment options for functional movement problems or pain conditions of the neck and back are provided through our collaboration with the Osher Center for Integrative Medicine, including:

- Manual therapy by an experienced physician (including spinal manipulation if indicated)
- Massage by practitioners with experience in pain conditions
- Acupuncture following a diagnosis according to Traditional Chinese Medicine
- Biofeedback by an experienced nurse
- Hands-on mind-body interventions for psychosomatic pain conditions
- Group programs for Mindfulness-Based Stress Reduction, Yoga, and Tai Chi

The first line of treatment for patients at the UCSF Spine Center is always a combination of non-surgical therapies. Patients with serious disorders, such as tumors, myelopathy, or instability, may be referred for surgical evaluation, but these patients are also evaluated by physiatrists and managed with non-surgical adjuvant therapy.

In a recent study at UCSF, 76% of patients with cervical disorders causing neck and radicular arm pain improved with conservative treatments, including cervical transforaminal epidural injection, physical therapy, and medication.
epidural steroid injections

An epidural steroid injection can be used not only to treat pain and reduce inflammation, but also for diagnostic and prognostic purposes.

Patients who receive 80% or greater relief from injections are 90-95% likely to benefit from surgery. Images taken for injections can be used to localize the source of pain and visualize the nerve roots. For patients with multilevel disorders, the injections can help determine which level is the main pain generator. Symptoms can then be managed with less invasive surgery if the conservative treatments fail to improve function. Injections can also be used to resolve discrepancies between symptoms and imaging.

It has been shown that transforaminal epidural (TFE) steroid injections are more effective than interlaminar epidural steroid injections, and are more selective and specific for localizing pain. TFE injections, under fluoroscopic guidance, are given where the nerve root is exiting the spine, allowing a greater percentage of the steroid to reach the ventral epidural space — the site of most inflammation — and enter the nerve root sleeve.

cervical transforaminal injections

Cervical transforaminal injections are done using digital subtraction angiography, allowing the physician to have a clear view of the spinal radicular artery to ensure that injections do not block blood flow and result in complications. Over 2,000 cervical transforaminal injections and 10,000 spine injections have been performed at UCSF with no serious complications.
Minimally invasive surgery is available for a number of spinal disorders, ranging from degenerative diseases to spinal tumors. These procedures have potential to greatly benefit patients by reducing surgical risk, pain, blood loss, risk of infection, and time to recovery. Our specialists have extensive training and experience in minimally invasive spinal techniques, some of which can be performed in the outpatient setting. State-of-the-art instrumentation designed for these procedures allow for improved visualization and mobility.

### Minimally invasive techniques for the thoracic spine

Minimally invasive thoracoscopy techniques for anterior thoracic spine tumors use three to four small incisions through which the tumor can be removed. A voice-activated robotic arm aids in this surgery by following commands and helping to position the thoracoscopic camera for visualization. We are also one of the only centers in the United States to offer minimally invasive transpedicular thoracic discectomies and minimally invasive transpedicular corpectomies for tumors.

<table>
<thead>
<tr>
<th>Indication</th>
<th>Minimally Invasive Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herniated discs with cord compression</td>
<td>Transpedicular discectomy Costotransversectomy</td>
</tr>
<tr>
<td>Fractures</td>
<td>Fusion</td>
</tr>
<tr>
<td>Instability</td>
<td></td>
</tr>
<tr>
<td>Tumors</td>
<td>Thoracoscopic robotic surgery</td>
</tr>
<tr>
<td></td>
<td>Posterior resection</td>
</tr>
</tbody>
</table>

Minimally invasive transpedicular discectomy of the thoracic spine is performed through a tube just 26 mm in diameter.
minimally invasive techniques for the cervical spine

Using specialized tubular retractors and endoscopes that can move through tiny incisions, UCSF spine surgeons are able to treat cervical spine disorders with minimally invasive surgery.

Axial T2 weighted MRI of the C7-T1 level showing a left-side disc herniation compressing the neural foramen. This disc herniation was subsequently removed with a posterior minimally invasive foraminotomy and discectomy.

<table>
<thead>
<tr>
<th>Indication</th>
<th>Minimally Invasive Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herniated discs</td>
<td>Foraminotomy and Discectomy</td>
</tr>
<tr>
<td>Degenerative spinal disease</td>
<td>Foraminotomy</td>
</tr>
<tr>
<td></td>
<td>Fusion</td>
</tr>
<tr>
<td>Fractures</td>
<td>Fusion</td>
</tr>
<tr>
<td>Trauma</td>
<td></td>
</tr>
<tr>
<td>Tumors</td>
<td>Decompression</td>
</tr>
<tr>
<td></td>
<td>Resection</td>
</tr>
</tbody>
</table>

minimally invasive techniques for the lumbar spine

A variety of advanced minimally invasive techniques are also available to treat the lumbar spine.

Intradural tumor removal at T12-L1 through a minimally invasive expandable tubular retractor.

<table>
<thead>
<tr>
<th>Indication</th>
<th>Minimally Invasive Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herniated discs</td>
<td>Discectomy</td>
</tr>
<tr>
<td>Cauda equina syndrome</td>
<td>Lamino-foraminotomy</td>
</tr>
<tr>
<td>Spondylosis/</td>
<td>Anterior lumbar interbody fusion (ALIF)</td>
</tr>
<tr>
<td>Spondylolisthesis</td>
<td>Transforaminal lumbar interbody fusion (TLIF)</td>
</tr>
<tr>
<td></td>
<td>Posterolateral fusion</td>
</tr>
<tr>
<td>Stenosis</td>
<td>Lamino-foraminotomy</td>
</tr>
<tr>
<td>Tumors</td>
<td>Resection (with or without fusion)</td>
</tr>
<tr>
<td>Pseudoarthrosis</td>
<td>Revision fusion</td>
</tr>
</tbody>
</table>
Degenerative Cervical Spine Disorders

The cervical spine is the most flexible anatomic region in the axial skeleton. Distinct segments of the cervical spine give us the ability to perform complex neck motions like head turning or tilting and to carry weight or absorb impact while protecting the delicate spinal cord and nerve roots that pass through the cervical vertebra. Vital supportive structures of the cervical spine, such as the discs, facet joints, and surrounding ligaments, are subject to repetitive injury and degeneration from normal activities, such as work or sports, and from aging, stress, or trauma.

The Occipito-Cervical Junction

Instability in the atlanto-occipital joint results in hyper-mobility of the junction between the head and the neck, which can cause severe pain or paralysis. It may result from rheumatoid arthritis or congenital defects that can accelerate degenerative arthropathy, resulting in basilar invagination. The UCSF Spine Center uses the latest developments in imaging, computer-assisted surgery, and instrumentation to provide safer and more effective decompression and arthrodesis.

The Atlanto-Axial (C1-2) Joint

Chronic C1-2 instability and subsequent joint degeneration is primarily caused by trauma, congenital odontoid insufficiency, or rheumatoid arthritis. UCSF spine surgeons have substantial experience with complex surgical procedures, including use of either transarticular screws or pedicle screws to restore stability to this segment without injuring the vertebral arteries.

Subaxial Cervical Spine

The most common degenerative disorders of the cervical spine affect the sub-axial C3-C7 segments. Symptoms of disc herniation, joint degeneration, and spondylostenosis include radicular pain and sensorimotor deficit or myelopathy with spasticity and pathological reflexes. At UCSF, minimally invasive approaches can be performed posteriorly.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck pain and headache, radiating to the shoulders, arms, and hands</td>
<td>Radiculopathy due to disc herniation and spondylosis</td>
</tr>
<tr>
<td>Diminished dexterity</td>
<td>Myelopathy caused by spinal cord compression from neural canal stenosis</td>
</tr>
<tr>
<td>Spastic gait</td>
<td></td>
</tr>
<tr>
<td>Neurogenic bladder dysfunction</td>
<td></td>
</tr>
<tr>
<td>Neck pain during movement and head flexion</td>
<td>Segmental instability caused by degenerative spondylolisthesis, kyphosis, or post-traumatic deformity</td>
</tr>
</tbody>
</table>
Degenerative Thoracolumbar Spine Disorders

Degenerative thoracolumbar disorders are becoming increasingly prevalent as patients have longer, healthier, and more active lives. While much of the treatment is non-surgical, there are certain conditions that require surgery. Some degenerative diseases can be easily treated with small, minimally invasive procedures, but others require large, reconstructive operations. The spine surgeons at UCSF have considerable experience treating the entire spectrum of degenerative disorders, as well as in-depth knowledge of the success rates of each procedure. This experience enables them to guide patients towards the appropriate treatment based on the entire clinical picture, not just a focal finding.

Thoracolumbar conditions treated include:
- Disc herniations
- Stenosis
- Kyphosis
- Spondylolisthesis
- Adult scoliosis

Left) Preoperative lateral x-ray film demonstrating L5/S1 spondylolysis with spondylolisthesis and foraminal stenosis. Right) Postoperative lateral x-ray film following ALIF with anterior cage and plate and minimally invasive posterior decompression and pedicle screw fixation.
spinal tumors

The UCSF Spine Center offers treatment for all primary and metastatic tumors from the skull base to the sacrum. We treat a high volume of spinal tumor cases each year and our spine surgeons are continually at the forefront of developing new techniques for optimal resection of the most difficult tumors.

Our surgical team has special expertise in transpedicular corpectomy and en bloc resection, sparing many cancer patients from a thoracotomy procedure and resulting in less morbidity and shorter hospital stays.

All spine tumor cases are routinely reviewed at a multidisciplinary spine tumor board to determine the best treatment options for each patient. The close collaboration between neurosurgeons, orthopaedic surgeons, radiation oncologists, and oncologists at the UCSF Helen Diller Family Comprehensive Cancer Center offers patients the benefit of care from a variety of specialists.

The UCSF Spine Center is one of few programs to offer the latest CyberKnife VSI™ radiosurgery platform for the treatment of spinal tumors. This non-invasive, painless treatment can be done in one to five sessions and can be used to treat primary and metastatic tumors definitively or as a supplement to surgery. The CyberKnife can also be used to treat patients who have inoperable tumors or who were previously irradiated.

Advantages of CyberKnife VSI™ Radiosurgery for Spinal Tumors:

- Robotics and advanced image-guidance adjust for a patient’s movements and map the precise location of the lesion during treatment.
- Focused radiation delivers a maximally aggressive dose of radiation to the target abnormality with minimal impact on the healthy tissue.
- No frame is used to immobilize the patient.
- Treatment is completed on outpatient basis without the need for a hospital stay.
- The VSI™ System is the latest development in CyberKnife technology. Faster radiation delivery and variable beam apertures enable us to considerably reduce the treatment time, extending the advantages of radiosurgery over conventionally fractionated radiation therapy.

The Spine Center faculty who specialize in tumors are members of the Spine Oncology Study Group — an international collaboration of spine tumor experts who partner in studying the behavioral pattern of these tumors and analyzing the efficacy of current therapies.

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The CyberKnife radiosurgery platform at UCSF Medical Center provides non-invasive treatment for spinal tumors.

- Spondylectomy (en bloc resection) for primary and metastatic tumors, including sacral tumors
- Transpedicular corpectomy for metastatic tumors
- Cervical transpedicular technique for ventral intradural tumors
- Lateral transpedicular approach to deep midline tumors of the cervical spine
- Image-guided tumor resection using advanced neuronavigation software

surgical techniques for removal of malignant neoplasms
Vertebral fractures occur with twice the frequency of hip and wrist fractures combined. Approximately 700,000 vertebral compression fractures are diagnosed in the United States annually. As with many fragility fractures, vertebral compression fractures are more common in women than men; however, the consequences are severe in both. Patients may experience acute and chronic pain, kyphotic deformity (increased forward curve of the spine), compromised respiratory and GI function, increased risk of future fractures, decreased quality of life, increased anxiety, depression, and death.

The UCSF Spine Center provides care from specialists in spine surgery, radiology, internal medicine, gerontology, endocrinology, physical therapy, orthotics and prosthetics, pain management, and skeletal health. Comprehensive and integrated care is essential to minimize the severe morbidity and mortality associated with vertebral compression fractures, as well as prevent future fractures.

Vertebral compression fractures can occur during simple activities of daily living, such as coughing, sitting down quickly, or taking a step wrong. Vertebral fractures in younger patients typically result from substantial trauma.

Older patients and those with osteoporosis have a high risk of spinal fractures, particularly vertebral compression fractures. The reasons are multi-factorial but include low bone mass and strength, as well as an increased risk of falling. In these patients, vertebral compression fractures are more common in women than men; however, the consequences are severe in both. Patients may experience acute and chronic pain, kyphotic deformity (increased forward curve of the spine), compromised respiratory and GI function, increased risk of future fractures, decreased quality of life, increased anxiety, depression, and death.

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high-risk spine surgery team

A high-risk spine team has been formed at UCSF to improve surgical care for elderly patients (> 65 years) with spinal conditions, who are at higher risk of complication during surgery. Each patient is treated by a hospitalist and a nutritionist who optimizes the patient’s diet prior to surgery. A neurosurgeon and an orthopaedic surgeon operate on each patient simultaneously with the goals of decreasing blood loss and shortening operating times.

Orthopaedic surgeon Vedat Deviren and neurosurgeon Christopher Ames collaborate in the operating room to perform a spinal fusion for a high-risk patient.
### Indicators of Possible Vertebral Compression Fractures in Older Patients

- Development of back pain
- Stooped or hunched posture
- Loss of 0.5 inch or more in height in one year
- Loss of more than 1.5 inches from original height
- Protuberant abdomen
- Decreased respiratory capacity
- Early satiety, weight loss

### In Patient Management vs. Out Patient Management

<table>
<thead>
<tr>
<th>In Patient Management</th>
<th>Out Patient Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical management of co-existing conditions</td>
<td>Spine Clinic</td>
</tr>
<tr>
<td>Imaging (Xray, CT, MRI)</td>
<td>Imaging (Xray, CT, MRI)</td>
</tr>
<tr>
<td>Surgical Care</td>
<td>Surgical Care</td>
</tr>
<tr>
<td>• Percutaneous vertebral augmentation</td>
<td>• Percutaneous vertebral augmentation</td>
</tr>
<tr>
<td>• Decompression and fusion</td>
<td></td>
</tr>
<tr>
<td>Non-surgical Management</td>
<td>Non-surgical Management</td>
</tr>
<tr>
<td>• Pain management</td>
<td>• Pain management</td>
</tr>
<tr>
<td>• Physiatry</td>
<td>• Physiatry</td>
</tr>
<tr>
<td>• Short-term bracing, if indicated</td>
<td>• Orthotics, if bracing is indicated</td>
</tr>
<tr>
<td>Physical Therapy for safe mobility, fall prevention, and discharge planning</td>
<td>Physical Therapy for safe mobility and fall prevention</td>
</tr>
<tr>
<td>Skeletal Health</td>
<td>Skeletal Health</td>
</tr>
<tr>
<td>• Evaluation (risk-factor screening, labs)</td>
<td>• Evaluation (risk-factor screening, dual x-ray absorptiometry, labs)</td>
</tr>
<tr>
<td>• Optimization of nutrients</td>
<td>• Treatment of osteopenia/osteoporosis</td>
</tr>
<tr>
<td>• Patient education</td>
<td>• Patient education</td>
</tr>
<tr>
<td>• Stand Tall exercise program for osteoporotic patients</td>
<td></td>
</tr>
</tbody>
</table>
Our spine surgeons place particular emphasis on adequate and thorough neural decompression and protection, combined with restoration of normal global and regional spinal balance. State-of-the-art spinal cord monitoring techniques are employed by PhD-level electrophysiologists in the operating rooms to provide the highest levels of patient safety.

Conditions treated include:
- Adult degenerative scoliosis
- Adult idiopathic scoliosis
- Adolescent scoliosis
- Congenital deformities
- Scheuermann’s kyphosis
- Severe lordotic deformities
- Severe kyphotic deformities
- Failed-back syndrome
- Flat-back syndrome
- Chin-on-chest kyphotic deformity
- High-grade spondylolisthesis
- Neuromuscular scoliosis
- Ankylosing spondylitis
- Rheumatoid arthritis

To restore functional capacity and eliminate pain, our skilled team uses a wide variety of techniques, including pedicle subtraction osteotomies, Smith-Peterson osteotomies, Ponte-type osteotomies, and vertebral column resection.

spinal deformity in patients with parkinson’s disease

Movement disorders and spine care specialists at UCSF work together closely to care for patients with both Parkinson’s disease and spinal deformity. Although there is little guidance for management, this issue is becoming increasingly relevant with a growing elderly population of Parkinson’s patients.

Spinal deformity can be a consequence of Parkinson’s disease, and a recent study at UCSF demonstrated a 50% complication rate for operations on these patients. Adjacent segment degeneration and junctional kyphosis are common in Parkinson’s patients, and these patients often require multiple surgeries to treat spinal deformity.
All the faculty and staff in the UCSF Spine Center are dedicated to improving our care of spine patients. Performing clinical research allows us to improve care in a way that reaches people with spinal conditions worldwide. By systematically and analytically reviewing our patients’ outcomes, we can implement the best evidence-based practices. Many of our patients are involved in specific ongoing studies, and all patients are asked to complete outcomes questionnaires so that we may objectively and carefully evaluate the effectiveness of our recommendations and surgeries.

**current areas of study**

- Incidence and risk factors for degeneration and disease adjacent to a fusion
- Risk factors for developing kyphosis at the end of a fusion
- Use of teriparatide (parathyroid hormone) to potentially increase the healing rate of spine fusions
- Specialized MRI sequences to determine which discs may be painful
- Evaluating the risk factors for complications of surgery, such as infection, DVT/PE, or reoperation
- Improved nerve monitoring techniques for placement of pedicle screws
- Defining the coexistence of cervical spondylosis and adult spinal deformity
To refer a patient to the UCSF Spine Center, call (866) 81-SPINE or (866) 817-7463.

Visit us online at neurosurgery.ucsf.edu and orthosurg.ucsf.edu

UCSF Spine Center
400 Parnassus Ave., Third Floor
San Francisco, CA 94143-0332
Fax: (415) 353-4047