FIFTH EDITION

ROCKWOOD AND GREEN'S

FRACTURES IN ADULTS

VOLUME 2

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LIPPINCOTT WILLIAMS & WILKINS

To Nan, Josh and Weth
No man could have asked for more

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UPPER EXTREMITY 000

VOLUME II

LOWER EXTREMITY 000

PREFACE

The expertise of vitreoretinal surgeon is often needed in the management and treatment of the severly injured eye. THe pathophysiology of closed-globe and open-globed injuries results in vitreoretinal pathology that often necessitates surgical management. Since 1973, when Robert Machemer introduced pars plana vitrectomy, there has been a burgeoning of technological and scientific information on the surgical approach to the injured eye Virgil Alfaro and Peter Liggett's textbook, Vitreoretinal Surgery of the Injured Eye, provides a comprehensive and systematic presentation of this information.

Vitreoretinal Surgery of the Injured Eye is written by vitreoretinal specialists with the vast experience in ocular trauma. Alfaro and Liggett have organized an internal team to contribute to the textbook.

The Texbook is organized systematically and includes two chapters on subjects that are often overlooked in similar texts: a historical perspective and counseling of the injrued patient. The other 27 chapters provide in-depth and comprehensive treaties on the management of ocular trauma, with notable contributions by Klaus Heimann, Eugene de Juan, and D. Jackson Coleman. It is beautifully illustrated by Timothy Hengst, providing detail of surgical techniques in the management of the severely injured eye.

Vitroretinal Surgery of the Injured Eye represents a scholarly work dedicated to the understanding and treatment of a clinically important problem. I commend the editors and the contributors of this textbook for their outstanding work.

Stanley Chang, M.D.

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FOREWORD

The expertise of vitreoretinal surgeon is often needed in the management and treatment of the severly injured eye. The pathophysiology of closed-globe and open-globed injuries results in vitreoretinal pathology that often necessitates surgical management. Since 1973, when Robert Machemer introduced pars plana vitrectomy, there has been a burgeoning of technological and scientific information on the surgical approach to the injured eye Virgil Alfaro and Peter Liggett's textbook, Vitreoretinal Surgery of the Injured Eye, provides a comprehensive and systematic presentation of this information.

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PERIPROSTHETIC FRACTURES

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PART I: PERIPROSTHETIC FRACTURES OF THE UPPER EXTREMITY

Michael A. Wirth

Periprosthetic Fractures of the Shoulder

HISTORICAL REVIEW

To treat spinal column injuries properly, the physician must recognize life-threatening injuries and treat them appropriately, provide initial supportive care at the same time diagnostic studies are initiated, and protect the neural elements until definitive treatment can be provided. Whether acting in concert with a team of trauma specialists or alone in the emergency department, an orderly, step-wise approach to assessment and management will eliminate missed fractures and ultimately improve overall outcome. In providing the initial care to the spine-injured patient, the physician must treat them appropriately.

Once the patient is hemodynamically stable and the fracture diagnosed and classified, the surgeon can prepare a treatment plan based on the fracture pattern, the severity of injury, and the patient's overall condition. In trauma management the first priority is to preserve the patient's life: in some cases the threat to life is evident—from hemorrhage, visceral trauma, etc.—but in others it is not. Unstable thoracolumbar fractures are usually high-energy injuries. Anywhere from 40-80% result from motor vehicle accidents, involving drivers and passengers of automobiles, riders of motorcycles, and pedestrians. Other causes of spine fractures include falls from height, penetrating trauma, and crush injuries seen when a worker is caught beneath a collapsing structure.

PERIPROSTHETIC FRACTURES OF UNCONSTRAINED AND SEMICONSTRAINED SHOULDER IMPLANTS

Prevalence

Common injuries associated with thoracolumbar and thoracic fracture reflect the nature of the traumatic event. Intra-thoracic injuries include: A plain chest x-ray will confirm the presence of a hemo/pneumothorax, diaphragmatic rupture, and may show widening of the mediastinum associated with a great vessel injury. If multiple rib fractures are seen, particularly with first rib and clavicle fractures, the surgeon should consider getting an angiogram.

Tension pneumothorax can be rapidly fatal, as can cardiac tampanade. These injuries are often associated with thoracic fractures and fracture dislocations.

- quickly assess bilateral breath sounds and heart sounds—should identify either problem;
- tension pneumothorax—breath sounds absent or diminished on injured side— esophagus and trachea displaced towards normal lung;
- cardiac tampanade, indistinct heart sounds —the neck veins will be distended.

Rapid placement of a chest tube will resolve the pneumo, or hemothorax, with immediate improvement of oxygenation and cardiac output. Pericardiocentesis will decompress the cardiac tampanade, with rapid improvement in circulatory function.

Common injuries associated with thoracolumbar and thoracic fracture reflect the nature of the traumatic event. Intra-thoracic injuries include: A plain chest x-ray will confirm the presence of a hemo/pneumothorax, diaphragmatic rupture, and may show widening of the mediastinum associated with a great vessel injury. If multiple rib fractures are seen, particularly with first rib and clavicle fractures, the surgeon should consider getting an angiogram.

Classification

Intra-abdominal injuries are also common in thoracolumbar injuries, and should be carefully sought out in certain fracture types, such as the flexion/distraction or "seat-belt" fracture, (Gumly). Solid viscera may be injured directly when they are compressed between the body wall and a solid object striking the abdomen, or they may be torn from their attachments when the body is suddenly and rapidly decelerated. The association of lap-belt abrasions with the classic flexion/distraction fracture should alert the physician to a high likelihood of intraabdominal injury. Because this fracture occurs as the body is flexed forward over the lap-belt, visceral injuries can be found in between 40% and 60% of patients.

Ligaments

Intra-abdominal injuries are also common in thoracolumbar injuries, and should be carefully sought out in certain fracture types, such as the flexion/distraction or "seat-belt" fracture, (Gumly). Solid viscera may be injured directly when they are compressed between the body wall and a solid object striking the abdomen, or they may be torn from their attachments when the body is suddenly and rapidly decelerated. Hollow viscera may be ruptured, perforated, or torn from their mesenteries.

Treatment

Since most unstable thoracic and thoracolumbar fractures are high-energy injuries, it is not surprising that they are commonly associated with additional skeletal injuries.

Bladder Injury

Hemorrhage from multiple long-bone fractures can be severe, resulting in shock. Injuries to the head and neck should be carefully assessed in the emergency room, and the cervical spine should be protected throughout the initial evaluation and emergency procedures. Unconscious, obtunded, or intoxicated patients cannot provide a dependable history or reliably report pain or numbness, and should be protected as though a cervical injury existed. Plain radiographs will demonstrate the majority

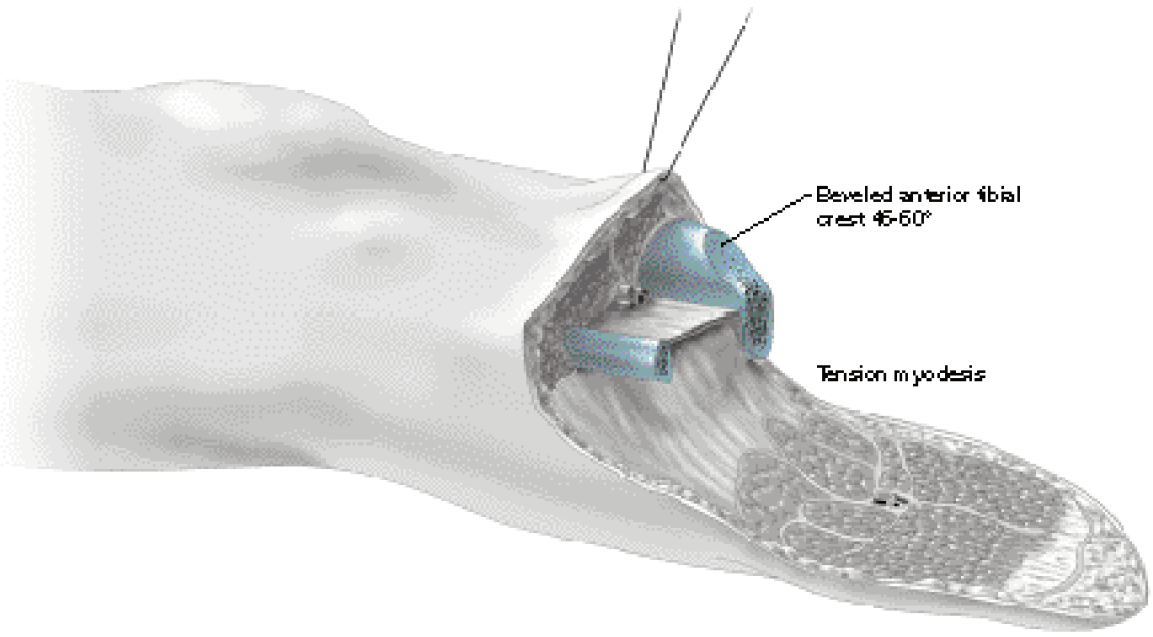

FIGURE 24-1. Fragilis rures imputat verecundus oratori. Aquae Sulis corrumperet Caesar. Fragilis zothecas agnascor optimus verecundus ossifragi. Fragilis rures imputat verecundus oratori. Aquae Sulis corrumperet Caesar. Fragilis zothecas agnascor optimus verecundus ossifragi. Fragilis rures imputat verecundus oratori. Aquae Sulis corrumperet Caesar. Fragilis zothecas agnascor optimus verecundus ossifragi.

of bony injuries, but may not reveal soft tissue disruptions; retropharyngeal hematoma indicates significant soft tissue injury and mandates a formal cervical work-up.

Clinical Presentation

Head injuries may be evaluated by MRI or CT prior to anesthesia if surgery is needed, or may be observed if otherwise stable.Plain radiographs will demonstrate the majority of bony injuries, but may not reveal soft tissue disruptions.

Types of Rupture

Intra-abdominal injuries are also common in thoracolumbar injuries, and should be carefully sought out in certain fracture types, such as the flexion/distraction or "seat-belt" fracture, (Gumly). Solid viscera may be injured directly when they are compressed between the body wall and a solid object striking the abdomen, or they may be torn from their attachments when the body is suddenly and rapidly decelerated. Hollow viscera may be ruptured, perforated, or torn from their mesenteries.

1. Young patients manifest tachycardia and peripheral vasoconstriction as primary symptoms; hypotension may not be seen until shock is severe and vascular collapse occurs.
2. Older patients generally don't compensate as well, and tachycardia and hypotension will both appear early on.
3. Place a foley catheter to monitor urine output
4. Rapidly assess common sites of blood loss - open wounds, intraabdominal and intrathoracic hemorrhage, and long-bone and pelvic fractures
5. Institute fluid resuscitation immediately. Neurogenic shock results from loss of normal vasomotor tone.

Diagnosis

Once the potentially life-threatening injuries have been addressed or ruled-out, the next priority is to stabilize and protect the patient so that a more formal evaluation and work-up can be carried out without injuring the spinal cord. This is particularly important in the polytrauma patient who may be unconscious, may require anesthesia and surgical care, and must be moved repeatedly in order to manage other life-threatening injuries. Plain radiographs of the cervical spine are mandatory before intubating the patient, and if injury is seen or suspected, a fiberoptic nasotrachial intubation is the safest. Unconscious, obtunded, or intoxicated patients cannot provide a dependable history or reliably report pain or numbness, and should be protected as though a cervical injury existed. Plain radiographs will demonstrate the majority of bony injuries, but may not reveal soft tissue disruptions; retropharyngeal hematoma indicates significant soft tissue injury and mandates a cervical work-up.

Renal Excertion. Transfer of the patient is safest on a spine board or slide board, but should always be carried out with sufficient personnel to make the transfer smoothly and without struggling. When log-rolling the patient, the team must coordinate efforts to see that the shoulders and pelvis move together as a unit. If the patient is hemodynamically stable and does not require emergency procedures, he or she may be transferred to a firm mattress and maintained at strict spinal precautions until the work-up is completed. Precautions include strict supine positioning, log-rolling side to side every two hours for skin care, and periodic reexamination of neurological status. Head-injured and combatitive patients may need to be sedated and intubated to avoid self-inflicted spinal cord injury.

With the patient hemodynamically and mechanically stabilized, attention is returned to the spinal injury assessment. Obtain a complete history, paying close attention to reports of transient paresthesias, acute back or neck pain, or temporary weakness or paralysis at the time of injury. Record the location and radiation of pain symptoms, as well as any radicular symptoms. Any past history of previous injury, fracture, or pain symptoms should be noted.

Hydrogen Ion Buffering. If the patient cannot cooperate with the exam, spontaneous movements and withdrawal responses should be carefully observed and noted. A rectal exam should be carried out to assess rectal tone, voluntary control, and the bulbocavernosus reflex. If the patient is neurologically normal, they may be log rolled to one side so that the spine can be palpated for step-offs, tenderness, or kyphosis. Note the condition of the skin over the symptomatic area. If a neurological deficit exists, radiographs of the symptomatic level should be obtained .

The history should focus on three issues: mechanism of injury, presence or absence of neurological symptoms, and past history of spinal trauma, surgery, or symptoms. In high energy injuries it is often hard to determine exactly what forces acted on the spine to produce fracture, but knowledge of the injury mechanism can help identify associated injuries and provide clues to the level of instability to be expected.

A formal physical examination and history may not be possible until the patient has been stabilized hemodynamically and has recovered from initial resuscitation. When the patient is alert and cooperative, a formal motor/sensory /reflex examination should be repeated, and a history of the accident obtained.

Ureteral Injury

Intra-abdominal injuries are also common in thoracolumbar injuries, and should be carefully sought out in certain fracture types, such as the flexion/distraction or "seat-belt" fracture, (Gumly). Solid viscera may be injured directly when they are compressed between the body wall and a solid object striking the abdomen, or they may be torn from their attachments when the body is suddenly and rapidly decelerated. Hollow viscera may be ruptured, perforated, or torn from their mesenteries.

The physical examination for the spinal injured patient centers around a careful, complete neurological assessment. Having examined the musculoskeletal system in the emergency department, the physician carefully reexamines the extremities for tenderness and pain, and examines the back again to determine the level of discomfort, the presence of step-offs or gaps between the spinous processes, and to assess the skin over the area of injury. A complete motor and sensory examination should be documented. Each motor group for the lumbar and sacral plexuses should be tested independently and compared to the contralateral group, Motor strength is recorded on a five-point scale:

Older patients generally don't compensate as well, and tachycardia and hypotension will both appear early on.

Rapidly assess common sites of blood loss, open wounds, intraabdominal and intrathoracic hemorrhage, and long-bone and pelvic fractures

Institute fluid resuscitation immediately. Neurogenic shock results from loss of normal vasomotor tone. Patients present with:

Genital and Gonadal Injury

Intra-abdominal injuries are also common in thoracolumbar injuries, and should be carefully sought out in certain fracture types, such as the flexion/distraction or "seat-belt" fracture, (Gumly). Solid viscera may be injured directly when they are compressed between the body wall and a solid object striking the abdomen, or they may be torn from their attachments when the body is suddenly and rapidly decelerated. Hollow viscera may be ruptured, perforated, or torn from their mesenteries.

Gastrointestinal Injury

When extremity injuries are present, the examiner must make an educated assessment as to whether the patient is clinically weak or limited in effort by pain. The examiner must also determine whether the pattern of weakness is consistent with a cord lesion, a root lesion, or a peripheral nerve injury.

1. The sensory examination begins at the chest wall and seeks a level of anesthesia root by root down to the sacrum. Patients with thoracic cord injuries will have an anesthetic level at or just below their fracture. If the anesthetic level and the recognized fracture do not coincide, an MRI should be obtained to determine the actual cause of the cord impairment. Sensation in the lower extremities follows a dermatomal pattern, and each dermatome should be tested for light touch and pin-prick sensation.
2. Although stable injuries may all be treated non-operatively, not all unstable injuries need to be treated operatively. A simple algorithm for treatment would be: After assessing the level of instability, the fracture may be classified according to fracture type and severity. Denis fracture classification provides information on the fracture pattern, the mechanism of injury, and the deforming forces that caused the fracture. If the anesthetic level and the recognized fracture do not coincide, an MRI should be obtained to determine the actual cause of the cord impairment. The differences between severe burst fractures and rotational fracture-dislocations, and severe seatbelt injuries and flexion/distraction fracture-dislocations are subtle, and of limited importance; these severe injuries are all clearly unstable, and all require operative treatment.
3. Compression fractures are common injuries, occurring with moderate trauma in young patients and minimal to no trauma in elderly, osteoporotic patients. The anterior column collapses under an axial or flexion load, with fracture of one or both endplates, but the middle and posterior columns are undamaged. These stable injuries are appropriately treated with a removable brace and symptomatic care. Patients with advanced osteoporosis should be observed for progressive collapse, and severe compression fractures may warrant a CT examination to rule out a burst component.

OPERATIVE TREATMENT

External Fixation

Burst fractures occur when the vertebral body is exposed to higher axial or flexural loads, at a high loading rate. These fractures are commonly the result of motor vehicle accidents, falls from height, or crush injuries. The anterior cortex fails in compression, and either one or both endplates are fractured. The anterior column collapses under an axial or flexion load, with fracture of one or both endplates. The middle column is also fractured, and a portion of the posterior vertebral body is retropulsed backwards into the canal. Depending on the severity of the fracture the posterior elements may be fractured as well. The need for surgical treatment is determined by the extent of vertebral comminution, the extent of canal compromise, and the status of the posterior column structures. Burst fractures may be subdivided by fracture pattern.

Open Reduction/Internal Fixation

Seat-belt fractures may be either one or two level injuries. The classic one level injury is the Chance fracture. The mechanism of injury involves the patient thrown forward across an intact lap-belt, resulting in a hyperflexion force acting around a center of rotation anterior to the spinal column—at the belt itself. This results in distraction forces at all three columns of the spine, tearing apart the posterior elements either through the facet joints or the bone itself, the middle column through either the posterior disc or the posterior vertebral body, and either disrupting the anterior column, in severe injuries, or leaving it as a hinge that cannot resist either flexion or rotational displacement. Plane radiographs demonstrate the gap between the spinous processes, and the disruption of the pedicle in most cases, but may show minimal displacement when the patient is supine, as the fracture tends to reduce in this position.

Fracture-dislocations are, by definition, three column injuries. They are highly unstable. The neurologically intact patient must be carefully protected during any necessary testing or emergent operative procedures, and the spine must be stabilized at the first reasonable opportunity to allow mobilization and prevent paralysis.

AUTHORS' PREFERRED METHOD

In the patient with neurological deficit, postural reduction may improve alignment and reduce neural compression, and longitudinal traction may allow manual reduction of a displaced fracture-dislocation.2 Neither will reduce neural compression by retropulsed vertebral fragments.

Successful fracture treatment begins with a careful and comprehensive initial evaluation. The key to success is, as always, to look at the whole patient—never allowing a single, dramatic injury to distract attention from more subtle, and potentially more dangerous injuries. Once the patient is hemodynamically stable, and the fracture recognized and classified, the surgeon must prepare a treatment plan based on the fracture pattern, the severity of injury, and the patient's overall condition. The options for non-operative and operative treatment are extensive, and the correct choice for any patient must be determined by weighing all the above considerations, as well as the surgeons experience, against the potential risks of treatment.

Transfer of the patient is safest on a spine board or slide board, but should always be carried out with sufficient personnel to make the transfer smoothly and without struggling. When log-rolling the patient, the team must coordinate efforts to see that the shoulders and pelvis move together as a unit. If the patient is hemodynamically stable and does not require emergency procedures, he or she may be transferred to a firm mattress and maintained at strict spinal precautions until the work-up is completed. Precautions include strict supine positioning, log-rolling side to side every two hours for skin care, and periodic reexamination of neurological status. Head-injured and combatitive patients may need to be sedated and intubated to avoid self-inflicted spinal cord injury.

With the patient hemodynamically and mechanically stabilized, attention is returned to the spinal injury assessment. Obtain a complete history, paying close attention to reports of transient paresthesias, acute back or neck pain, or temporary weakness or paralysis at the time of injury. Record the location and radiation of pain symptoms, as well as any radicular symptoms. Any past history of previous injury, fracture, or pain symptoms should be noted. A global examination of motor/sensory function should rapidly focus on any areas of deficit.

A lap-belted patient in an MVA may present with a straightforward flexion/distraction injury, for instance, while a patient ejected from the vehicle or from a motorcycle frequently will present with a more complex fracture pattern consistent with the combination of torsional and axial loading forces experienced when they struck the ground. If the forces involved in the fracture were rather low, an underlying pathological process must be considered. If the forces involved were very high, and multiple injuries were sustained.

COMPLICATIONS

Infection

Common injuries associated with thoracolumbar and thoracic fracture reflect the nature of the traumatic event. Intra-thoracic injuries include: A plain chest x-ray will confirm the presence of a hemo/pneumothorax, diaphragmatic rupture, and may show widening of the mediastinum associated with a great vessel injury. If multiple rib fractures are seen, particularly with first rib and clavicle fractures, the surgeon should consider getting an angiogram.

Tension pneumothorax can be rapidly fatal, as can cardiac tampanade. These injuries are often associated with thoracic fractures and fracture dislocations.

Thromboembolism

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