FLEX CEUs

Sacral and Pelvic Ring Injuries

Introduction

Sacral and pelvic ring injuries present complex challenges in physical therapy, given the intricate nature of these anatomical regions and their vital roles in movement, stability, and load-bearing. These types of injuries, often caused by traumatic events like falls, vehicle accidents, or high-impact sports, can significantly impair mobility, functionality, and quality of life. Timely and effective physical therapy intervention is essential to facilitate pain reduction, functional recovery, and improved patient outcomes. This course aims to provide physical therapists and physical therapist assistants with a thorough understanding of the anatomy, diagnostic techniques, fracture classifications, biomechanics, and prevalent injury patterns associated with the sacrum and pelvic ring. The course delves into research-backed strategies for patient assessment, treatment, and rehabilitation, addressing both the initial acute management and the longer-term recovery process. Participants will gain hands-on knowledge of manual therapy, therapeutic exercises, and other key modalities to develop tailored care plans that optimize recovery and enhance patient quality of life.

Background Information

Sacral and pelvic ring injuries occur when the bones of the sacrum and pelvis, which support the spine and help with weight-bearing and movement, are damaged. These injuries are relatively rare, but they can be serious, especially after high-impact events like car accidents or falls. In older adults with weaker bones, even minor falls can cause fractures in this area. Pelvic injuries are often linked with other complications, including injuries to internal organs or the spine, making treatment more complex. The sacrum and pelvic ring are vital for stabilizing the body and allowing movement, so damage to these structures can greatly affect mobility and function. A basic understanding of the anatomy,

common causes, and types of injuries is important for those involved in the care and rehabilitation of patients with these injuries. This knowledge helps physical therapists create effective treatment plans to improve recovery and restore movement.

Definition

References: 1

A sacral and pelvic ring injury is defined as any disruption, fracture, or dislocation involving the sacrum and the pelvic ring, which includes the sacrum, ilium, ischium, and pubic bones. The pelvic ring forms a continuous bony structure that stabilizes the axial skeleton and supports the transmission of forces between the trunk and lower extremities. Sacral fractures typically involve the posterior portion of the pelvic ring and can be categorized by Denis' classification into three zones based on location and potential for neurovascular involvement.

Pelvic ring injuries may be classified as stable or unstable, depending on the integrity of the anterior and posterior arch structures. Unstable fractures, which often result from high-energy trauma such as motor vehicle collisions, falls from height, or crushing injuries, involve significant displacement and disruption of the pelvic ligaments, leading to compromised structural integrity. In contrast, stable fractures are often seen in lower-energy trauma, such as minor falls in osteoporotic patients. These injuries often present with associated complications, including neurovascular damage, visceral injuries, and hemorrhage, necessitating a multidisciplinary approach for comprehensive management.

Epidemiology

References: 1, 2

Understanding the epidemiological trends of sacral and pelvic ring injuries is crucial for developing targeted prevention strategies and effective management protocols in clinical practice. This section will explore the prevalence, incidence, and demographics of those who sustain sacral and pelvic ring injuries.

Incidence and Prevalence

The incidence rates of sacral and pelvic ring injuries are estimated at 3-8% of all fractures among trauma patients. In the general population, the annual incidence of pelvic fractures has been reported to range from 10 to 35 cases per 100,000 individuals. This number may vary depending on several factors such as age, activity level, and geographical location. Major urban trauma centers often report higher incidence rates due to the nature and frequency of severe injuries encountered in these environments. The higher incidence in urban settings can be attributed to factors such as increased rates of high-energy trauma from motor vehicle accidents, industrial incidents, and sports injuries, leading to a more pronounced representation of sacral and pelvic ring injuries within trauma registries. Thus, understanding these incidence rates is essential for healthcare providers to anticipate the demands placed on trauma services and develop effective treatment and rehabilitation strategies for affected individuals.

Demographics

The demographics of sacral and pelvic ring injuries reveal significant variations based on age, gender, geographic location, and associated health conditions. Age plays a crucial role, with individuals aged 65 years and older exhibiting a markedly higher prevalence of these injuries. This increase is largely attributable to age-related factors such as osteoporosis. Research indicates that approximately 25% of older adults who sustain hip fractures may also present with concurrent pelvic fractures, highlighting the risk of this population to low-energy trauma.

Conversely, younger individuals, particularly those aged 15 to 40 years, often experience sacral and pelvic ring injuries because of high-energy trauma. This age group is more frequently involved in motor vehicle accidents, sports injuries, and falls from significant heights, which contribute to their higher incidence of injuries in trauma settings.

Gender differences further complicate the demographic landscape of these injuries. Males typically represent a greater proportion, accounting for approximately 60-80% of pelvic fracture cases, primarily due to a higher likelihood of engaging in high-risk activities and experiencing high-energy trauma. In contrast, females often sustain pelvic fractures linked to low-energy falls, particularly in the older population. The risk of these fractures in women increases post-menopause due to hormonal changes that contribute to bone density loss.

Urban areas tend to report higher incidence rates due to increased exposure to high-energy trauma, such as motor vehicle collisions and industrial accidents, while rural regions may experience more low-energy injuries stemming from falls. Additionally, access to healthcare facilities can affect the reporting and treatment of these injuries, leading to potential discrepancies in demographic trends across different regions.

Associated health conditions, including osteoporosis and obesity, can further affect the risk of these injuries. Older adults with osteoporosis are at a heightened risk for sacral and pelvic injuries, while individuals with obesity may face altered biomechanics and a greater likelihood of falls, increasing the incidence of injuries. Socioeconomic factors also play a role; individuals from lower socioeconomic backgrounds may encounter higher risks due to limited access to healthcare, higher rates of chronic conditions, and less engagement in preventive health measures.

Associated Injuries

References: 1, 3, 4

Pelvic ring and sacral injuries are often accompanied by a range of associated injuries due to the anatomical complexity of the pelvis and its proximity to vital structures. These associated injuries can significantly complicate management and impact patient outcomes. The following are some of the most common injuries associated with sacral and pelvic ring fractures.

Soft Tissue

Sacral and pelvic ring fractures often occur due to high-energy trauma such as motor vehicle accidents, falls from significant heights, or direct impact. These fractures can result in a range of associated soft tissue injuries due to the complex anatomy and proximity of vital structures around the pelvis. Soft tissue damage can significantly complicate both the clinical presentation and the recovery process, requiring careful management.

One of the primary soft tissue injuries involves the surrounding muscles. Muscles such as the gluteals, hip flexors, quadratus lumborum, and pelvic floor muscles may be strained, torn, or contused from the force of the trauma or the displacement of fractured bone fragments. The involvement of these muscles can result in significant pain, limited mobility, and impaired function in the hips and lower back. Physical therapy interventions will often focus on regaining strength, flexibility, and stability in these muscles.

In addition to muscle injuries, ligaments are often injured. The sacroiliac ligaments can be strained or torn, resulting in instability of the pelvic ring. Likewise, the pubic symphysis and its associated ligaments may be disrupted in cases of anterior pelvic ring fractures, leading to pelvic girdle instability. Rehabilitation in such cases

must address not only the healing of bone fractures but also the restoration of ligament integrity and joint stability.

Some patients may experience Morel-Lavallée lesions, a type of degloving injury where the soft tissue is sheared off from the underlying fascia, creating a potential space for fluid collection. This type of injury is common over areas like the greater trochanter or sacrum and can lead to chronic pain, infection, or delayed wound healing. These lesions may require drainage, and rehabilitation will need to carefully monitor the healing process to prevent further complications.

Neurological Injury

Sacral and pelvic ring fractures frequently result in neurologic injuries due to the proximity of the sacral nerve roots and lumbosacral plexus, which control motor and sensory function in the lower limbs, bladder, and pelvic organs. These injuries can cause significant complications, including radiculopathy, muscle weakness, and bladder or bowel dysfunction. Damage to the sacral nerve roots can lead to conditions like cauda equina syndrome, a medical emergency characterized by loss of bladder and bowel control, saddle anesthesia, and severe leg weakness, requiring urgent surgical intervention to prevent permanent damage.

Injuries to the lumbosacral plexus often cause motor and sensory deficits in the lower extremities, including weakness, paralysis, foot drop, and altered sensation, along with chronic neuropathic pain. The sciatic nerve is frequently affected, leading to difficulties with walking and balance. In severe cases, fractures may cause cauda equina syndrome, which requires immediate surgical decompression to prevent long-term neurological impairment.

Vasculature

Vascular injuries are significant and potentially life-threatening complications of sacral and pelvic ring fractures, especially following high-energy trauma, such as motor vehicle accidents or falls. Fractures can cause vascular injuries through direct laceration of iliac vessels or compression by displaced bone fragments, leading to severe internal bleeding and possible hemorrhagic shock if not promptly managed.

Initial management typically involves fluid resuscitation and stabilization of the fracture, with angiography or CT scans used to locate bleeding sources. Angiographic embolization may be employed to stop the bleeding, while surgical intervention may be necessary for more severe cases. In physical therapy, careful monitoring during rehabilitation is essential, as reduced blood flow can lead to delayed healing, tissue necrosis, or compartment syndrome. Restoring functional mobility while monitoring for complications like deep vein thrombosis is critical in the rehabilitation process.

Organ Damage

Given the proximity of the pelvis to vital organs, fractures can also lead to bladder and urethral injuries, particularly in cases involving anterior pelvic ring fractures. These structures may rupture or tear, leading to urinary leakage, infection, or even the need for surgical repair. Similarly, damage to the rectum or bowel can result in complications such as fecal incontinence or infections like peritonitis. These injuries require careful coordination with medical specialists to manage the surgical and rehabilitative aspects of care.

Associated Fractures

Sacral and pelvic ring fractures can be associated with injuries to the lumbosacral spine and facet joints due to the close anatomical and biomechanical connections

between these structures. The pelvis and sacrum serve as a critical foundation for the spine, and trauma to this area often disrupts the alignment and function of the lumbosacral junction, potentially leading to both acute and long-term complications.

Lumbosacral Spine Injuries

High-energy fractures of the sacrum can lead to displacement or compression of the L5-S1 intervertebral disc and vertebrae, resulting in structural instability. This instability can cause increased strain on the lumbar vertebrae and spinal discs, leading to conditions such as disc herniation or vertebral fractures. These injuries may result in significant pain, radiculopathy, and difficulty with mobility. The sacroiliac joint can also be impacted. Disruption of this joint due to sacral fractures or pelvic ring instability may cause sacroiliac joint dysfunction, leading to chronic pain in the lower back and buttocks, often radiating into the legs.

Facet Joint Injuries

The facet joints in the lumbar spine, particularly at the L4-L5 and L5-S1 levels, can be secondarily injured during sacral or pelvic trauma. These joints help stabilize the spine and control movement between vertebrae. With pelvic ring or sacral fractures, the altered mechanics and instability of the pelvis can lead to increased stress on the facet joints, potentially causing facet joint sprains, fractures, or subluxations.

Facet joint injuries may cause localized back pain, which is often aggravated by spinal extension or rotation. In cases of significant instability in the pelvis or sacrum, the increased forces on the lumbar spine can also accelerate facet joint degeneration, contributing to conditions like facet joint arthritis. This can result in chronic pain and stiffness in the lower back, as well as restricted mobility.

In managing sacral and pelvic ring fractures, addressing these associated injuries is critical for a full recovery. The physical therapy plan must consider not only the healing of bone fractures but also the complex interplay of muscles, ligaments, nerves, and other structures involved in the injury.

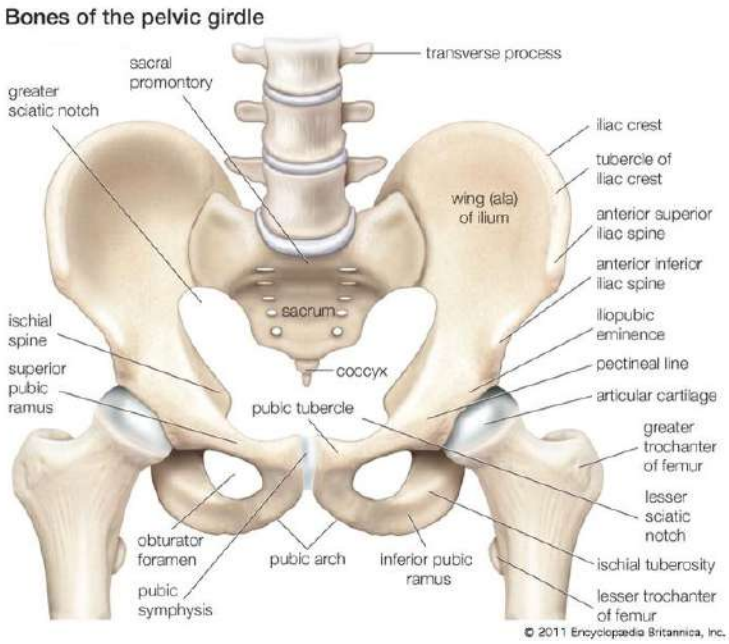
Anatomy

References: 5–8

Understanding the anatomy consisting of the sacrum and pelvis and their adjacent structures is crucial to build foundational knowledge of rehabilitation strategies. Physical therapists and assistants should have an in-depth understanding of the anatomy of the pelvis and sacrum to treat these areas and optimize function effectively.

Osteology

The pelvic girdle forms a bony ring that supports the weight of the upper body when sitting and standing and serves as an attachment for various muscles. The primary components of the pelvic girdle include the ilium, ischium, pubis, sacrum, and coccyx.



https://www.britannica.com/science/pelvis

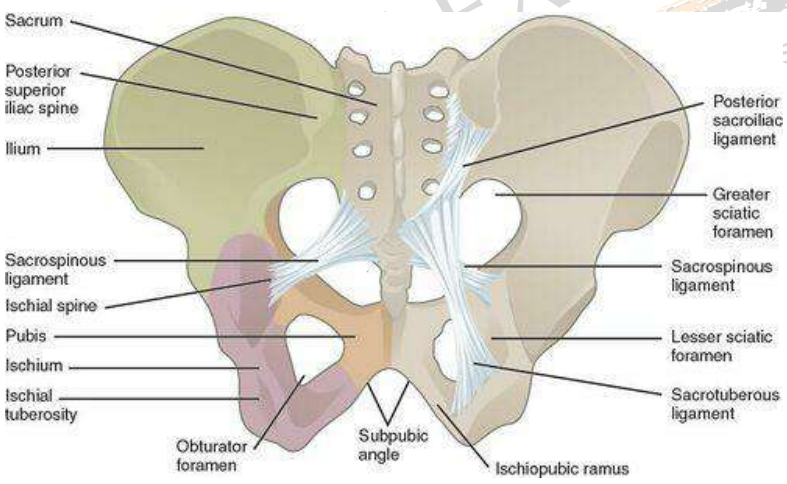
The ilium, the largest of the three pelvic bones, consist of a body and a broad, flared ala. It features several anatomical landmarks, including the iliac crest, which is the superior border of the ilium and serves as an important site for muscle attachment, such as the latissimus dorsi and internal and external obliques. The anterior superior iliac spine (ASIS) is a prominent bony landmark that is crucial for locating pelvic tilt and measuring leg length discrepancies. Additionally, the arcuate line is a curved line that marks the transition between the true and false pelvis. The ischium forms the posteroinferior aspect of the pelvis and has key features such as the ischial tuberosity, which is the weight-bearing portion of the ischium during sitting and serves as the attachment point for the hamstrings and sacrotuberous ligament. The ischial spine is a projection that serves as an attachment point for ligaments and muscles, including the sacrospinous ligament.

The pubis constitutes the anterior portion of the pelvic girdle and is divided into three parts: the pubic body, which articulates with the contralateral pubis at the pubic symphysis; the superior pubic ramus, which provides attachment for the

pectineus muscle and contributes to the pelvic brim; and the inferior pubic ramus, which joins with the ischium to form the ischiopubic ramus, an important structure in defining the pelvic outlet.

The sacrum consists of five fused sacral vertebrae (S1-S5) and has several notable features, including the sacral promontory, which is the anterior edge of S1 and serves as an important anatomical landmark during pelvic examinations. The anterior and posterior sacral foramina allow the passage of the anterior and posterior rami of the sacral nerves, while the ala are the wing-like structures that articulate with the ilium at the sacroiliac joint.

Finally, the coccyx is composed of three to five fused coccygeal vertebrae. It holds clinical significance in pelvic floor integrity and serves as an attachment point for various ligaments and muscles, contributing to the overall stability of the pelvic region.

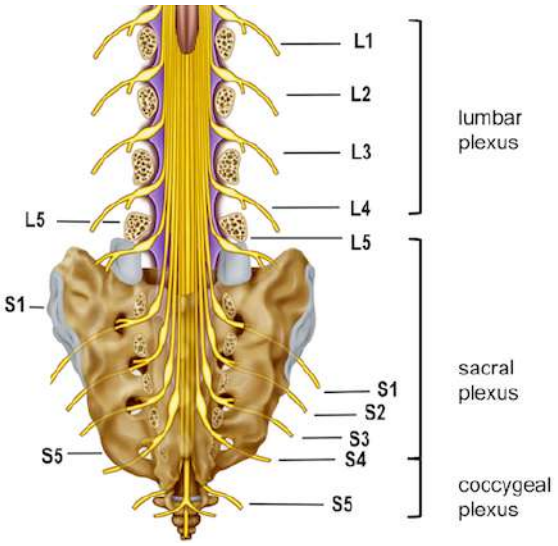


https://www.physio-pedia.com/Sacrotuberous_Ligament

Nerves

The sacral plexus, formed by the ventral rami of the first four sacral nerves (S1-S4), contributes to several major nerves. The S1 nerve provides motor innervation to the gluteus maximus and sensory innervation to the posterior aspect of the leg

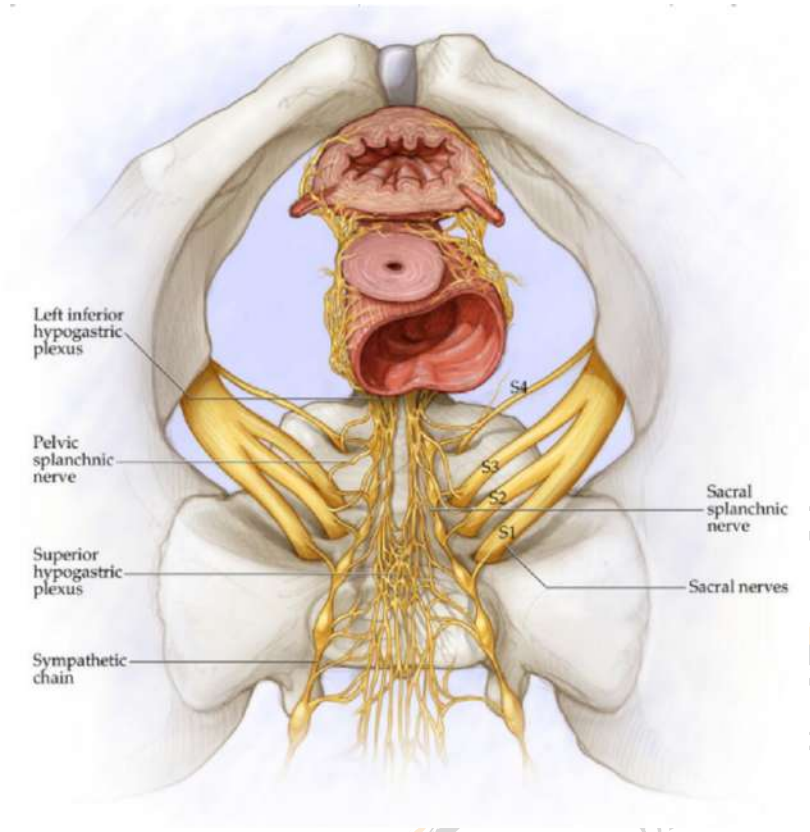
and foot, while S2 and S3 innervate the pelvic floor muscles and contribute to the sensory supply of the perineum. The sciatic nerve, formed by the L4-S3 roots, is the largest nerve in the body, responsible for motor and sensory function in the lower limb. The pudendal nerve (S2-S4) provides sensory innervation to the perineum and motor innervation to the pelvic floor muscles and external genitalia. It further divides into the inferior rectal nerve, which innervates the anal sphincter, the perineal nerve, which innervates the muscles of the perineum, and the dorsal nerve of the penis or clitoris, which provides sensory innervation to the genitalia.



https://anatomy.lexmedicus.com.au/collection/pelvis-hip

The autonomic nervous system in the pelvis consists of sympathetic and parasympathetic components. Sympathetic nerves originate from the thoracolumbar region (T10-L2), with the sympathetic trunk traveling down to the pelvis to form the hypogastric nerve, which innervates pelvic organs. In contrast, parasympathetic nerves originate from the sacral spinal cord (S2-S4) and include the pelvic splanchnic nerves, which carry sensory and autonomic fibers to pelvic viscera, such as the bladder and rectum. The inferior hypogastric plexus, formed by sympathetic fibers from the hypogastric nerve and parasympathetic fibers from the pelvic splanchnic nerves, provides autonomic innervation to pelvic organs.

Additionally, the coccygeal nerve supplies the skin over the coccyx and contributes to the innervation of the pelvic floor.



https://www.researchgate.net/figure/Pelvic-nerve-anatomy-The-sacral-spinal-nerves-contribute-to-the-lumbosacral-plexus-which_fig6_368275066

Overall, the nerves of the pelvis and sacrum play essential roles in both sensory and motor functions, significantly influencing pelvic floor dynamics, lower limb movement, and visceral function, making this knowledge vital for physical therapy, pain management, and surgical interventions.

Biomechanics

The sacrum transfers the load from the vertebral column to the pelvis and lower extremities through the sacroiliac joints, which allow limited motion while providing stability. When standing or walking, the pelvis and sacrum effectively absorb and distribute forces generated during activities, shifting weight from one

side of the pelvis to the other. The biomechanics of the pelvis include anterior and posterior pelvic tilt; anterior pelvic tilt occurs when the pelvis tilts forward, increasing lumbar lordosis and extending the hip joints, while posterior pelvic tilt involves tilting backward, decreasing lumbar lordosis and flexing the hips. Lateral pelvic tilt, where one side of the pelvis drops lower than the other, is common during walking and running, aiding in balance and efficient gait. The pelvis can also rotate around its vertical axis, which is crucial for activities like walking and running.

The sacrum helps absorb and distribute forces from weightbearing activity, preventing excessive strain on any single structure. Several muscles attach to the pelvis and sacrum, influencing its biomechanics. The gluteus maximus provides powerful hip extension and pelvic stability, while the hip flexors (iliacus and iliopsoas) assist in anterior pelvic tilt and hip flexion. Core muscles, including the rectus abdominis, obliques, and transverse abdominis, stabilize the pelvis and lumbar spine during movement, and the pelvic floor muscles support pelvic organs and maintain stability.

Etiology

References: 1, 7, 9

The etiology of sacral and pelvic ring injuries is multifactorial and typically involves a combination of traumatic events, anatomical considerations, and pre-existing conditions. Understanding these factors is crucial for effective diagnosis, treatment, and rehabilitation.

Motor Vehicle Accidents (MVAs)

Motor vehicle accidents are one of the most common causes of pelvic ring injuries, accounting for a substantial percentage of cases. The mechanism of injury

typically involves impact forces. In a collision, the body experiences rapid deceleration and impact forces that can lead to fractures. The pelvis, being a key weight-bearing structure, is particularly vulnerable to these forces.

Different types of collisions can result in various injury patterns. For example, frontal collisions often lead to direct impacts to the pelvis, while side-impact collisions can exert lateral forces, causing shearing injuries. Rollovers may result in complex injuries due to the combination of axial loading and lateral forces. Pelvic fractures from MVAs can be classified into different types based on the direction and nature of the forces involved. Sacral fractures are also common and often occur because of axial loading, where the weight of the body is transmitted through the sacrum during a collision. It is important to note that MVAs may also lead to additional injuries, such as lumbar spine fractures, abdominal organ injuries, and vascular damage, complicating the clinical picture and increasing the severity of overall trauma.

Falls from Height

Falls from significant heights represent another mechanism of high-energy trauma that can result in pelvic and sacral injuries. When an individual falls from a height, the force of impact can lead to axial loading on the pelvis. This occurs when the body strikes the ground vertically, transferring the impact force directly to the pelvic ring and sacrum.

Common scenarios include falls from ladders, scaffolding, or buildings. In older adults, even falls from relatively low heights can be problematic due to decreased bone density. The type of fracture often depends on the height of the fall and the position of the body upon impact. Common injuries include compression fractures of the sacrum due to the axial load, as well as bilateral fractures when the pelvis is subjected to significant force, leading to instability.

Age is a crucial factor in these injuries; younger individuals are more likely to sustain severe injuries due to the higher impact forces involved, while older adults may experience fractures with less force because of weakened bone structures.

Sports Injuries

Certain high-impact or contact sports can lead to pelvic and sacral injuries due to the physical demands placed on athletes. In sports such as football, rugby, and hockey, collisions with other players or the ground can result in significant trauma to the pelvis. Tackle injuries or falls during gameplay may lead to acute fractures, while dynamic sports like gymnastics, mountain biking, skiing, and skateboarding involve movements that can put excessive stress on the pelvis and sacrum.

In sports, common injuries include avulsion fractures, which occur when muscles attached to the pelvis exert force during sudden movements, leading to fractures at their attachment sites, such as the ischium or iliac crest. Stress fractures can also develop from repeated high-impact activities, especially in athletes who may already have compromised bone health. Risk factors for these injuries can include poor conditioning, inadequate warm-up, and pre-existing injuries that increase susceptibility to trauma.

Industrial Accidents

Work-related injuries involving heavy machinery or falls can also result in significant trauma to the pelvic region. Accidents involving cranes, forklifts, or other heavy equipment can cause substantial forces to be transmitted to the pelvis. Being struck by or pinned under heavy machinery can lead to serious injuries, including fractures. In addition, workers may experience falls from height. Repetitive strain from tasks involving bending or lifting may contribute to cumulative trauma, leading to degenerative changes or stress fractures over time. Injuries in industrial settings can range from acute fractures resulting from a single

traumatic event to chronic conditions stemming from repetitive motion or inadequate ergonomics, such as pelvic pain or instability.

Risk Factors

References: 3, 4

Several comorbidities and patient factors may lead to an increased risk of sacral and pelvic ring injury. This section aims to explain these factors to help give context to etiology and rehabilitation time frames for physical therapists and assistants.

Osteoporosis

Osteoporosis is a systemic skeletal disorder characterized by reduced bone density and deterioration of bone tissue, which leads to an increased risk of fractures. Several factors contribute to osteoporosis, including age, hormonal changes, particularly in postmenopausal women, nutritional deficiencies, sedentary lifestyle, and smoking. As bone density decreases, the structural integrity of bones, including those in the pelvis and sacrum, becomes compromised, rendering them more brittle and susceptible to fractures even from relatively low-energy trauma, such as a fall from standing height. In elderly populations, pelvic fractures resulting from falls are common and often lead to significant morbidity and mortality. Hip fractures are especially prevalent among individuals with osteoporosis and frequently require surgical intervention along with long-term rehabilitation.

Bone Diseases

Certain bone diseases can weaken the pelvic bones, increasing the risk of fractures. Notable conditions include Paget's disease, a chronic disorder that leads

to abnormal bone remodeling, resulting in enlarged and weakened bones. In the pelvis, Paget's disease can create areas of increased vascularity and disorganized bone structure, making it more susceptible to fractures, especially under stress from falls or high-energy trauma. Patients may present with pain, deformities, or complications like osteosarcoma. Diagnostic imaging may reveal characteristic changes in bone density and structure.

Another significant condition is metastatic bone disease, which increases fracture risk. The pelvis is a common site for metastatic lesions from cancers such as breast, prostate, or lung cancer. Patients may experience localized pain, swelling, and changes in mobility, with imaging studies like X-rays, CT scans, or MRIs essential for identifying lesions and assessing bone integrity.

Prior Injuries

Previous injuries to the pelvis or sacrum can create areas of weakness that predispose individuals to re-injury or new fractures. If a prior fracture did not heal completely or properly, it may result in malunion or nonunion, where the bone does not heal back together as expected. These conditions can lead to chronic pain, instability, and a higher likelihood of subsequent fractures. Additionally, previous injuries may alter biomechanics, leading to compensatory movement patterns that place additional stress on specific areas of the pelvis.

Types of Pelvic Ring Injuries

References: 3, 10, 11

Pelvic ring injuries can be classified based on the mechanism of injury, the stability of the fracture, and the specific anatomical structures involved. Understanding these types is crucial for diagnosis, treatment planning, and predicting potential complications.

Stable Pelvic Ring Injuries

Stable pelvic ring injuries involve fractures that do not disrupt the overall stability of the pelvic ring. These injuries are typically associated with lower-energy trauma and are less likely to lead to complications, such as nerve damage or significant hemorrhage. Common examples of stable pelvic ring injuries include pubic ramus fractures, which are fractures of the inferior or superior pubic ramus, often seen in older adults due to falls. Another example is isolated iliac wing fractures, which involve fractures of the lateral aspect of the ilium without involvement of the sacrum or other pelvic structures.

Unstable Pelvic Ring Injuries

Unstable pelvic ring injuries occur when the pelvic ring is disrupted, leading to instability. These injuries often arise from high-energy trauma, such as motor vehicle accidents or falls from heights. Unstable injuries can result in significant complications, including hemorrhage, nerve injury, and pelvic organ damage. Examples of unstable pelvic ring injuries include anterior-posterior compression injuries, which occur when forces compress the pelvis from the front to the back, leading to separation at the pubic symphysis and potentially involving the sacrum. Another example is lateral compression injuries, often causing fractures of the pubic rami and possible ilium fractures, with disruption of the sacroiliac joints. Vertical shear injuries are also classified as unstable, characterized by vertical displacement of the pelvis, often seen in high-energy trauma, leading to significant instability and disruption of the sacroiliac joints.

Combined Pelvic Ring Injuries

Combined pelvic ring injuries involve a combination of mechanisms, such as both APC and LC forces acting on the pelvis simultaneously. These injuries can present with complex patterns of instability and are often associated with severe soft

tissue and neurovascular injuries. An example is fracture-dislocation of the sacroiliac joint, which occurs when the sacroiliac joint is disrupted in conjunction with fractures of the pelvic ring, leading to severe instability and potential neurological complications. Additionally, complex pelvic ring injuries may involve multiple fractures across the pelvic ring and can include fractures of the acetabulum, ilium, and sacrum, often requiring comprehensive surgical intervention.

Acetabular Injuries

Acetabular fractures, while sometimes considered separately from pelvic ring injuries, can be closely related to pelvic ring stability. These fractures can occur due to similar high-energy mechanisms and may be associated with instability in the pelvic ring. Examples of acetabular injuries include transverse acetabular fractures, which involve a fracture line that traverses the acetabulum and often leads to joint instability. Another type is posterior wall fractures, which involve a fracture of the posterior wall of the acetabulum and can affect hip joint stability.

Types of Sacral Fractures

References: 12, 13

There are two different main methods to classify sacral fractures. These are the Denis Classification and the AOSpine classification. Being familiar with both will help PTs and PTAs understand the injuries their patients with sacral fractures have sustained.

Denis Classification

The Denis classification is a widely recognized system for categorizing sacral fractures based on their anatomical location and the potential for neurological

injury. Developed by Dr. Paul Denis in 1983, this classification system divides sacral fractures into three distinct types, which helps in guiding management and predicting patient outcomes.

Zone 1: Lateral Zone

Zone 1 encompasses the lateral aspects of the sacrum, specifically the sacral wings or alae. Fractures in this zone are typically stable and may not significantly compromise the integrity of the sacral canal. They often involve single fractures without displacement, making them less complex than fractures in other zones. Clinically, Zone 1 fractures are less likely to cause neurological deficits due to their distance from the neural structures located in the central sacrum. Treatment for these fractures usually involves conservative measures, including pain management and activity modification, allowing for a favorable prognosis without the need for surgical intervention.

Zone 2: Central Zone

Zone 2 includes the central portion of the sacrum, where the sacral canal resides, and may involve fractures through the sacral body. Fractures in this zone can be more complex, with potential horizontal, vertical, or transverse or U-type fracture patterns that may compromise the stability of the sacrum. Due to their proximity to the nerve roots within the sacral canal, Zone 2 fractures carry a higher risk of neurological compromise. Patients may present with symptoms such as radicular pain, weakness, or bowel and bladder dysfunction. Careful evaluation with imaging studies is essential for these injuries, and surgical intervention may be required, especially in cases involving significant displacement or neurological deficits.

Zone 3: Medial Zone

Zone 3 consists of the medial aspects of the sacrum, which is closer to the sacral midline and includes the sacral foramina. Fractures in this zone are often associated with high-energy trauma and can result in significant instability. The location of Zone 3 fractures poses a risk for compression of the sacral nerve roots, leading to neurological symptoms such as radicular pain, weakness, or disturbances in bowel and bladder function. Management of these fractures frequently requires surgical intervention to stabilize the fracture and relieve any neural compression, making them more complex than those in the other zones. Careful monitoring and follow-up are essential to ensure optimal recovery and minimize long-term complications.

AOSpine Classification

The AOSpine classification for sacral fractures is a systematic framework that categorizes sacral fractures based on their anatomical characteristics, stability, and the presence of neurological deficits. This classification is part of the broader AOSpine classification system and provides a standardized language for healthcare professionals to communicate effectively about these injuries. The classification divides sacral fractures into three main types: A, B, and C, with further subdivisions based on specific fracture characteristics.

Type A: Stable Sacral Fractures

Type A fractures are characterized by stable, isolated fractures of the sacrum, which do not involve significant displacement or compromise of the sacral canal. This category includes subtypes such as A1, which refers to isolated sacral alar (wing) fractures, and A2, which denotes non-displaced fractures of the sacral body. Typically resulting from low-energy trauma, such as falls from standing height, these fractures are particularly common in older adults with compromised

bone density. Due to their stable nature, Type A fractures generally do not lead to neurological deficits. Management is usually conservative, focusing on pain control and activity modification, allowing for a favorable prognosis.

Type B: Unstable Sacral Fractures

Type B fractures are classified as unstable injuries that may involve both sides of the sacrum or exhibit significant displacement. This category includes subtypes B1, which consists of unilateral sacral fractures with instability, and B2, which refers to bilateral sacral fractures. Often associated with high-energy trauma, such as motor vehicle accidents or falls from heights, Type B fractures can compromise the integrity of the sacral canal. Patients with these fractures may present with neurological symptoms due to potential nerve root involvement. As a result, management often requires surgical intervention to stabilize the fracture and prevent further complications.

Type C: Complex Sacral Fractures

Type C fractures represent complex and severely unstable injuries that involve both the sacrum and the pelvic ring, leading to significant instability and the potential for neurological injury. This category includes subtypes such as C1, which refers to fractures with vertical shear mechanics, and C2, which denotes fractures associated with high-grade pelvic ring injuries. Type C fractures are commonly caused by high-energy impacts and complex trauma mechanisms, such as falls from heights or severe motor vehicle collisions. Given their potential for instability and neurological compromise, Type C fractures generally require surgical intervention to stabilize the injury and relieve any neural compression.

Section 1 Key Words

Lumbosacral Plexopathy – A neurological condition characterized by dysfunction or damage to the lumbosacral plexus

Morel-Lavallée Lesions – A type of closed soft tissue injury characterized by the separation of skin and underlying fascia, leading to the formation of a potential space filled with lymphatic fluid

Denis Classification – A widely used framework for categorizing sacral fractures based on their location and severity

Section 1 Summary

Injuries to the sacrum and pelvic ring represent significant damage to the crucial structures that provide support for the spine and facilitate weight-bearing and movement. Although these injuries are relatively uncommon, they can have serious consequences, particularly in high-impact situations such as car accidents or falls. For older adults with compromised bone density, even minor falls can result in fractures in this area. Additionally, pelvic injuries are frequently associated with other complications, including damage to internal organs or the spine, complicating treatment efforts. Given the critical role the sacrum and pelvic ring play in stabilizing the body and enabling mobility, any injury to these areas can severely impact a patient's functional abilities. A thorough understanding of the relevant anatomy, common causes, and types of injuries is essential for physical therapists to develop effective treatment plans aimed at enhancing recovery and restoring mobility.

Medical Management

Initial medical management often focuses on stabilization, pain control, and assessment of associated injuries. Depending on the nature of the injury, whether stable or unstable, therapeutic strategies may include non-operative management with physical therapy and activity modifications or surgical intervention to restore pelvic stability and prevent further complications. Understanding the principles of medical management in these cases is essential for PTs and PTAs involved in the care and rehabilitation of affected patients, ensuring a holistic approach to recovery and the restoration of function.

Imaging

References: 9

The evaluation of sacral and pelvic ring injuries typically involves a combination of imaging modalities, including radiographs (X-rays), computed tomography (CT), and magnetic resonance imaging (MRI). Each imaging technique provides distinct information that is crucial for accurate diagnosis and treatment planning.

Radiographs (X-rays)

Radiographs, or X-rays, serve as the initial imaging modality for assessing sacral and pelvic ring injuries due to their accessibility and speed. Standard pelvic X-rays typically include anteroposterior (AP), inlet, and outlet views to evaluate the pelvic ring and sacrum comprehensively. These images can reveal fractures of the ilium, pubis, ischium, and sacrum, as well as assess the alignment and integrity of the pelvic ring. X-rays can identify displacement and instability in the pelvic structure, which is crucial for determining treatment strategies. However, they have limitations; subtle or occult fractures, especially in the sacrum, may be missed, necessitating further imaging for a complete assessment.

Computed Tomography (CT)

Computed tomography (CT) is a more advanced imaging technique that provides detailed cross-sectional images of the pelvis and sacrum, making it highly effective in evaluating complex injuries. CT scans can detect fractures that may not be visible on standard X-rays, offering high sensitivity for assessing the extent and type of pelvic ring injuries. They can delineate fracture patterns, helping differentiate between stable and unstable injuries and allowing for the evaluation of associated injuries to adjacent structures, such as the acetabulum and sacroiliac joints. Additionally, CT is invaluable in surgical planning, as it provides a clear three-dimensional view of the fracture anatomy, facilitating the development of appropriate intervention strategies.

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is particularly useful for assessing soft tissue injuries and bone marrow changes associated with sacral and pelvic ring fractures. MRI excels at detecting bone marrow edema, which may indicate microfractures or stress injuries that are not visible on X-rays or CT scans. It can also evaluate associated soft tissue injuries, including damage to muscles, ligaments, and neurovascular structures around the pelvis, which is essential for understanding the full impact of the injury. While MRI is not typically used as a first-line imaging modality for acute trauma, it plays a significant role in the follow-up of patients with suspected complications, chronic pain, or in pre-surgical evaluations, providing critical information that can influence treatment decisions.

Surgical Management

References: 12–16

The surgical management of sacral and pelvic ring injuries is critical for restoring stability, function, and quality of life in patients with significant trauma. These injuries can result in complex fractures that disrupt the pelvic ring and sacrum, often leading to instability, pain, and in some cases, neurological deficits due to nerve root compression. Various surgical techniques are employed depending on the fracture pattern, degree of instability, and presence of neurovascular compromise.

Percutaneous Screw Fixation

Percutaneous screw fixation is a minimally invasive surgical technique used to stabilize fractures in the sacrum and pelvic ring. This technique is especially beneficial for fractures involving the sacroiliac joint, sacral fractures, and disruptions of the posterior pelvic ring. The procedure is performed by inserting screws through small incisions in the skin, using imaging guidance such as fluoroscopy or CT-based navigation. The screws are directed into the sacrum, ilium, or both, depending on the specific injury and the stabilization required.

The primary advantage of percutaneous screw fixation is its minimally invasive nature. The use of small incisions significantly reduces soft tissue disruption, leading to faster recovery times, less postoperative pain, less blood loss, and a lower risk of infection compared to open surgical techniques. This approach is particularly beneficial in patients with complex pelvic ring injuries who may not be able to tolerate more extensive open surgeries due to their overall condition. Percutaneous screw fixation also provides strong and stable fixation, allowing early mobilization and rehabilitation, which contributes to better long-term functional outcomes.

One of the primary risks of percutaneous screw fixation is the possibility of nerve injury. Another complication is the malpositioning of screws. Even with imaging guidance, screws can inadvertently be placed in undesirable locations, such as

penetrating the sacral foramina (which house the nerve roots). Hardware failure is another potential issue, particularly if the fracture fails to heal or the screws become loose. Finally, deep infections or hardware-related infections can occur and may require further surgical intervention.

Posterior Tension Band Plating

Posterior tension band plating is a surgical technique used to stabilize the posterior pelvic ring, which includes the sacrum, the sacroiliac joints, and the posterior iliac crest. Posterior tension band plating restores this stability by applying a strong, rigid fixation across the disrupted area, mimicking the natural tension band effect that supports weight transfer through the pelvis. The technique involves placing a metal plate along the posterior aspect of the pelvis, usually anchored with screws into the ilium or sacrum. This plate acts as a tension band, holding the bones in place and allowing for proper alignment and healing. This method is particularly useful in patients with unstable posterior pelvic ring injuries, such as sacroiliac joint disruptions or sacral fractures with posterior displacement.

The primary benefit of posterior tension band plating is restoring the structural integrity and stability of the pelvis. This technique allows for better load distribution across the pelvis, enabling the patient to bear weight earlier and more safely, shortening recovery time. In addition, tension band plating provides a rigid fixation, reducing the likelihood of further displacement or malalignment of the fractured bones. It is particularly beneficial in cases where nonoperative treatment or less invasive options (such as percutaneous fixation) are not sufficient to achieve adequate stability.

One of the primary complication concerns is the risk of infection, particularly because this technique requires an open approach, which involves a larger incision and more soft tissue disruption compared to percutaneous methods.

Infections can occur in the wound or around the hardware, sometimes necessitating additional surgery for debridement or hardware removal. Hardware-related issues can also arise, such as plate or screw loosening, breakage, or malposition. Additionally, the posterior pelvis contains critical neurovascular structures, such as the sciatic nerve and blood vessels, which are at risk of injury during the surgical procedure. Another potential complication is nonunion or delayed union of the fracture. If the fracture does not heal properly or in a timely manner, the patient may experience prolonged pain and disability, which can lead to the need for further surgical intervention.

Iliosacral and Lumbopelvic Fixation

Iliosacral fixation involves the insertion of screws across the sacroiliac joint from the ilium into the sacrum. This procedure stabilizes the sacroiliac joint by compressing the bones together, maintaining alignment and preventing further displacement. It can be done either percutaneously or through an open approach, depending on the fracture pattern and the degree of instability. Lumbopelvic fixation is a more extensive procedure that incorporates both the lumbar spine and the pelvis. It involves the placement of screws into the pedicles of the lumbar vertebrae (usually L4 or L5) and extending them into the ilium or sacrum. These screws are connected by rods to create a solid construct that links the spine and pelvis, providing additional stability for fractures that involve the sacrum or lower lumbar spine. This technique is particularly useful in cases of sacral fractures with vertical instability or severe pelvic ring injuries that cannot be managed with iliosacral screws alone.

Iliosacral and lumbopelvic fixation offer enhanced biomechanical stability compared to less invasive methods, making them ideal for fractures involving vertical shear forces or significant displacement. This stability ensures that the pelvic ring or sacral fracture remains in place during the healing process, reducing

the risk of malalignment. Both techniques are versatile. Iliosacral screws can stabilize both sacral fractures and sacroiliac joint disruptions, while lumbopelvic fixation provides a comprehensive solution for injuries involving the pelvis and lower spine. Lumbopelvic fixation is especially effective in managing spinopelvic dissociation, where the sacrum is split from the rest of the spine. The strong fixation provided by these techniques allows for earlier weight-bearing and rehabilitation. In cases where sacral fractures result in nerve compression or spinopelvic instability, lumbopelvic fixation can reduce the risk of long-term neurological deficits by stabilizing the spine and sacrum. This is particularly important in fractures that involve the sacral nerve roots and conditions like cauda equina syndrome.

Nerve injury is a significant risk during iliosacral or lumbopelvic screw placement due to the proximity of the sacral nerve roots and the sciatic nerve. If screws are placed incorrectly, they can compress or injure the nerve roots, leading to sensory or motor deficits, pain, or dysfunction. Hardware failure is another potential complication. Despite the strength of these constructs, screws or rods can loosen, break, or fail, particularly in patients with poor bone quality, such as those with osteoporosis. Hardware failure may compromise fixation and lead to further displacement of the fracture, requiring revision surgery. Infection is a concern, especially with lumbopelvic fixation, as it requires an open approach and more extensive tissue dissection than percutaneous methods.

Decompression of Neural Elements

Decompression of neural elements is a surgical intervention performed when sacral or pelvic ring fractures result in the compression of nerve roots or other neural structures, leading to neurological symptoms. These injuries can cause impingement or entrapment of the sacral nerve roots, often resulting in severe pain, sensory or motor deficits, or even bladder and bowel dysfunction. The goal

of neural decompression is to relieve the pressure on these structures, restore neurological function, and prevent long-term disability. This procedure typically involves removing bone fragments, hematomas, or soft tissue that are compressing the neural elements. In sacral fractures, particularly those involving the sacral foramina or sacral canal, bony fragments may press on the sacral nerve roots. The surgeon may perform a laminectomy or foraminotomy to create space for the nerves and alleviate pressure. In severe cases, this procedure may be combined with stabilization techniques such as lumbopelvic fixation or sacral screw placement to ensure the fracture is immobilized and the decompressed nerves are protected from further injury.

The primary benefit of decompression of neural elements is the relief of neurological symptoms caused by nerve root compression. Patients often present with pain, weakness, numbness, or loss of function in the lower limbs, as well as bladder or bowel dysfunction in severe cases (cauda equina syndrome). By surgically decompressing the nerve roots, these symptoms can be alleviated, and the risk of permanent neurological damage can be minimized.

Decompression of neural elements, like any surgical procedure, carries certain risks and potential complications. One of the primary concerns is further nerve injury during surgery. This could result in new or worsened neurological symptoms, including paralysis or loss of function in the lower limbs. Infection is another potential complication, especially since decompression often involves open surgery to expose the nerves and remove compressive elements. Another possible complication is cerebrospinal fluid leakage. During the decompression procedure, particularly if a laminectomy is performed, there is a risk of inadvertently puncturing the dura. This can result in a CSF leak, which may cause headaches, nausea, and an increased risk of infection, and it may require further surgical intervention to repair the dural tear. Post-surgical instability of the spine

or pelvis can also occur after decompression due to removing bone and compromising structural stability.

Nonsurgical Management

References: 1, 17

For certain stable sacral and pelvic ring injuries, or when surgical intervention is not appropriate or necessary, nonsurgical management can be effective in promoting healing and reducing pain. These conservative treatments are aimed at stabilizing the injury, minimizing discomfort, and allowing the body to heal naturally. The goal is to optimize biomechanical, sacral, pelvic, and alignment and to minimize neurologic impact.

Pain Management

Effective pain control is essential in the nonsurgical management of sacral and pelvic ring injuries, especially given the pain associated with these injuries. Pain management may involve nonsteroidal anti-inflammatory drugs, such as ibuprofen or naproxen, to help reduce inflammation and pain in the acute phase. In cases of severe pain, short-term use of opioids may be necessary, but these medications should be used cautiously to avoid dependence and side effects. Muscle relaxants may also be prescribed to relieve muscle spasms, which are common due to the body's attempt to stabilize the injured area. Additionally, local anesthetic injections or nerve blocks can provide temporary pain relief, particularly in cases of sacral fractures where nerve root irritation is involved.

Bracing and Support Devices

Pelvic binders or braces can be used to immobilize the pelvis and support the healing process, but not to excess due to the potential development of

compensatory muscle patterns. A pelvic binder is a circumferential device that compresses the pelvis and provides stability by limiting movement in the fracture area. It is commonly used in the early stages of treatment, particularly for fractures with minor displacement or those caused by low-energy mechanisms, such as falls. Additionally, sacroiliac belts or custom-made orthotics may be used to support the sacroiliac joint and reduce stress on the pelvis during ambulation. These devices help distribute weight more evenly across the pelvis, reducing pain and enhancing mobility.

Pharmacological Osteoporosis Treatment

If the pelvic or sacral injury is associated with osteoporosis, pharmacological treatment aimed at improving bone density is a critical aspect of management. Medications such as bisphosphonates or denosumab may be prescribed to slow bone resorption and strengthen the bones. Calcium and vitamin D supplementation are also important to promote bone health and aid in fracture healing.

Activity Modification and Lifestyle Changes

For patients with stable pelvic or sacral injuries, lifestyle and activity modifications are often recommended to reduce stress on the healing bones. This might include avoiding activities that place excessive strain on the pelvis, such as heavy lifting, high-impact exercises, or prolonged standing. Patients are typically encouraged to gradually increase their activity levels as the healing process progresses. Lifestyle changes, such as smoking cessation and maintaining a healthy weight, can also positively influence bone healing. Smoking impairs bone healing by reducing blood flow and nutrient delivery to the fracture site, while maintaining a healthy weight reduces stress on the pelvis during the recovery period.

Nutritional Support

Proper nutrition plays a key role in bone healing. Ensuring adequate intake of protein, calcium, and vitamin D is essential for bone health and repair. A balanced diet that provides all the necessary nutrients can support the body's natural healing mechanisms and reduce the risk of complications such as delayed union or nonunion. In cases of severe injury or in patients with additional nutritional needs, dietary supplements or consultation with a nutritionist may be recommended to optimize bone healing.

Prognosis

References: 12

The prognosis of sacral and pelvic ring injuries varies based on several factors, including the type and severity of the injury, patient age and health, associated injuries, and the timeliness of treatment. Stable fractures typically have a favorable prognosis, often healing well with conservative management. In contrast, unstable injuries requiring surgical intervention may have a more complex recovery process and a higher risk of complications, such as nonunion or malunion. Younger patients generally experience better outcomes than older adults, who may have underlying health issues that complicate recovery. The presence of associated injuries, particularly to the spine or nerves, can negatively impact prognosis, especially if nerve damage occurs.

Timely and effective treatment is critical for favorable outcomes. Early stabilization and appropriate management can reduce the risk of complications and chronic pain. Rehabilitation is also vital; those who participate in tailored programs tend to achieve better functional recovery. Most patients can expect to return to their previous activity levels, especially with stable injuries. However, some may

experience chronic pain or complications like post-traumatic arthritis. Regular follow-up is essential for monitoring recovery and addressing any issues.

Section 2 Key Words

Percutaneous Screw Fixation – A minimally invasive surgical technique used to stabilize fractures or injuries, particularly in areas like the pelvis or spine

Posterior Tension Band Plating – A surgical technique used to stabilize fractures, particularly those of the pelvic ring and certain spinal injuries

Iliosacral and Lumbopelvic Fixation - Surgical techniques used to stabilize the pelvis and lower spine, particularly in cases of fractures, instability, or deformities

Section 2 Summary

Medical management focuses on stabilization, pain control, and assessment of associated injuries. Management strategies may include non-operative management with physical therapy and activity modifications or surgical intervention to restore pelvic stability and prevent further complications. Understanding the principles of medical management, whether surgical or nonsurgical, in these cases is essential for PTs and PTAs involved in the care and rehabilitation of affected patients, ensuring a whole-person approach to rehabilitation.

Physical Therapy Management

A comprehensive physical therapy approach is essential for addressing not only the physical impairments associated with the injury but also the psychological and social factors that can influence recovery. Physical therapists should utilize a

multifaceted treatment strategy that includes thorough assessment, pain management, strengthening and stabilization exercises, gait training, and education on body mechanics and activity modification. By employing evidence-based interventions and fostering a collaborative relationship with patients, physical therapists aim to optimize healing, enhance functional outcomes, and improve overall quality of life for individuals recovering from sacral and pelvic ring injuries.

Examination

References: 4, 17, 18

The examination of patients with sacral and pelvic ring injuries is a critical first step in the physical therapy management process, as it provides essential information for developing an effective treatment plan. These injuries, often resulting from trauma or high-impact activities, can lead to significant functional impairments, pain, and altered mobility. A comprehensive examination involves a thorough patient history to understand the mechanism of injury, as well as an assessment of pain characteristics and prior medical history. Physical therapists then conduct a detailed physical evaluation, focusing on strength, range of motion, neurologic function, vascular status, and pelvic alignment.

Patient History

The patient's history is a critical starting point for the examination process, as it provides insights into the mechanism and context of the injury. Understanding how the injury occurred, whether through trauma from a fall, a motor vehicle accident, or during a sports activity, can help assess the severity of the injury and identify any potential associated injuries. It is also essential to document when the symptoms first appeared, including the progression of the pain and any changes in

its intensity or location over time. Gathering detailed information about the characteristics of the pain, such as its specific location, quality (whether it is sharp, dull, or radiating), and any factors that aggravate or alleviate the discomfort, can aid in formulating an appropriate treatment plan. Additionally, the clinician should inquire about the patient's medical history, including any previous injuries, surgeries, or underlying conditions, such as osteoporosis or rheumatoid arthritis, which may impact recovery and rehabilitation outcomes.

Strength Assessment

Assessing muscle strength is a fundamental aspect of the examination, particularly in evaluating the functional capabilities of the patient. The clinician should focus on key muscle groups relevant to the pelvic and lower extremity function. This includes assessing the strength of the hip abductors and adductors, hip flexors and extensors, as well as the core stabilizers, which play a crucial role in maintaining pelvic stability and proper posture. Functional strength testing can also be incorporated to evaluate how strength deficits affect the patient's mobility and activities of daily living. For instance, movements such as squatting, bridging, and single-leg stance can help identify specific weaknesses and compensatory patterns that may have developed due to the injury.

Range of Motion (ROM)

A comprehensive assessment of ROM is vital for understanding the functional limitations imposed by sacral and pelvic ring injuries. The clinician should measure both active and passive ROM in the hips and lumbar spine to identify any restrictions and areas of discomfort that may be contributing to the patient's pain and functional limitations. In the hip joint, it is essential to evaluate all planes of motion, including flexion, extension, abduction, adduction, as well as internal and external rotation. Similarly, the lumbar spine should be assessed for flexion,

extension, lateral bending, and rotation. These measurements will provide valuable information regarding the extent of mobility impairment and can guide the selection of appropriate therapeutic interventions aimed at restoring normal motion.

Neurologic Evaluation

A thorough neurologic evaluation is critical to rule out any potential nerve involvement associated with sacral and pelvic ring injuries. This assessment should include a sensory examination to evaluate the patient's sensation in the lower extremities. Clinicians can assess sensory modalities such as light touch, pinprick, and proprioception to identify any deficits that may indicate nerve injury or dysfunction. Reflex testing is also important, particularly the assessment of deep tendon reflexes such as the patellar and Achilles reflexes, which can provide insights into the integrity of the neurological pathways. Additionally, the clinician should evaluate the strength and control of lower extremity muscles to identify any motor function deficits that may affect the patient's mobility and overall rehabilitation process.

Vascular Assessment

The vascular assessment is essential for ensuring that the patient has adequate blood flow to the lower extremities, which can impact healing and recovery. The clinician should check for the presence of pulses in the lower extremities, specifically the dorsalis pedis and posterior tibial pulses, to assess vascular integrity. Capillary refill time can be evaluated in the toes to gauge perfusion and circulatory status. Furthermore, inspecting for signs of swelling and edema in the pelvic and lower limb regions is crucial, as these can indicate vascular compromise, inflammation, or other complications associated with the injury. By carefully evaluating vascular status, the clinician can make informed decisions

about the patient's treatment plan and any necessary referrals for further evaluation.

Pelvic Tilt Angle

Measuring the pelvic tilt angle is an important component of the physical therapy examination, as it can provide valuable information about the patient's posture, spinal alignment, and overall biomechanical function. The clinician can assess the pelvic tilt angle using a goniometer or inclinometer during standing or supine positions, which helps to understand the relationship between pelvic positioning and the patient's pain or functional limitations. Evaluating pelvic tilt can reveal compensatory strategies the patient may be using to manage discomfort, and it can help identify potential areas of intervention, such as muscle imbalances or postural corrections. Understanding the pelvic tilt angle not only aids in establishing baseline measurements but also allows for monitoring progress throughout the rehabilitation process.

Short Term Plan of Care

References: 9, 19

The primary objectives during the initial phase of rehabilitation are to control pain and inflammation, protect the injured pelvic and sacral structures, and prevent deconditioning. Physical therapy in the short term will occur across many practice settings, beginning in acute care after surgery and ending in home health or outpatient orthopedic care. This phase lasts four to six weeks.

Pain Management

Pain management is a critical focus early in the rehabilitation process. Modalities such as ice, heat, and TENS can help control pain and inflammation. Proper

positioning with pillows is also important to support the pelvis and reduce mechanical stress on the sacrum. Patient education on rest and avoiding prolonged bed rest helps minimize stiffness and discomfort.

Activity Modification & Weight-Bearing Precautions

Following the physician's recommendations, patients may need to adhere to non-weight-bearing (NWB) or partial weight-bearing (PWB) restrictions. Assistive devices such as walkers or crutches can help reduce load on the injured structures. Teaching safe transfers and functional mobility ensures that the patient maintains mobility without compromising the healing process.

Early Exercises

Early in recovery, light exercises are necessary to prevent joint stiffness and maintain circulation. These may include ankle pumps, heel slides, and gentle knee flexion and extension while in a supine position. Pelvic tilts (if pain-free) can be introduced to activate the core muscles gently. Incorporating deep breathing exercises enhances circulation and prevents respiratory complications. Gluteal and quadriceps sets are useful to maintain strength in the lower extremities. Core activation exercises can improve pelvic stability without overloading the sacral region. Maintaining aerobic fitness is essential, even during periods of limited mobility. Upper body ergometry or seated exercises can be used to support cardiovascular health without placing stress on the pelvis. These activities also help prevent deconditioning during the early recovery phase.

Gait Training

If weight-bearing is permitted, gradual gait training can begin. Patients should progress cautiously from NWB to PWB, ensuring proper use of assistive devices

and focusing on even weight distribution. Emphasis on postural control and safe movement patterns will minimize further injury.

Expected Outcomes

By the end of this phase, patients should experience reduced pain and inflammation, improved mobility with or without assistive devices, and prevention of complications such as muscle atrophy or deep vein thrombosis (DVT). The goal is to restore basic functional independence while following weight-bearing restrictions to protect the injured structures.

Long Term Plan of Care

References: 9, 18

The long-term phase of rehabilitation focuses on progressive strengthening, restoring functional movement, improving mobility, and achieving full independence. The duration may vary from six weeks to six months or more, depending on the severity of the injury, surgical interventions, and the patient's recovery speed.

Strengthening and Muscle Re-Education

Progressive resistance exercises are introduced to rebuild the strength of the lower extremity and core muscles. Strengthening is based upon their presentation and may progress from isometric to total body movements through space. Typical functional strengthening movements such as squats, lunges, and step-ups are recommended and help the patient prepare for real-world activities. Core stability training, such as planks, dead bugs, and side bridges, improves pelvic control and prevents future injuries. If pelvic dysfunction is present, pelvic floor exercises are incorporated to restore normal function.

Mobility and Flexibility Training

During this phase, joint mobilization techniques target the hips, lumbar spine, and pelvic region to restore full ROM. Stretching exercises for the hamstrings, hip flexors, and quadriceps address any tightness caused by prolonged immobility or compensatory movements. Postural alignment exercises may be introduced to correct any imbalances in the pelvis and spine. Again careful consideration should be given especially if there is history of a fracture or there is extensive soft tissue damage.

Gait Training and Proprioceptive Exercises

As the patient transitions to full weight-bearing, gait retraining focuses on improving walking patterns and achieving proper weight distribution. Balance exercises, such as single-leg stands, unstable surfaces, and tandem walking, help rebuild proprioception and stability. Weaning off assistive devices is done gradually, ensuring the patient regains confidence and control during movement.

Cardiovascular Conditioning

To rebuild endurance, patients engage in low-impact aerobic activities such as swimming, stationary biking, or using an elliptical. For more active individuals, sports-specific activities like running and agility drills are gradually reintroduced under supervision. These exercises help restore cardiovascular fitness while preparing the patient for higher levels of physical performance.

Pain Management and Psychosocial Support

Although pain should decrease during this phase, manual therapy or myofascial release may be used to relieve lingering discomfort or stiffness. Cognitive-behavioral strategies can help patients manage chronic pain or reduce fear of re-

injury. If the injury has led to anxiety or depression, psychological counseling may be recommended to address these issues and promote emotional well-being.

Functional Training and Return to Work or Sports

Functional training focuses on activities that simulate real-life tasks, such as lifting, bending, and car transfers. Patients with physically demanding jobs may benefit from work conditioning programs to ensure they can safely resume their duties. Athletes undergo sports-specific training that includes running, jumping, and agility drills to prepare them for full participation in their sport.

Home Exercise Program

Patients are provided with a structured home exercise program to promote self-management. This program includes strengthening, mobility, and cardiovascular exercises tailored to their recovery progress. Periodic updates to the HEP ensure that exercises remain appropriate as the patient advances.

Expected Outcomes

By the end of this phase, patients are expected to achieve full ROM and strength in the lower extremities and core. They should be able to walk independently with a normal gait and perform daily activities without pain. Athletes and physically active individuals should be prepared to return to sport-specific movements safely. Education on injury prevention and self-care strategies helps prevent future issues and ensures long-term well-being.

Physical Therapy Treatment Types and Considerations

References: 4, 9, 18, 19

The rehabilitation of pelvic ring and sacral injuries requires a comprehensive, individualized approach that accounts for the severity of the injury, surgical interventions, and the patient's recovery trajectory. Key elements include pain management, restoring mobility, muscle strengthening, gait retraining, and addressing any psychological challenges. Below is a detailed outline of treatment types and considerations.

Conservative Management (Non-Surgical)

In cases where the fracture is stable and does not require surgical intervention, conservative management focuses on allowing the injury to heal naturally while minimizing movement and stress on the affected area. Treatment involves activity modification, pain management through modalities such as ice and TENS, and the use of assistive devices like walkers or crutches to limit weight-bearing. Patients are often placed under NWB or PWB restrictions until healing progresses.

A primary consideration in conservative management is balancing immobilization with early mobilization. Too much rest can lead to muscle atrophy, joint stiffness, and cardiovascular deconditioning, while premature activity may disrupt healing. Physical therapists must carefully monitor pain, mobility, and function during this phase, gradually introducing movement as the patient’s condition improves.

Post-Surgical Rehabilitation

Patients with unstable fractures or significant displacement may require surgical intervention. Rehabilitation after surgery focuses on pain management, mobility restoration, and muscle reconditioning, following strict surgical protocols.

Initially, therapists should focus on pain control through modalities like ice, heat, or electrical stimulation and limiting activity to a protocol. Manual therapy and scar tissue management techniques help maintain soft tissue flexibility and

minimize adhesions. Progression to weight-bearing activities and strength exercises follows the surgeon's post-operative guidelines, which are essential to avoid complications. Close communication with the surgical team ensures the therapist aligns treatment with the latest restrictions and clearances to prevent setbacks.

Pain Management Techniques

Pain is a major limiting factor during recovery, and addressing it effectively helps the patient stay engaged in therapy. In addition to pharmacological interventions, heat and cold therapy are used to control inflammation, while TENS units can relieve nerve-related pain or muscle spasms. Manual therapy techniques, including joint mobilization and myofascial release, may also help reduce stiffness and discomfort.

A critical consideration is avoiding over-reliance on passive treatments, which can create dependency and hinder progress. Instead, physical therapists should encourage active involvement in recovery through exercises and movement strategies. If chronic pain persists, cognitive-behavioral therapy (CBT) or other psychological interventions may be needed to address pain-related anxiety or fear of re-injury.

Weight-Bearing Progression and Gait Training

Weight-bearing progression is a crucial aspect of rehabilitation, determined by the extent of the injury and surgical protocols. Initially, patients may require assistive devices such as crutches or walkers to reduce the load on the pelvis. Over time, therapists guide the patient through gradual increases in weight-bearing, focusing on proper gait mechanics to prevent compensatory patterns.

Therapists should monitor for signs of Trendelenburg gait or other imbalances, which can develop from muscle weakness or instability. Gait retraining emphasizes symmetrical weight distribution and coordination to prevent long-term dysfunction. Regular assessments are necessary to determine when it is safe for the patient to progress to independent ambulation.

Core Stability and Pelvic Floor Rehabilitation

The pelvis plays a central role in core stability, and injury to this area can disrupt the function of the abdominal, back, and pelvic floor muscles. Rehabilitation includes core-strengthening exercises such as planks, bird-dogs, and side bridges to restore stability. For patients with pelvic floor dysfunction, Kegel exercises or other targeted interventions may be necessary to regain control.

A gradual approach is recommended, starting with low-load isometric exercises and progressing to more challenging activities as the patient's stability improves. Monitoring for asymmetrical movement patterns is essential to ensure that compensations are addressed early. If needed, biofeedback tools can help the patient engage the core and pelvic floor muscles effectively.

Joint Mobilization and Flexibility Training

Pelvic ring and sacral injuries can result in stiffness of the hips, lumbar spine, and pelvic joints, leading to limited mobility and compensatory movement patterns. Therapists should use manual therapy techniques such as joint mobilizations and soft tissue mobility, while a stretching routine targets muscles that may have become tight, such as the hip flexors, hamstrings, and adductors.

Care must be taken when performing joint mobilizations to avoid disrupting healing tissues, especially early in the rehabilitation process. As flexibility improves, therapists incorporate functional mobility exercises to ensure gains in

ROM translate into daily activities. Pelvic alignment exercises may also be used to address any imbalances in posture.

Balance and Proprioceptive Training

Injuries to the pelvis and sacrum often impair balance and proprioception, increasing the risk of falls. Rehabilitation incorporates progressive balance exercises, starting with static activities like single-leg stands and advancing to dynamic tasks on unstable surfaces, such as BOSU balls or foam pads. Proprioceptive drills enhance the patient's awareness of body position, helping to restore stability and confidence.

Therapists must tailor the difficulty of balance exercises to the patient's abilities and gradually increase the challenge to match their progress. Athletic patients may benefit from sport-specific balance drills, while those with more sedentary lifestyles focus on functional tasks like tandem walking.

Cardiovascular Conditioning and Functional Training

Maintaining cardiovascular fitness during recovery is essential, especially for patients with prolonged mobility restrictions. Low-impact aerobic activities, such as swimming, stationary biking, or using an elliptical, help maintain endurance without stressing the pelvis. For athletes and active individuals, therapists gradually reintroduce higher-impact activities like running or jumping as healing allows.

Functional training prepares the patient to return to work or daily life. This includes simulated tasks such as lifting, bending, and getting in and out of a car. Work conditioning programs may be implemented for those with physically demanding jobs, ensuring they can safely resume their duties. Functional testing helps assess the patient's readiness to return to specific activities or sports.

Psychosocial and Behavioral Considerations

Pelvic ring and sacral injuries can have a significant impact on the patient's mental well-being, leading to anxiety, depression, or fear-avoidance behaviors. Addressing these issues is critical to achieving a full recovery. Physical therapists should provide patient education to build confidence and reduce fear of movement. Cognitive behavioral therapy or counseling may be recommended for those experiencing emotional challenges or chronic pain.

Regular goal-setting and positive reinforcement help maintain motivation throughout the rehabilitation process. Therapists should foster open communication about the patient's concerns and pain levels, encouraging them to stay engaged in therapy and take an active role in their recovery.

Section 3 Key Words

Cognitive Behavioral Therapy – A psychological intervention that reframes thoughts and behaviors such as pain-related anxiety, fear-avoidance behaviors, and low motivation

Pelvic Tilt Angle - The orientation of the pelvis relative to the horizontal plane, which can be measured in both the anterior-posterior direction

Section 3 Summary

A comprehensive physical therapy approach is crucial for addressing both the physical impairments and the psychological and social factors that impact recovery from sacral and pelvic ring injuries. Effective rehabilitation requires a multifaceted strategy that integrates thorough assessments, pain management, strengthening and stabilization exercises, gait training, and education on body mechanics and activity modification.

Case Study 1

Sarah, a 34-year-old female, sustained an unstable pelvic ring fracture with sacral involvement (zone II sacral fracture) following a motor vehicle accident. She underwent percutaneous iliosacral screw fixation to stabilize the injury and was referred for physical therapy on the third post-operative day to begin acute rehabilitation. Before her injury, Sarah had no significant medical history or prior fractures. Basic mobility causes severe pain, rated 8/10 at rest and 9/10 with movement. She expresses anxiety and fear about movement, worried that it might worsen her injury. The initial assessment revealed that she has a slight posterior pelvic tilt, limited hip and lumbar range of motion due to pain, weak gluteal and core muscles (graded 3/5), and mild numbness along the posterior thigh, likely due to nerve irritation. Per surgical protocol, Sarah is non-weight-bearing on her left side and will require a walker for mobility during the acute phase of recovery.

Reflection Questions

1. What rehabilitation strategies should be used in the acute phase of Sarah's rehabilitation?
2. How might Sarah's psychological state be addressed throughout her acute phase?
3. What may be key challenges in managing Sarah's acute phase rehabilitation?

Responses

1. This time should focus on managing pain, preventing deconditioning, and facilitating safe mobility while adhering to weight-bearing restrictions. Pain

management strategies may involve ice therapy, proper positioning with pillows for pelvic support, and diaphragmatic breathing exercises to promote relaxation. Functional mobility strategies, such as log-rolling techniques should be taught to minimize pelvic stress during bed transfers, along with assisted sit-to-stand transfers with NWB status on the left side. Early strengthening exercises may focus on core activation with abdominal bracing and gluteal squeezes, along with ankle pumps to maintain circulation and prevent venous complications. Short-distance ambulation with a walker may be introduced if Sarah has enough strength and ability to not bear weight on the left lower extremity.

2. Sarah's anxiety and fear of movement should be managed through education about her injury and recovery, along with emotional support from her care team, which should include a mental health professional to help with coping from her injury and recovery process.

3. The main challenges would be managing Sarah's high pain levels and fear of movement, which initially may limit her participation in therapy. Additionally, the non-weight-bearing restriction on her left side posed challenges for safe mobility and exercise selection.

Case Study 2

John, a 42-year-old male, sustained a stable pelvic ring fracture with a sacral insufficiency fracture following a fall from a ladder. He underwent conservative management, as surgical intervention was not required, and was initially instructed to follow a partial weight-bearing protocol (now is weight bearing as tolerated). After six weeks, he begins outpatient physical therapy.

At his first outpatient visit, John reported persistent pain (5/10) in his lower back and pelvis, particularly during prolonged sitting and walking. He was frustrated with pain as he could not yet return to work as an electrician. John noted mild stiffness and weakness in his hips and lower back, along with occasional numbness in his left leg, which limited his ability to perform activities like climbing stairs and bending forward. His primary goal was to resume work without limitations. The assessment revealed poor core and gluteal strength (graded 3+/5), reduced hip range of motion, mild pelvic asymmetry, and compensatory gait, including a slight limp due to pelvic instability and gluteal weakness. Additionally, tightness in the hip flexors and hamstrings was noted.

Reflection Questions

1. What should physical therapy treatment initially focus on?
2. What aspects of care should John be educated on throughout the plan?
3. After reducing pain and restoring strength and function, what is the next step in John's recovery?

Responses

1. Treatment should begin with strategies to control pain and improve mobility. Manual therapy techniques such as soft tissue mobilization would help release tension in the hip flexors and hamstrings. Pelvic tilting exercises would help restore pelvic control, bridging exercises would help activate the gluteal muscles and improve pelvic stability, and hip flexor and hamstring stretching would help to restore flexibility. Gait training with a progression to full weight bearing should be prioritized as well.

2. Education on home exercises, pain management, and body mechanics are essential for John's recovery. It will allow him to take an active role in his rehabilitation, maintain flexibility, avoid compensatory patterns, and eventually manage his symptoms independently.

3. The next phase will focus on building endurance and functional strength to prepare John for his return to full work duties. Higher-level balance and agility exercises will be introduced to mimic the movements required for his job as an electrician. Continued monitoring for any signs of compensatory movements or re-injury will ensure long-term success and independence.

Case Study 3

Lisa, a 54-year-old female, sustained a complex pelvic ring fracture with bilateral sacral fractures from a cycling accident one year ago. She underwent surgical fixation with iliosacral screws and completed several months of initial rehabilitation, including inpatient and early outpatient physical therapy. Lisa continues to experience chronic pelvic pain, lower back stiffness, and mobility limitations that have affected her ability to return to daily activities. On evaluation, Lisa reports difficulty standing or walking for more than 15 minutes without discomfort, persistent pain during functional mobility, and sleep disturbances due to pelvic discomfort at night. She also notes emotional distress and fear of reinjury leads her to avoid activities that can trigger her pain. On assessment, she displays antalgic gait with limited hip extension on the right, pelvic asymmetry, weak gluteal and core muscles (graded 3+/5), restricted hip range of motion, and myofascial tightness in her lower back and hip flexors. Lisa's primary goals include improving her pain management, restoring functional mobility, and rebuilding strength so she can engage in walking, gardening, and yoga, activities she used to enjoy.

Reflection Questions

1. What might be challenging about Lisa's case?
2. What strategies may allow progress given Lisa's fear of movement?
3. What interventions might help improve Lisa's gait pattern?

Responses

1. Addressing the physical limitations and psychological barriers Lisa developed over time is challenging. Fear of re-injury and avoidance of activity had worsened her physical condition, leading to muscle weakness, gait abnormalities, and chronic pain patterns.
2. The therapist should educate Lisa on chronic pain science and that pain does not equal harm. Activities should be introduced with graded exposure, allowing Lisa to adjust to them physically and mentally. Lisa would benefit from referral to a mental health professional to discuss the psychological and emotional impact of her injury.
3. Gait training with verbal and visual feedback, slowly increasing walking distances, and strengthening/stabilizing the glutes and core will help to improve her antalgic gait pattern.

Conclusion

The management of sacral and pelvic ring injuries requires a nuanced understanding of anatomy, biomechanics, and the complex interplay of forces that affect these structures. This course has explored critical aspects of diagnosing, assessing, and treating these injuries, emphasizing evidence-based rehabilitation techniques and approaches. Applying the knowledge gained from this course will

enable physical therapists and physical therapist assistants to address the challenges these injuries present. From acute care management to long-term recovery, the tools and strategies provided support optimal healing, pain reduction, functional restoration, and improvement in patients' quality of life. With a deeper understanding of the sacrum and pelvic ring, along with practical interventions like manual therapy, therapeutic exercises, and individualized care plans, clinicians are now well-prepared to manage these injuries effectively and ensure positive outcomes for patients.

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