

## Spondylolysis/Spondylolistheis: Management and Return to Activity Guidelines

Hanbing Zhou MD



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### Disclosures

- I have no relevant financial relationships to disclose.



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### Spondylolysis/Spondylolistheis:

1. Spine Anatomy
2. Pathophysiology
3. Natural History/Genetics
4. Clinical Presentation
5. Physical Exam
6. Imaging findings
7. Impact on athletes
8. Non-operative management
9. Operative management



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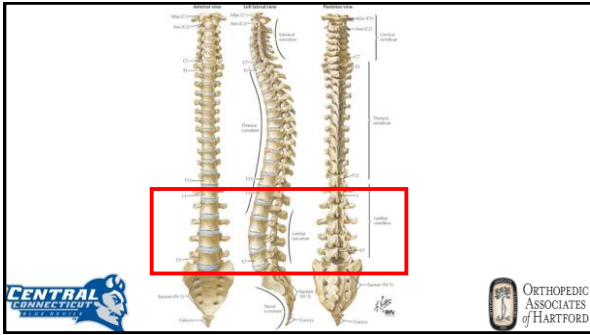
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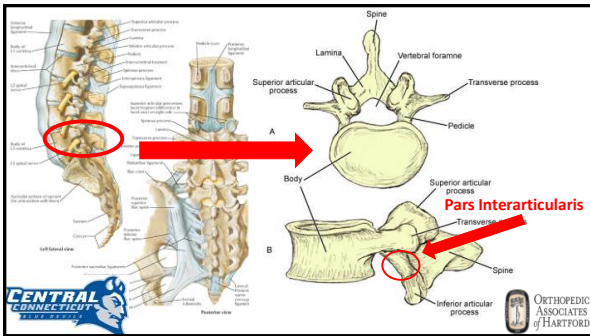
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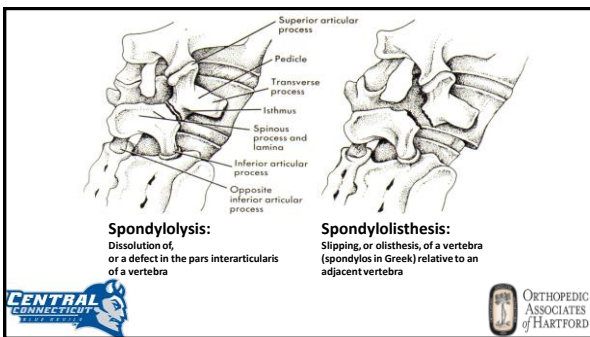
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### Types of spondylolisthesis

- Dysplastic (children)
- Isthmic (children, 85%)
- Degenerative
- Traumatic
- Pathologic
- Iatrogenic

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### MEYERDING CLASSIFICATION

Based on the ratio of [overhanging part of the superior vertebral body] to [anteroposterior length of the inferior inferior vertebral body].

- grade I: 0-25%
- grade II: 26-50%
- grade III: 51-75%
- grade IV: 76-100%
- grade V: spondylolysis >100%

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### Loads on the Spine

Lumbar hyperextension produces compressive loads at the facet joints.

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### Genetics<sup>3</sup>

- 15-70% of first-degree relatives of individuals with the disorder
- 2-3x more frequent in boys than girls
- Slippage 2-3x more often than boys



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### Natural History

- 5% of general population
- Fredrickson et al.<sup>4</sup>: 500 first-grade children in 1955
  - 4.4% at age of 6
  - 6% in adulthood
  - 2x common in males
  - 15% with pars defect progressed to spondylolisthesis
  - No slip >40%
  - Back pain/SF-36 no different with age-matched general population group
  - Progression secondary to degeneration of the L5-S1 vertebral disc



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### Clinical Presentation

- 75% of back pain in children is "overuse"<sup>5</sup>
- Most common identifiable cause is spondylolysis
- 40% recall traumatic injury event<sup>6</sup>
- Insidious or gradual onset
- Low back pain primarily worsening with extension related activities



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### Physical Exam

- Tenderness and pain on palpation of spinous process of affected vertebra
- Lordotic lumbar spine
- Muscle guarding either unilateral or bilateral of erector spinae
- Weakness in gluteals and abdominals
- Pain on extension
- Positive single leg hyperextension test<sup>14</sup>
- Hamstring tightness



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### AP/Lateral/Oblique Radiographs

"Scotty dog": Broken neck → spondylolysis



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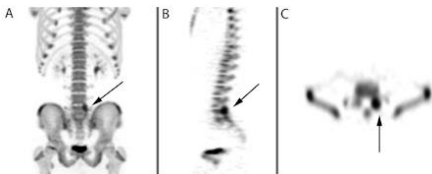
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### Bone Scan/SPECT

- Increased signal: bony activity and healing potential
- Absence of signal: non-union, minimal healing potential<sup>12</sup>



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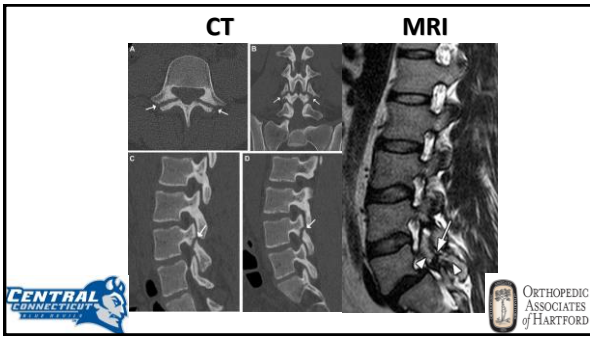
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### Athletes

- Symptomatic spondylolysis in athletes with low back pain is 15-47%<sup>7-8</sup> (general population 6-8%)
- Professional soccer: 38.1%<sup>9</sup>
- Baseball players: 44.1%<sup>9</sup>
- Divers: 43%
- Wrestlers: 30%
- Weightlifters: 23%



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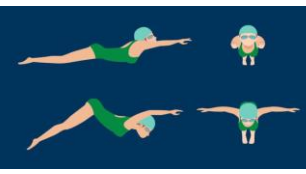

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Butterfly style and breaststroke swimmers are reported to have the highest incidence of spondylolysis when compared to other swimming styles<sup>10</sup>

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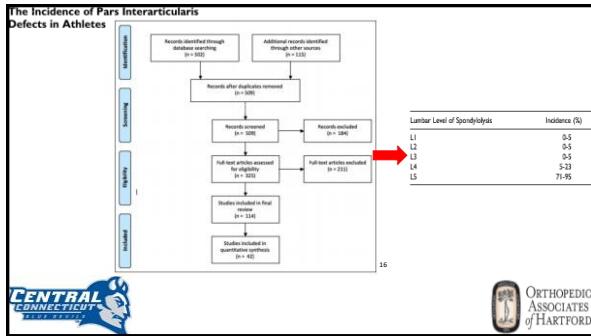
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Incidence of Pars Interarticularis Defects				Incidence of Spondylolysis				Incidence of Spondylolisthesis							
Sport	Sample Size	n	%	Sample Size	n	%	Sample Size	n	%	Sample Size	n	%	Sample Size	n	%
Baseball	20	0	0.0	Baseball	20	0.0	Baseball	20	0.0	Baseball	20	0.0	Baseball	20	0.0
Basketball	30	0	0.0	Basketball	30	0.0	Basketball	30	0.0	Basketball	30	0.0	Basketball	30	0.0
Football	100	1	1.0	Football	100	1.0	Football	100	1.0	Football	100	1.0	Football	100	1.0
Gymnastics	100	1	1.0	Gymnastics	100	1.0	Gymnastics	100	1.0	Gymnastics	100	1.0	Gymnastics	100	1.0
Hockey	100	1	1.0	Hockey	100	1.0	Hockey	100	1.0	Hockey	100	1.0	Hockey	100	1.0
Softball	100	1	1.0	Softball	100	1.0	Softball	100	1.0	Softball	100	1.0	Softball	100	1.0
Tennis	100	1	1.0	Tennis	100	1.0	Tennis	100	1.0	Tennis	100	1.0	Tennis	100	1.0
Volleyball	100	1	1.0	Volleyball	100	1.0	Volleyball	100	1.0	Volleyball	100	1.0	Volleyball	100	1.0
Winter	100	1	1.0	Winter	100	1.0	Winter	100	1.0	Winter	100	1.0	Winter	100	1.0
Other	100	1	1.0	Other	100	1.0	Other	100	1.0	Other	100	1.0	Other	100	1.0

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## Non-Operative Treatment

- **Activity Modification**
  - Cessation of inciting sports activities
  - Non-steroidal anti-inflammatory agents
  - Reduction of lumbar lordosis
- **Physical Therapy**
  - Hamstring stretching
  - Trunk strengthening
  - Avoidance of inciting activities



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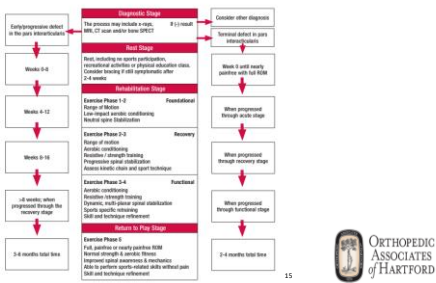
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### Rehabilitation Guidelines for Lumbar Spondylolysis/Spondylolisthesis



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### Rehabilitation Guidelines for Lumbar Spondylolysis/Spondylolisthesis

#### Rehabilitation Timeline: Phases of the Exercise Progression

Stage	Rest/Protection	Rehabilitation Foundational	Rehabilitation Recovery	Rehabilitation Functional	Return to Sport	Total Time to Return to Sport
Exercise Phase	1	2	3	4	5	
Emphasis	Rest/protection, Core initiation, Abdominal bracing	Static stabilization	Dynamic stabilization and coordination	Athletic enhancement and gradual return to activity	Development of maintenance exercise routine	
Duration	4-6 weeks	+ 1 - 4 weeks	+ 2 - 4 weeks	+ 2 - 6 weeks	Return to sport	2-6 months



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**PHASE 1 Rest & Protection, Core Initiation, Abdominal Bracing** begins on the first day of complete rest (Day #0) and continues for 4-8 weeks, depending on your progress. To promote proper healing of the stress fracture(s) it is important to rest completely and for the entire length of time recommended by your health care professional.

Appointments	<ul style="list-style-type: none"> <li>First rehabilitation appointment should be within 1-2 weeks of diagnosis, every 1-2 weeks thereafter</li> </ul>
Rehabilitation Goals	<ul style="list-style-type: none"> <li>Allow sufficient time for healing to occur, hold all sports participation, protect the area</li> <li>Pain-free with daily activities</li> <li>Initiate deep abdominal stabilization recruitment</li> <li>Gradually increase flexibility of key upper/lower body muscles</li> </ul>
Precautions	<ul style="list-style-type: none"> <li>No active or passive lumbar extension ROM</li> <li>Consider bracing if still symptomatic after 2-4 weeks rest</li> </ul>
Suggested Therapeutic Exercises	<ul style="list-style-type: none"> <li>Abdominal bracing in various postures (supine, prone over pillow, 4 point, kneeling, standing)</li> <li>Stretching exercises for key UE/LJ muscles with emphasis on neutral spine alignment and in non-weightbearing postures</li> <li>Supine 90-90 active knee extension hamstring stretch</li> <li>Child's pose latissimus dorsi stretch</li> <li>Supine pectoralis stretching in 90-90 shoulder position</li> <li>Supine or side-lying hip flexor &amp; quad stretching</li> <li>Supine figure 4 piriformis stretching</li> </ul>
Cardiovascular	<ul style="list-style-type: none"> <li>Light stationary biking</li> </ul>

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**PHASE 2 Static Stabilization** begins after the necessary 4-8 weeks of rest required to achieve significant pain reduction. It usually takes 1-3 weeks to master the foundational movement patterns in phase 2, depending on the individual.

Appointments	<ul style="list-style-type: none"> <li>Every 7-10 days</li> </ul>
Rehabilitation Goals	<ul style="list-style-type: none"> <li>Maximize pain free (or nearly pain free) range of motion</li> <li>Pain free with daily activities</li> <li>Increase abdominal and core strength</li> <li>Improve normal hip and thoracic mobility</li> <li>Progress flexibility and lumbar stabilization in weight bearing postures</li> <li>Improve patient proprioception</li> <li>Maximize neuromuscular flexibility in key upper/lower body muscles</li> <li>Re-establish aerobic fitness</li> </ul>
Precautions	<ul style="list-style-type: none"> <li>No active or passive lumbar extension ROM</li> </ul>
Suggested Therapeutic Exercises	<ul style="list-style-type: none"> <li>Diaphragm</li> <li>Double leg bridges</li> <li>4 point alternate arm or leg raises</li> <li>Side lying hip abduction or clam shells</li> <li>Side Planks</li> <li>Targeted foam with abdominal bracing in sitting</li> <li>Sitting on Swiss ball, alternate sitting on arm or leg</li> </ul>
Cardiovascular Exercise	<ul style="list-style-type: none"> <li>Light moderate stationary biking</li> <li>Deep water jogging in pool with flotation vest</li> </ul>
Progression Criteria	<ul style="list-style-type: none"> <li>Reduction increase in abdominal strength</li> <li>Can comfortably hold and pain free lumbar flexion and lateral flexion range of motion</li> <li>Ability to hold bridge and side plank for 30 seconds without pain</li> <li>Ability to maintain neutral spine posture during dynamic arm or leg ROM</li> </ul>

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**PHASE 3 Dynamic Trunk Stabilization & Coordination** can be initiated when the goals of phase 2 are met. On average, this will begin ~2-3 months from Day #0. It usually takes 2-4 weeks to achieve the goals in this phase, depending on the individual.

Appointments	<ul style="list-style-type: none"> <li>Every 1-2 weeks</li> </ul>
Rehabilitation Goals	<ul style="list-style-type: none"> <li>Continue increase in abdominal strength</li> <li>Maximize flexibility</li> <li>Improve normal joint mobility hip and thoracic spine, mobilize if necessary</li> <li>Recreate lumbar extension in non-weightbearing postures</li> <li>Progress aerobic fitness</li> <li>Begin sport specific drills to prepare for return to sports participation</li> </ul>
Precautions	<ul style="list-style-type: none"> <li>Avoid prolonged back pain with initiation of lumbar extension ROM</li> </ul>
Suggested Therapeutic Exercises	<ul style="list-style-type: none"> <li>30-90 with medicine ball and Swiss ball sit and for plyometrics</li> <li>Single leg bridges</li> <li>Oblique trunk rotation in back lying (progress to one ball)</li> <li>Supine rotation curls on Swiss ball</li> <li>Dynamic strengthening hip hinge and overhead reach</li> <li>Swiss ball</li> <li>OK to increase upper body weight lifting with spine motion</li> </ul>
Cardiovascular	<ul style="list-style-type: none"> <li>Moderate intensity stationary biking or elliptical machine</li> <li>Shallow water jogging and jumping into or pool (precaution to chest depth)</li> </ul>
Progression Criteria	<ul style="list-style-type: none"> <li>No discomfort pain with lumbar range of motion and sport drills</li> <li>Physician's release if necessary</li> </ul>
Suggested Therapeutic Exercise	<ul style="list-style-type: none"> <li>Multi-planar strength progression, including forward, lateral and diagonal targets</li> <li>Dynamic core exercise (leggings) with the weights, single plane activities and progressing to higher velocity multi plane activities</li> <li>Equipment specific balance and proprioceptive drills</li> <li>Hip and core strengthening</li> <li>Stretching for patient specific muscle imbalances</li> </ul>
Cardiovascular Exercise Return to Sport Criteria	<ul style="list-style-type: none"> <li>Replicate sport or work specific energy demands</li> <li>Dynamic neuromuscular control with multi plane activities, without pain</li> </ul>

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**PHASE 4 Athletic Enhancement and Gradual return to activity when the goals of phase 3 are met, you can initiate this phase. It usually takes 2-4 weeks to achieve the goals depending on the individual. This phase takes into account the unique demands of the sport; progresses into impact loading through running and jumping, provide sport-specific exercises and leads to the development of a maintenance program.**

Appointments	<ul style="list-style-type: none"> <li>Every 1-2 weeks</li> </ul>
Rehabilitation Goals	<ul style="list-style-type: none"> <li>Maintain flexibility in key muscle groups</li> <li>Maintain strength in abdominals and hip muscles</li> <li>Initiate lumbar extension-ARM if necessary for sport</li> <li>Initiate impact loading of the spine including jogging, running, jumping/landing</li> </ul>
Suggested Therapeutic Exercises	<ul style="list-style-type: none"> <li>In clinic, Diagonal #1 and #2 trunk rotation patterns with medicine ball (avoid chest)</li> <li>Lunge (front, backfoot, side) with dumbbells or medicine ball</li> <li>Body weight suspension exercises (such as TRX)</li> <li>Progression to Impact Loading (see Addendum A)</li> <li>Gradual exposure to sport-specific activities and drills, making sure to concentrate on spine stability</li> </ul>
Impact Loading Progression	<ul style="list-style-type: none"> <li>See Addendum A</li> </ul>
Cardiovascular	<ul style="list-style-type: none"> <li>Moderate-high intensity intervals with stationary biking</li> <li>Include Impact Loading on land (see Addendum A)</li> </ul>
Progression Criteria	<ul style="list-style-type: none"> <li>Successful completion of a comprehensive exercise program</li> <li>Be able to demonstrate sport-specific skills and practice drills without pain. This depends on the sport, and may include intervals of sprinting and pivoting/jumping and landing, back hyperextension and/or twisting.</li> </ul>

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### Spinal Orthotics

- Patients with unacceptable symptoms
- Positive findings on SPECT scan: healing potential
- Compliance is more important than type of brace
- No difference between bracing and no bracing at 1 year<sup>17</sup>**





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### Outcome of Non-operative Management

- >80% have resolution of symptoms
- 75%-100% of acute lesions heal
- All unilateral acute lesion heal
- 50% of bilateral lesions heal
- No chronic defects heal

• 90% return to previous levels of activity<sup>8</sup>

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### Surgical options

A Buck's repair B Scott's wiring C Morscher technique

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### Surgical options

- L5-S1 in-situ fusion with autogenous iliac crest bone graft
- No bracing needed

Sacrospinous Multifidus Longissimus Iliocostalis Psoas major Psoas minor

Bone grafts are taken from the pelvis and placed on the area to be fused

Posterolateral gutter fusion

Bone graft

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### Surgical options (Low grade spondylolisthesis)

- L5-S1 fusion with instrumentation with or without interbody

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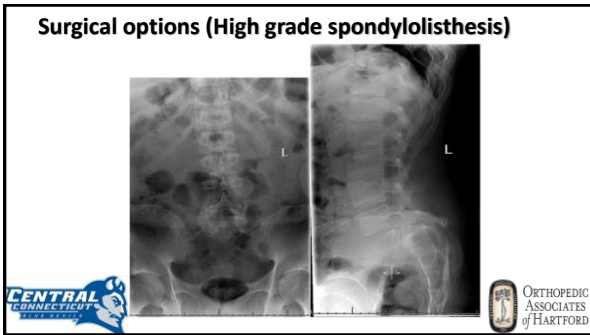
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### Return to Play after Surgery

- Radcliff et al.<sup>18</sup>:
  - Core strengthening and non- impact activity 2 weeks postoperatively
  - First 3 months, all exercises are done with a neutral spine
  - After 3 months, higher impact training may start
  - At 4-6 months sport specific training begins
  - Athletes may return to play when they demonstrate normal strength, normal range of motion and no pain with sport specific activity; 6-12 months after surgery
- Wide variability:
  - Ranging from 62-66% allowing RTP for noncontact sports at 6 months → one year

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### Return to Play

	No. of Athletes With Pars Defects	Conservative Therapy	Surgical Therapy	Returned to Previous Level of Play	Retired
Donaldson et al <sup>15</sup>	11	11	0	10	1
Hardcastle et al <sup>12</sup>	12	9	3	Not reported	5
Engstrom et al <sup>13</sup>	18	18	0	18	0
McCarroll et al <sup>14</sup>	22	21	1 <sup>a</sup>	22	0
Jackson et al <sup>16</sup>	11	11	0	11	0
<b>Total</b>	<b>74</b>	<b>70</b>	<b>4</b>	<b>61</b>	<b>6</b>

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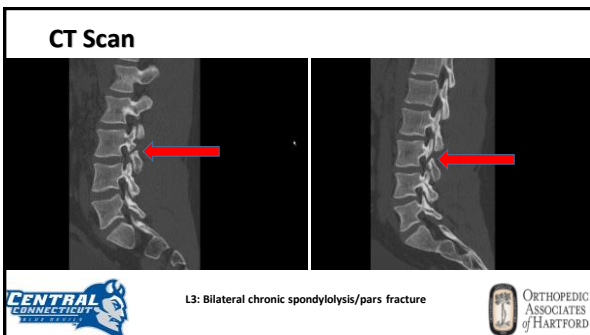
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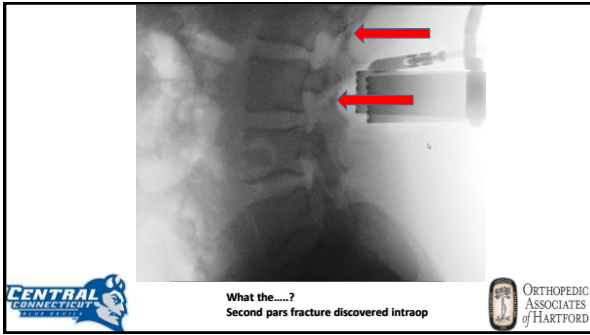
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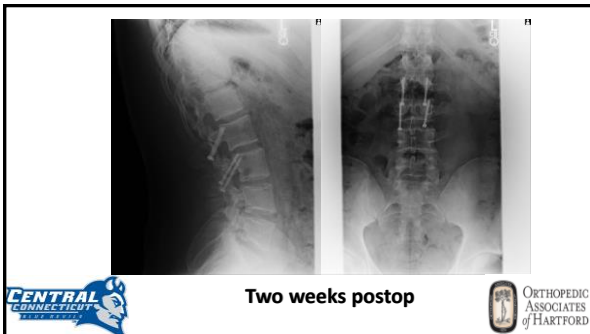
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**Spondylolysis/Spondylolisthesis:  
Management and Return to Activity Guidelines**

1. Case-by-case basis
2. Resolution of symptoms
3. Full pre-injury range of motion and strength
4. Completion of structured rehabilitation program

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