

# Spinal Injuries



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# Spinal Injuries

- AAOS – Neck
  - Cervical Fracture
- AAOS - Spine





# 1. Cervical Fracture: Overview

- Cervical fractures usually result from high-energy trauma, such as automobile crashes or falls.
- Athletes are also at risk. A cervical fracture can occur if:
  - A football player "spears" an opponent with his head.
  - An ice hockey player is struck from behind and rams into the boards.
  - A gymnast misses the high bar during a release move and falls.
  - A diver strikes the bottom of a shallow pool.
- Any injury to the cervical vertebrae can have serious consequences because a larger percentage of the spinal nerves run through the center of the vertebrae
- Damage to the cervical spinal cord could result in paralysis or death.
- Injury to the spinal cord at the level of the cervical spine can lead to temporary or permanent quadriplegia, paralyzing the entire body from the neck down.
- AAOS

# Cervical Fracture

- Each year there are 6,000 to 10,000 spinal cord injuries
- 35-45% are due to motor vehicle accidents account for
- Falls account for 25% to 30%.
- Most of the rest are related to sports, especially football, rugby, ice hockey, soccer, diving, gymnastics, and wrestling.
- Nevertheless, catastrophic neck injuries are infrequent in sports, with a prevalence of less than 2/100,000 neck injuries.



# Cervical Fracture

- Hyperflexion was previously thought to be the major cause of injury.
- Axial loading is now recognized as the primary cause of injury although flexion-rotation, hyperflexion, or extension may produce significant injuries.





# Cervical Fracture: Axial Loading

- When the spine (neck) is slightly extended, external forces to the neck can be dissipated with controlled spinal motion through the muscles and curvature of the spine.
- When the neck is slightly flexed (30°), the vertebra line up in a linear (straight) fashion.
- Under this alignment, the force is absorbed entirely by the bones ligaments and disks, rather than the muscles.
- This is called axial loading.

# Cervical Fracture: Axial Loading

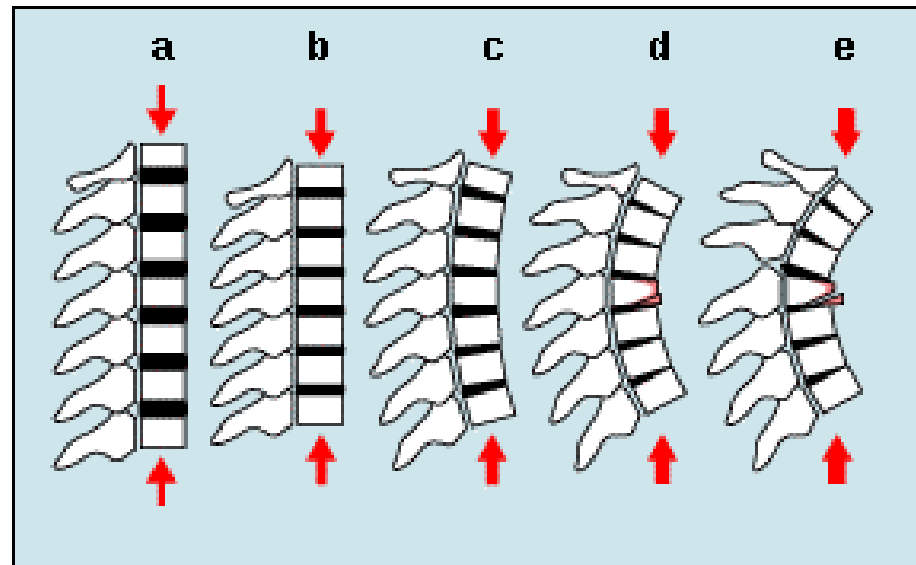


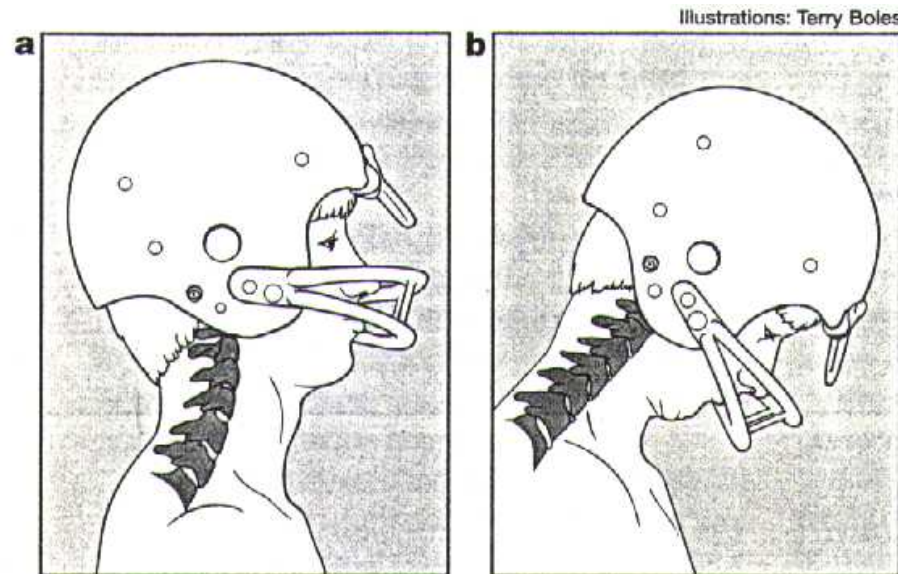
Figure 11. Spear tackler's spine involves loss of normal cervical lordosis. When subjected to an axial loading force, the straightened cervical spine behaves like a segmented column. The force first compresses the intervertebral discs (a and b). As maximum compression is reached, the spine flexes and buckles (c) with resulting fracture, subluxation, or dislocation (d and e). The combination of spear tackler's spine and head-first tackling is extremely dangerous.



# Cervical Fracture: Axial Loading

- When sufficient force is applied, the bones, ligaments, and disks fail, resulting in maximal compressive deformation followed by flexion and buckling with resulting fracture of the vertebrae.
- At the time of the collision, the head stops but the trunk continues to move forward, compressing the vertebrae.
- This sequence of events occurs in as little as 8.4 msec.

# Cervical Fracture: Axial Loading



**Figure 1.** When the head is held upright (a), the cervical spine shows its natural lordosis. At approximately 30° of flexion (b), however, the lordosis is straightened, converting the spine into a column.

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headfirst into

Miami Project to Cure  
Paralysis. "A bad bruise  
of only one or two inches  
is enough to leave you  
paralyzed."



NBC SPORTS

## Danger Ahead

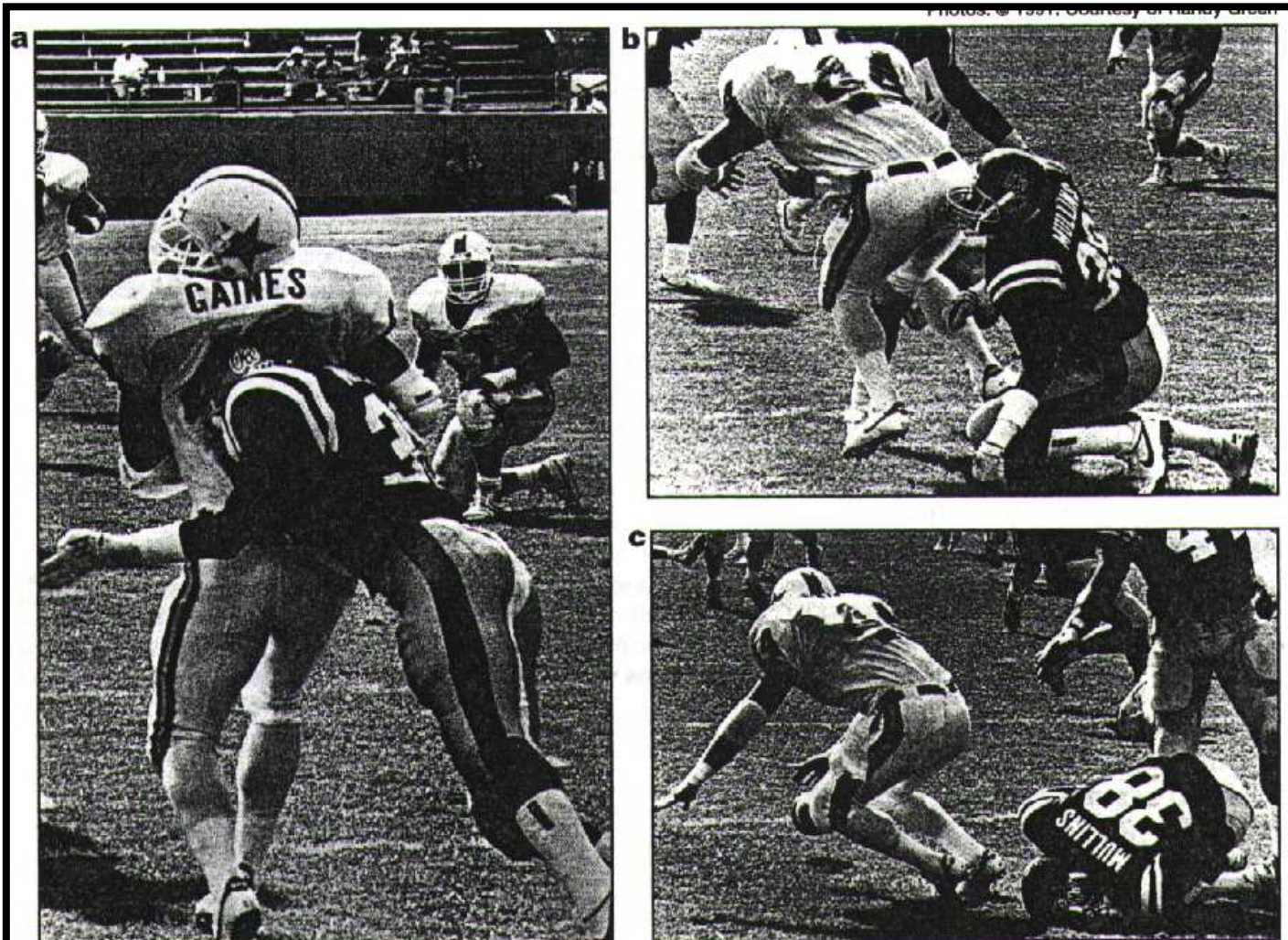
When tackler hits with head down, spine compresses, then buckles at point near impact, fracturing cervical vertebra.



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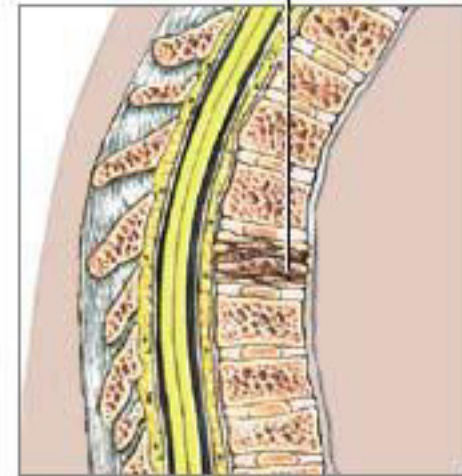


**Figure 3.** A college defensive back (dark jersey) is shown ramming an opposing ball carrier with his head, resulting in severe axial loading of his cervical spine. The defensive player suffered fractures of C-4, C-5, and C-6 and was rendered quadriplegic. The injury occurred October 28, 1989.

# Cervical Fracture

- Injuries may occur at speeds as low as 8-9 miles per hour.
- Head motion seems to have little influence on the injury.
- Most common injuries at C4-C6 but tend to be higher in older individuals

Compression fracture



# Cervical Fracture



- *68% of all spinal injuries are cervical.*
- *\$7.6 billion per year*
- *Risk ratios vary with location.*



# Cervical Fracture

- *Gymnastics - Trampoline*

- *From 1955 to 1978 there were 114 cases of quadriplegia associated with trampoline use. Since then the number of cases has drop dramatically.*

- *Ice-Hockey - Checking or sliding into the boards*

- *From 1977 to 1983 there were 42 spinal injuries (in Canada?). Since then, injuries has decreased by 50%<sup>1</sup> In the early 1980's, 12 to 15 spinal injuries and 4 cases of quad. were reported.<sup>2</sup>*

- *Fewer than 10 football players each year have sustained permanent injury to the cervical spinal cord since 1977.*



# Cervical Fracture

- *Football - Inadequate helmet design; Spearing*
- *In 1904 Pres. Teddy Roosevelt called for an end to “brutality” in organized football. This led to the development of the NCAA.<sup>4</sup>*
- *From 1971 to 1975 there were 259 cervical injuries (4.1/100,000 players) and 99 cases of permanent quad. (1.58 /100,000 players). Since then the numbers have dropped dramatically (1.3/100,000 and 0.4/100,000 players, respectively).*



# Cervical Fracture

- *In 1976 the NCAA banned spearing. Since then spinal injuries dropped from 110 to 40 and players rendered quad. dropped from 34 to 5.<sup>3</sup>*
- *From 1984 to 1987, 24 US players sustained permanent injury, 100 additional players recent temporary damage.*
- *Since 1977 the incidence rate is 0.6/100,000 high school players and 1.69/100,000 college players.<sup>2</sup>*



# Cervical Fracture

- *Diving, usually recreational, is the most common sports-related cause of spinal cord injury, accounting for up to 10% of all spine injuries.<sup>2</sup>*



# Cervical Fracture: Treatment

- It has been estimated that 50% of neurological damage is created after the initial traumatic event, particularly in uncontrolled (recreational) settings.
- If the player is unconscious, assume cervical damage.



# Cervical Fracture: Treatments

- The methods of spinal cord resuscitation seek to
  - Minimize hypoxia by maintaining blood flow and breathing
  - Minimize edema and inflammation with intravenous corticosteroids
  - Minimize damage to nerve cell membrane by not moving the person and eventual reduction of spinal deformity so as to relieve cord deformation

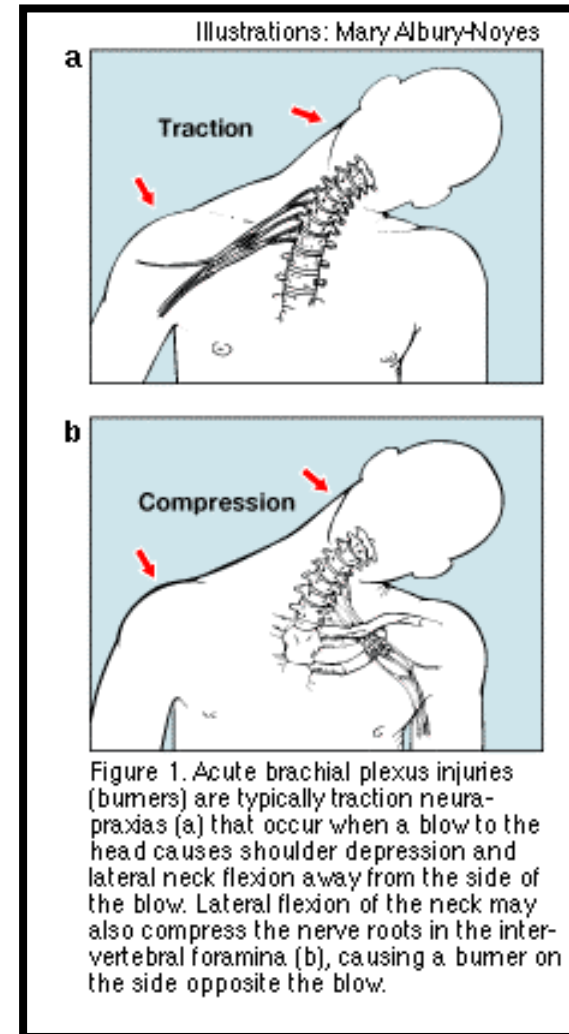


# Cervical Fracture: *Prevention*

- 1. Continued research.
- 2. The identification of injury, epidemiologic, and clinical evidence.
- 3. Education of coaches and players. Keep head up (neck extension) on contact!
- 4. Establishment and enforcement of appropriate rules.

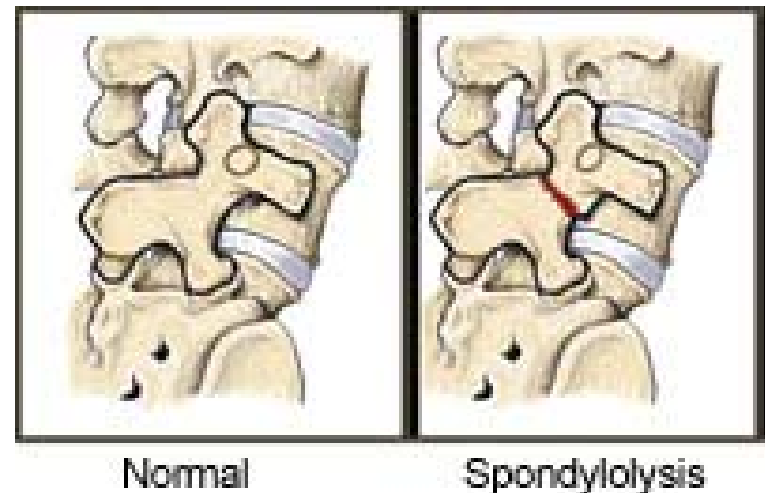
## 2. “Burner” or “Stinger”

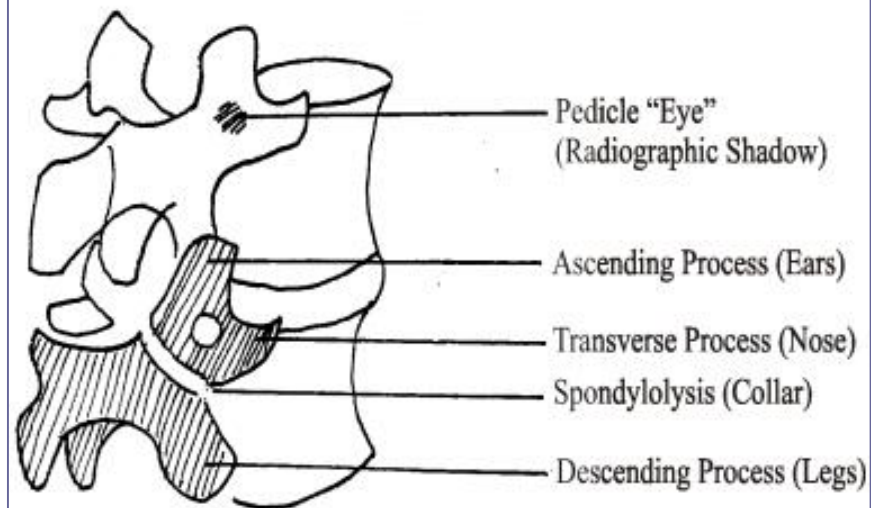
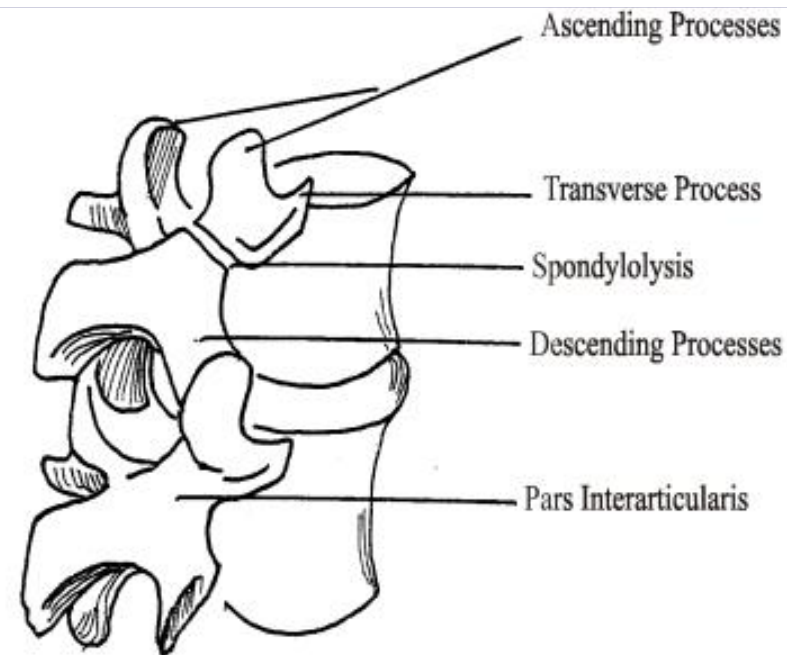
- Experienced by 50% of college football players at one time or another.
- Is not a spinal cord injury.
- Stretching of the cervical nerve roots because of excess lateral flexion of the neck
- Generally symptoms resolve in 5 to 10 minutes, although permanent deficits have been documented in players who have repeated episodes.



### 3. Spondylolysis (spon-dee-low-lye-sis)

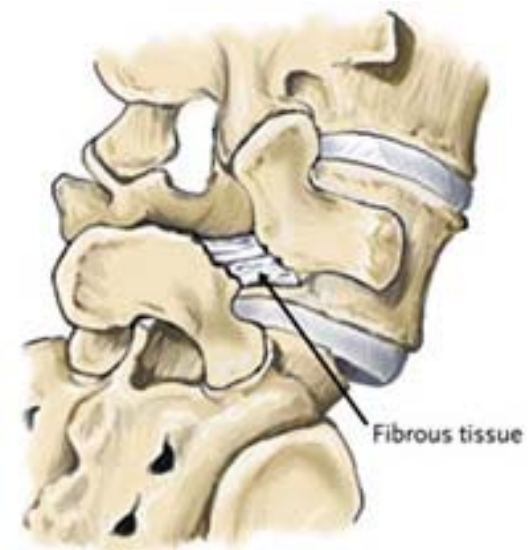
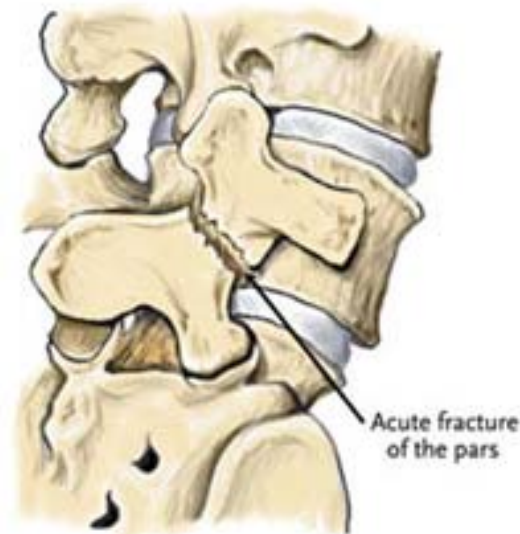
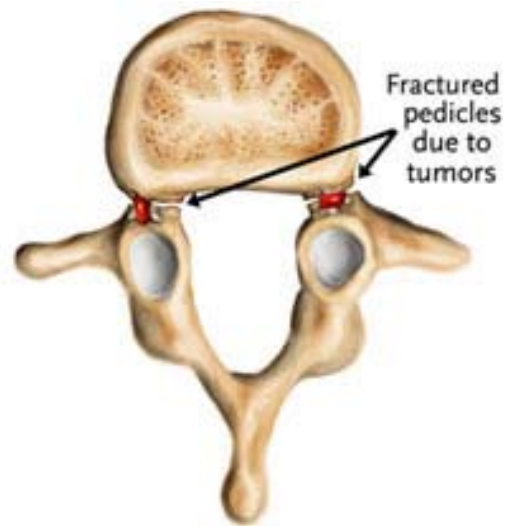
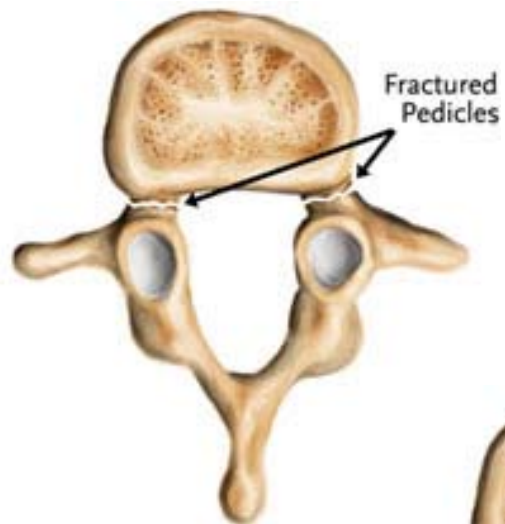
- Repetitive flexion and extension of the low back may sustain stress fractures of the pars interarticularis (between the superior and inferior articular facets) of the lower spine
- It usually affects either the fourth or the fifth lumbar vertebra in the lower back.
- Children between the ages of 5 and 15 are at greater risk, with symptoms not showing until age 10 to 15 years.





**Figure 1:** Schematic drawing of an oblique roentgenogram of the lumbar spine, showing the characteristic "Scotty dog" look of its posterior elements. Note that the defect in the pars interarticularis appears to be a collar around the dog's neck.

# Spondylolysis



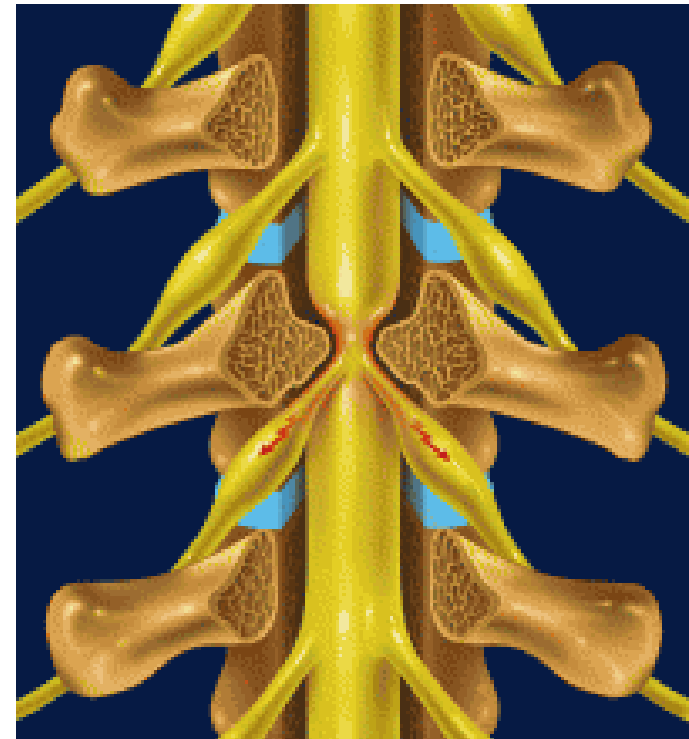


# Spondylolysis

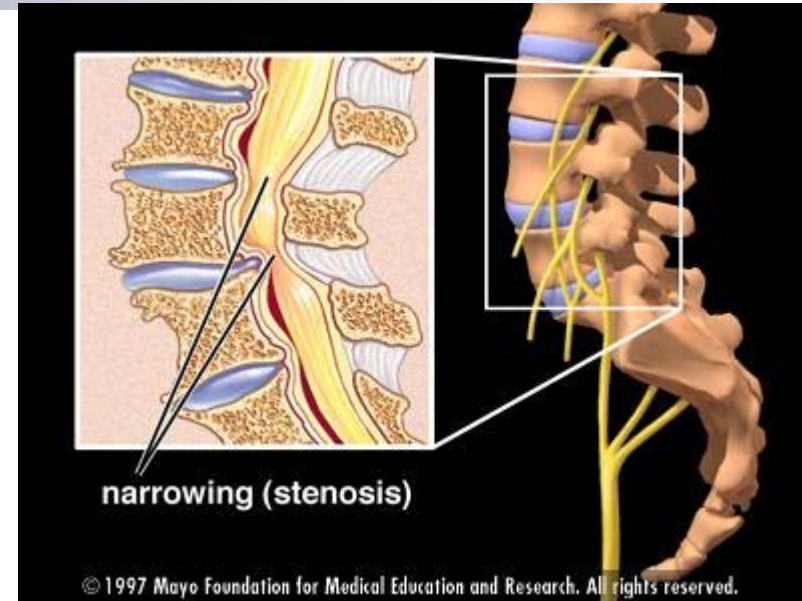
- The stress fracture can weaken the bone so much that it is unable to maintain its proper position and the vertebra slip out of place.
- If too much slippage occurs, the bones may begin to press on nerves and surgery may be necessary to correct the condition.
- Causes:
  - Genetics: There may be a hereditary aspect to spondylolysis. An individual may be born with thin vertebral bone and therefore be vulnerable to this condition. Significant periods of rapid growth may encourage slippage.
  - Overuse: Some sports, such as gymnastics, weight lifting and football, put a great deal of stress on the bones in the lower back. They also require that the athlete constantly over-stretch (hyperextend) the spine. In either case, the result is a stress fracture on one or both sides of the vertebra.
  - Sports requiring weight-loading, rotation, and/or hyper extension are high risk.

## 4. Spinal Stenosis

- In spinal stenosis, the spinal canal narrows and pinches the spinal cord and nerves.
- The result is low back pain as well as pain in the legs.
- Stenosis may pinch the nerves that control muscle power and sensation in the legs.



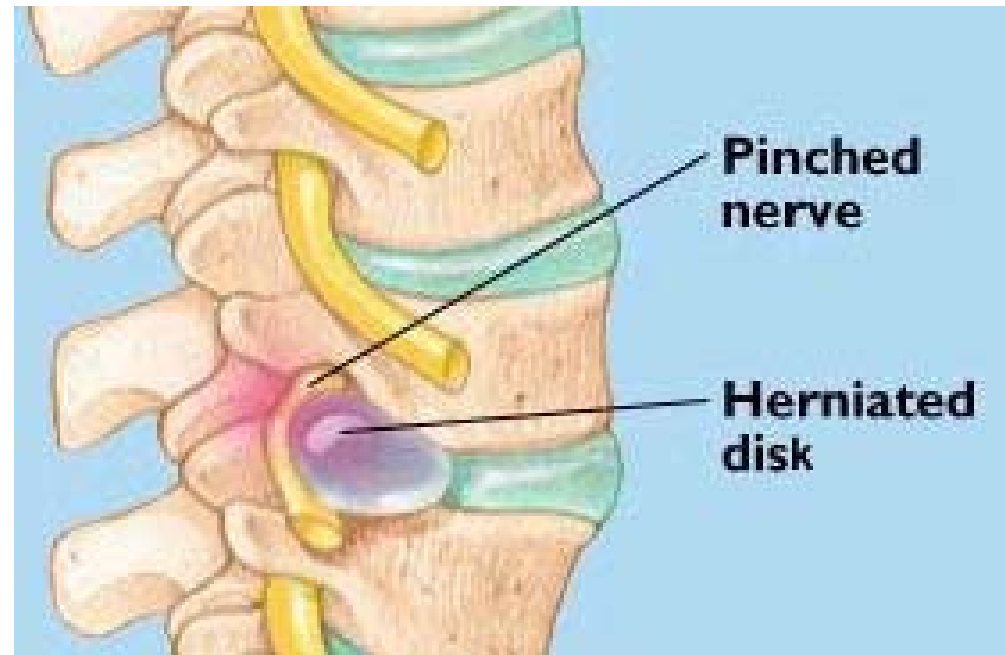
# Spinal Stenosis



## ■ Causes of spinal stenosis

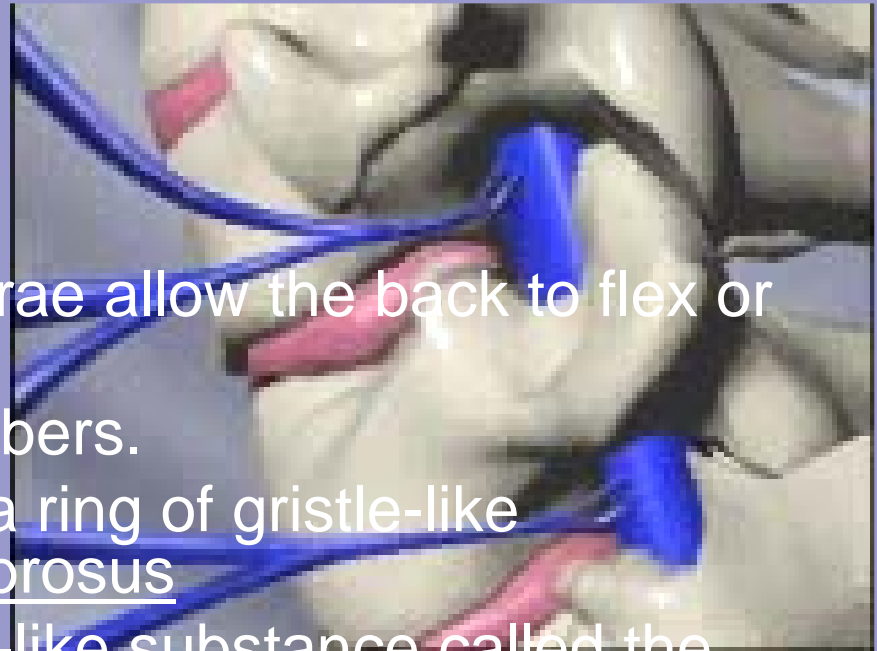
- Aging. As you get older, the ligaments (tough connective tissues between the bones in the spine) can thicken. Spurs (small growths) may develop on the bones and into the spinal canal. The cushioning disks between the vertebrae may begin to deteriorate. The facet joints (flat surfaces on each vertebra that form the spinal column) also may begin to break down.
- Heredity. If the spinal canal is too small at birth, symptoms may show up in a relatively young person.
- Changes in blood flow to the lumbar spine.

## 5. Herniated Disk



# Herniated Disk

- The disks between the vertebrae allow the back to flex or bend.
- Disks also act as shock absorbers.
- The outer edge of the disk is a ring of gristle-like cartilage called the annulus fibrosus
- The center of the disk is a gel-like substance called the nucleus pulposus.
- A disk herniates or ruptures when part of the center nucleus pushes the outer edge of the disk into the spinal canal, and puts pressure on the nerves.
- As the disk material pinches and puts pressure on the nerve roots, pain results. Sometimes fragments of the disk enter the spinal canal where they can damage the nerves that control bowel and urinary functions.

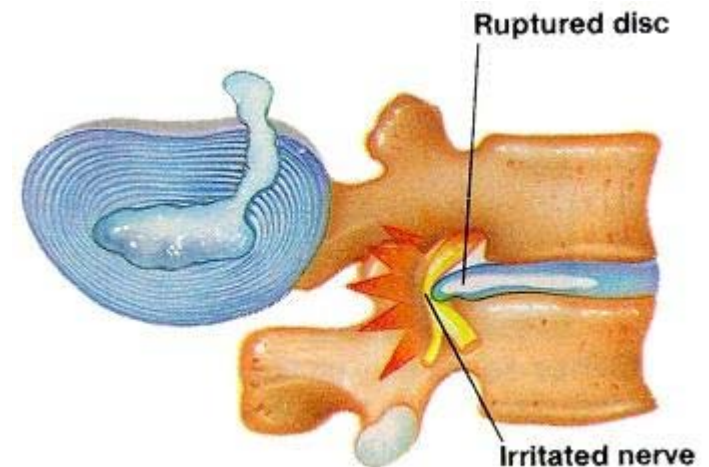
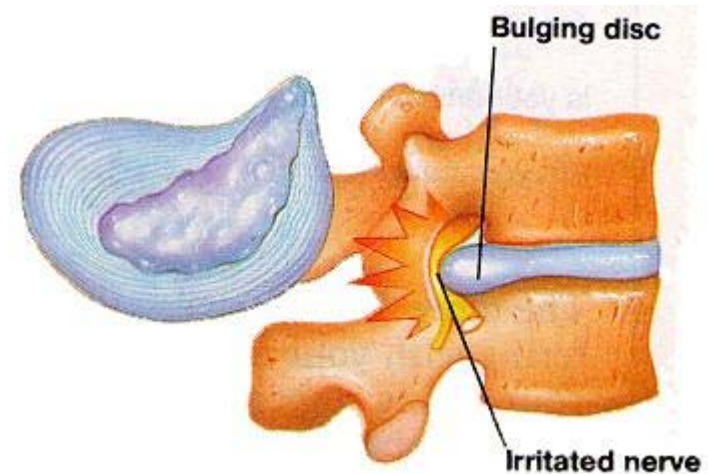


# Herniated Disk

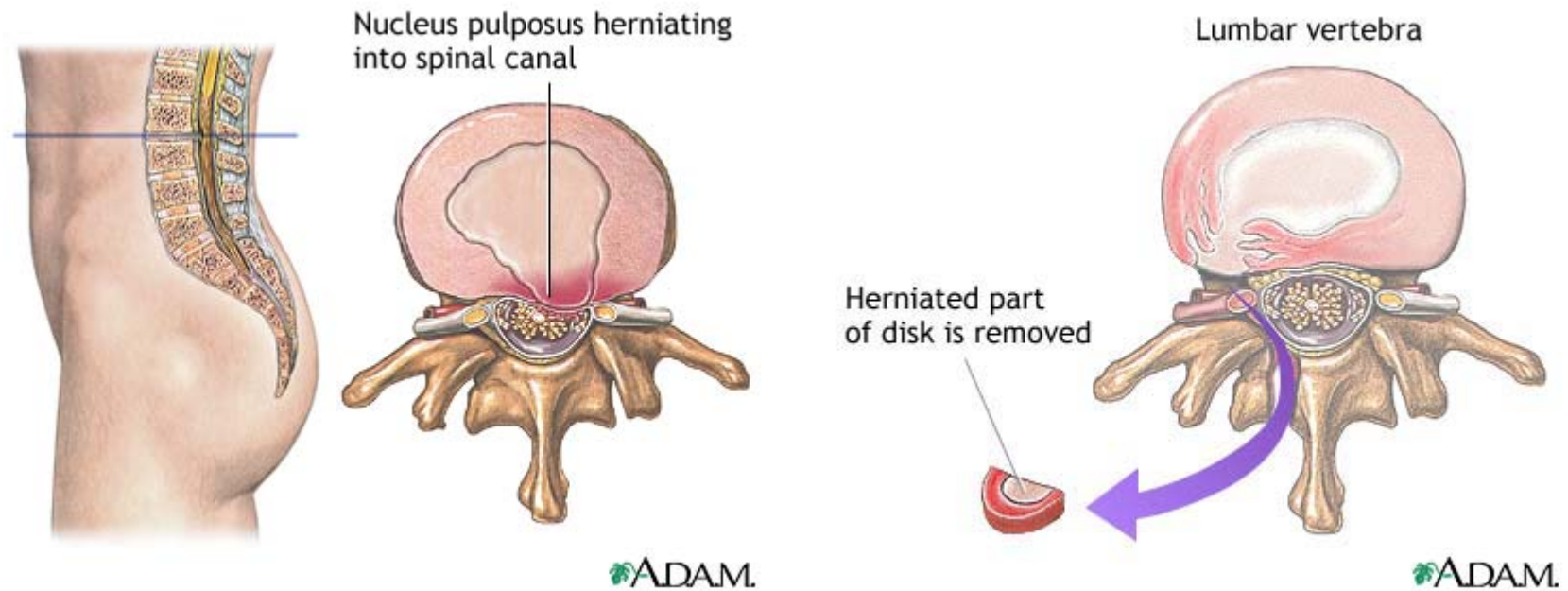
## ■ Causes

- ☐ aging
- ☐ wear-and-tear
- ☐ excessive weight which can squeeze the softer material of the nucleus out toward the spinal canal
- ☐ bad posture
- ☐ improper lifting
- ☐ sudden pressure (which may be slight)

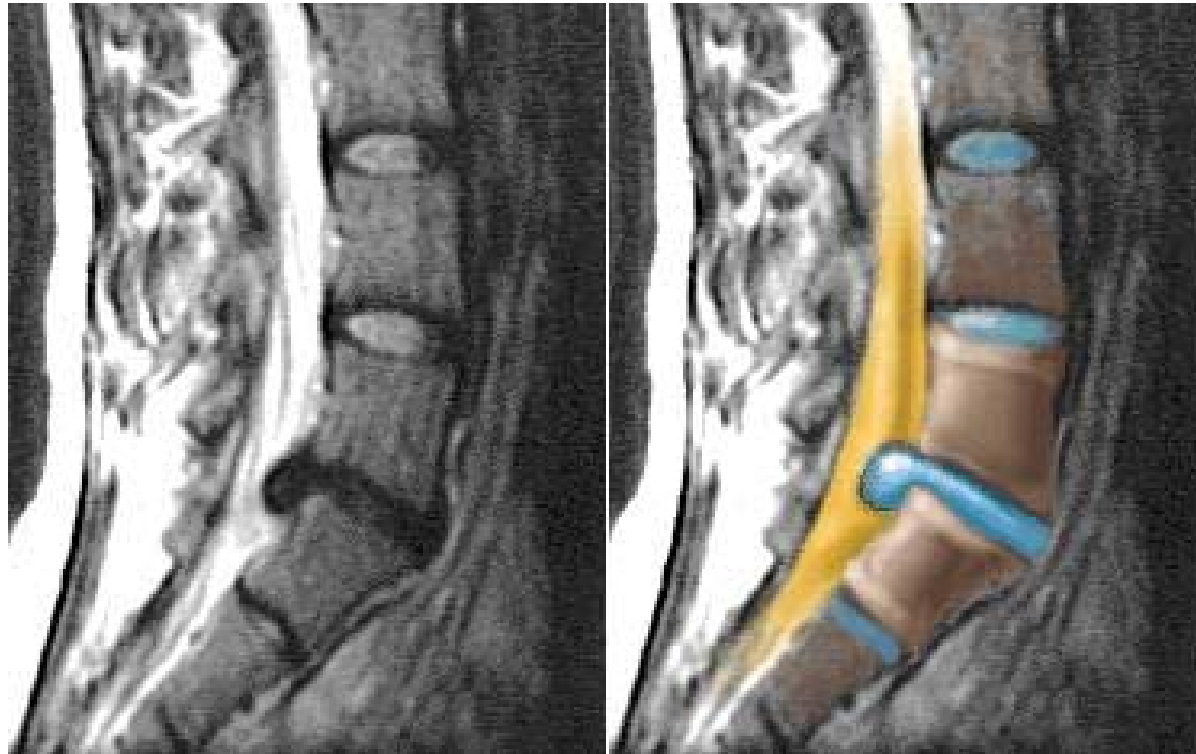
- Also known as a "slipped" or "ruptured" disk in the back.



# Herniated Disks

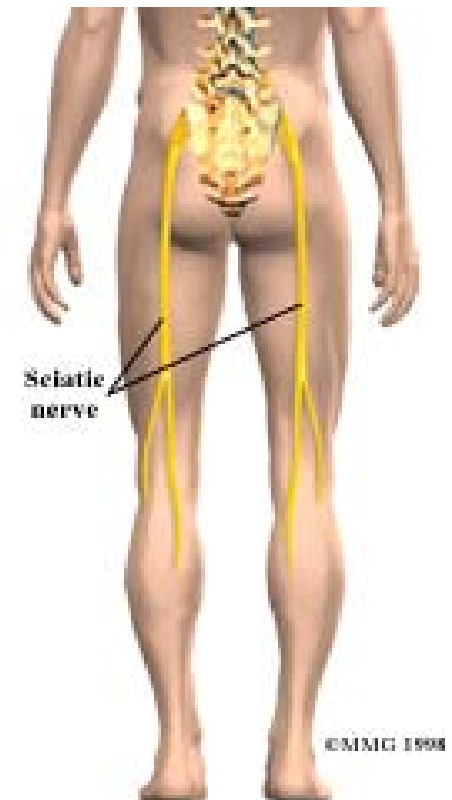


# Herniated Disks



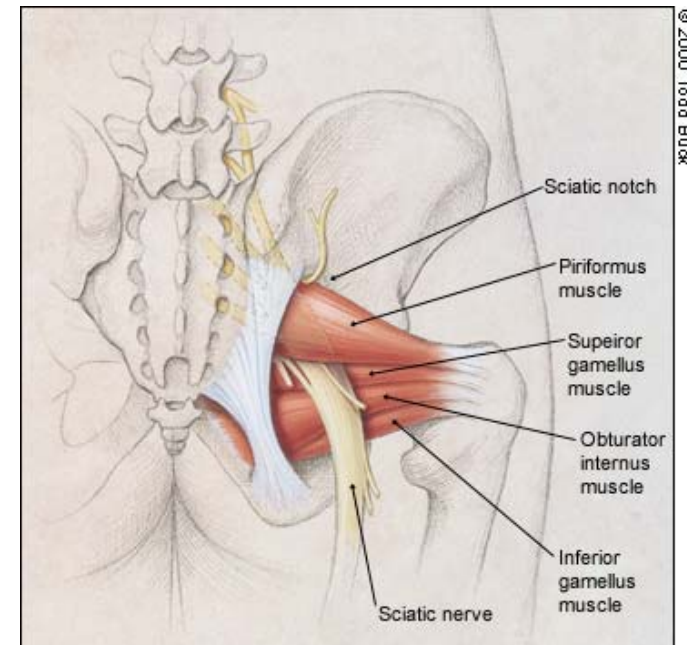
## 6. Sciatica

- Symptom: pain in your lower back or hip that radiates down from your buttock to the back of one thigh and into your leg
- A protruding disk in your lower spinal column pressing on the roots to your sciatic nerve.
- Sciatica (lumbar radiculopathy) may feel like a bad leg cramp that lasts for weeks before it goes away.
- You may have pain, especially when you sit, sneeze or cough. You may also feel weakness, "pins and needles" numbness, or a burning or tingling sensation down your leg.
- You're most likely to get sciatica when you're 30-50 years old.



# Sciatica

- Sciatica pain is due to the effects of general wear and tear, plus any sudden pressure on the disks that cushion the vertebrae of your lower (lumbar) spine.
- About 80-90 percent of people with sciatica get better, over time, without surgery.





## 7. Lower Back Injuries

- Cervical region is most susceptible to acute injuries
- Lumbar region is most susceptible to chronic injuries
  - Weight-loading sports that compress the spine
    - weight lifting, running
  - Rotation-causing events
    - racket sports and golf
  - Back arching events
    - rowing, swimming and volleyball



# Lower Back Injuries

- Due to weak abdominal muscles and tight hamstrings.
- Due to mechanical strain of the ligaments and joints from from inadequate warm up, weak abdominal muscles, and/or tight hamstrings.
- Results in lordosis of the lower back.
- Patients complain of low back pain after long periods of standing or playing.
- Can treat with muscle strengthening exercises or anti-lordotic Boston brace.



# Lower Back Injuries: Prevention

- Strong abdominal muscles
- Proper technique.
  - This often involves developing gluteal and quadriceps strength so that you can crouch without excessively swaying the lower back.
- Balanced program of both stretching and strengthening.

Illustrations: © 1998 Terry Boles

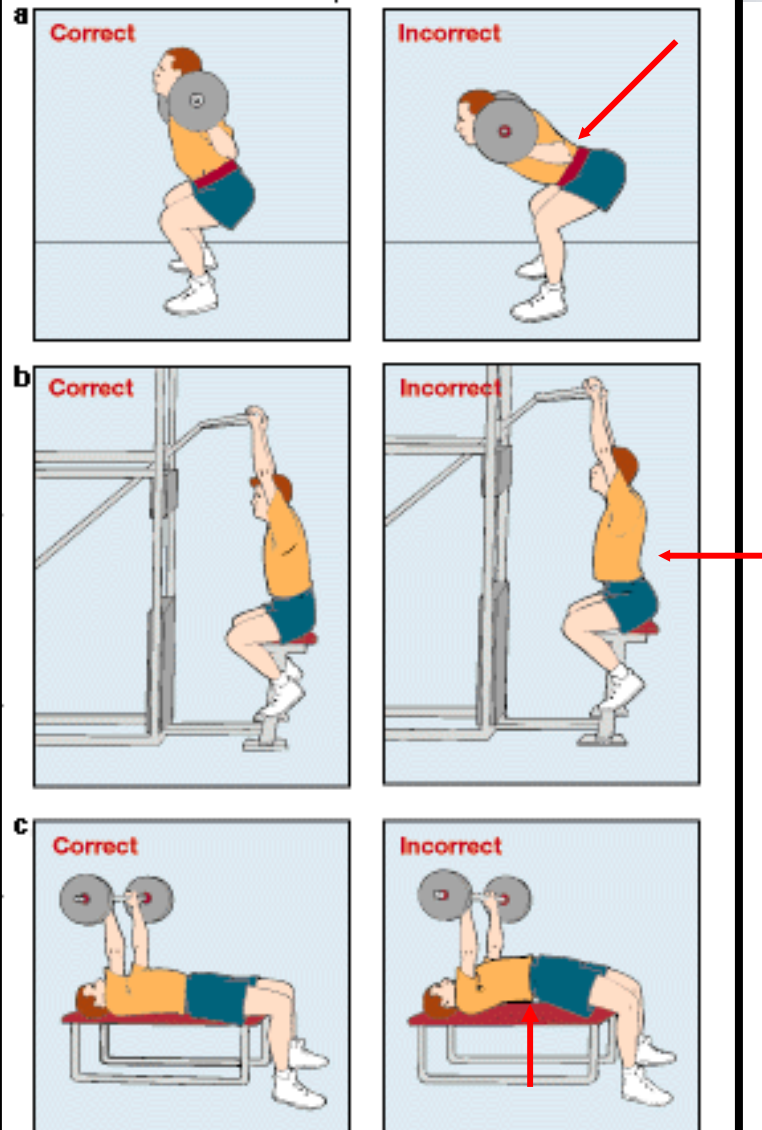


Figure 2. Spondylolysis, a fracture or stress reaction of the pars interarticularis, can occur because of improper technique during weight lifting. Patients should avoid hyperextending the lumbar spine during squats (a), military (deltoid) presses (b), and bench presses (c).



# Abdominal Exercises

- Concern: When the thigh is fixed, the hip flexors are a prime flexor of the trunk.  
When the leg is down flat, the length of the flexors are at optimal length for action.
- When the thigh is not fixed, the abdominal muscles flex the trunk until the shoulder blades are raised from the floor, the hip flexors do the rest of the flexion.

# Abdominal Exercises

- When the trunk is flexed with the thigh fixed, the hip flexors contract in this position and pull the lumbar region of the back inward, increasing the inward lumbar curve.
- An imbalance between the hip flexors and the abdominal muscles can lead to postural increases in the lumbar region resulting in lordosis, herniation of the intervertebral disks, and pinching of the nerves in the lower back.





# Abdominal Exercises

- To isolate the abdominal muscles during sit ups, the knees should be bent and the feet should be free to prevent "fixation" of the thigh.
- When clasping the hands behind the head during sit-ups, the person with weak abdominal muscles has the tendency to jerk the head forward, risking injury to the cervical spine.

# Abdominal Exercises [LINK](#)

- Hands crossed over the chest.
- With the knees bent and feet flat on the floor, the lumbar region of the spine is somewhat stabilized which reduces the risk of hyperextending the lumbar vertebrae.
- Curl towards the chest until the shoulders are raised from the floor.
- Further flexion than this is accomplished by the hip flexors.

Figure: © 1997. Terry Boles

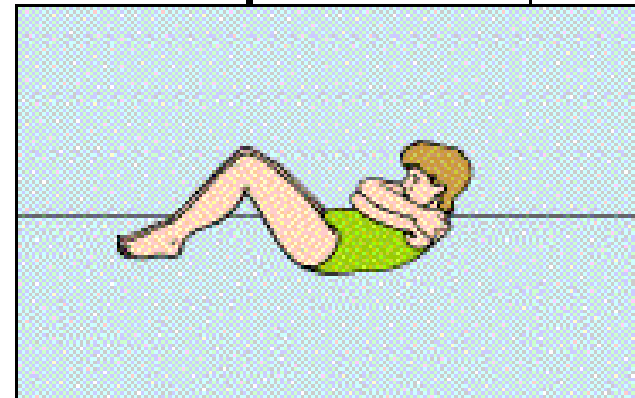
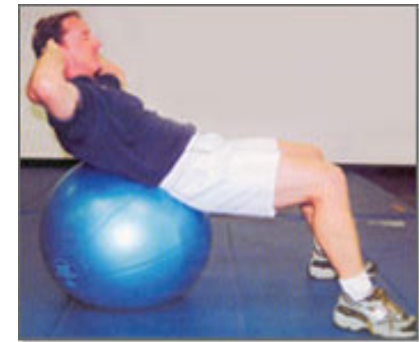


Figure 1. To do a sit-up, lie on your back with your knees bent about 90° and feet flat on the floor. Raise your torso, shoulders, and head 6 to 12 inches. Tense your abdominal muscles and hold this position for a few seconds. Return slowly to the floor and repeat. To avoid neck injury, hold your hands at your sides, across your chest (as shown), or (if you can) crossed behind your neck with either hand on the opposite shoulder. Do not interlace your fingers behind your head or neck.

# Abdominal Exercises

- Lie on top of the ball so that your lower back is supported, your thighs are parallel to the ground and your feet are flat and shoulder-width apart.
- Place your arms across your chest or behind the head, gently supporting your head.
- Allow your body to curve over the top of the ball letting your stomach muscles stretch.
- Tighten your stomach muscles as you curl your body up and around the ball.
- Once you have reached the top, slowly lower yourself down and repeat.
- Once you master that, try twisting slightly as you curl-up.



Full sit-ups aren't necessary, crunches shorten muscle motion, so try the stability ball

[LINK](#)

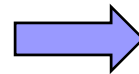
# Abdominal Exercises

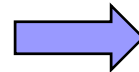
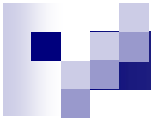
- No one exercise is best or better.
- Curl ups provide less lumbar stress for a given amount of muscle activity.

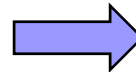
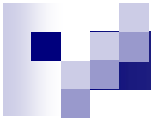


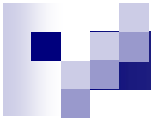
# Abdominal Exercises

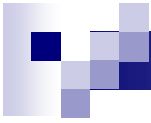
- Rectus Abdominis and Obliques dynamically contract only if actual waist flexion occurs.
- With no waist flexion, Rectus Abdominis and External Oblique will only isometrically contract to stabilize the pelvis and waist during hip flexion.
- It may be necessary to completely flex the hips before waist flexion is possible
- ExRx

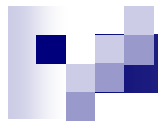












# Spot Reduction

# Concussion

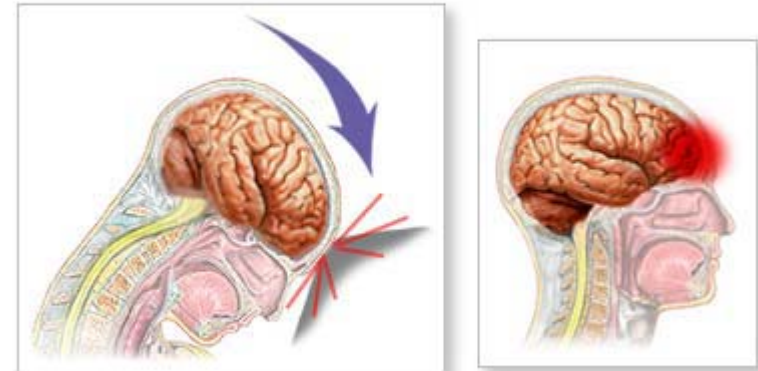
- The brain is composed of soft, delicate structures that lie within the rigid skull.
- Within the brain are (cranial) nerves that are responsible for many activities, such as eye opening, facial movements, speech and hearing.
- These nerves carry and receive messages that allow the person to think and function normally.
- There are also centers that control level of consciousness and vital activities, such as breathing.
- There is very little extra room within the skull cavity.



# Concussion

- An injury to the head causes the brain to bounce against the rigid bone of the skull.
- This force may cause a tearing or twisting of the structures and blood vessels of the brain, which results in a breakdown of the normal flow of messages within the brain.
- Less damage nerves can repair themselves.
- More severely damaged nerves lead to swelling and disintegration of the nerve.

A concussion is a violent jarring or shaking that results in a disturbance of brain function



ADAM.



# Concussion

- **Grade 1**

The mild concussion occurs when the person does not lose consciousness (pass out) but may seem dazed.

- **Grade 2**

The slightly more severe form occurs when the person does not lose consciousness but has a period of confusion and does not recall the event.

- **Grade 3**

The classic concussion, which is the most severe form, occurs when the person loses consciousness for a brief period of time and has no memory of the event. Evaluation from a health-care provider should be performed as soon as possible after the injury.



# Concussion

- Unconsciousness is not required for a concussion to occur.
- A player who has suffered a concussion is 4 times more like to suffer another one.
- Concussion are underreported at all levels.
- Football guidelines for returning to play are more lenient than boxing.
- NJ Boxing commission requires 60 days.



# Concussion

- Increase in number of concussions is associated with a decrease in cognitive function.
- Learning disabilities are also associated with a decrease in cognitive function.
- Can be fatal.