



## MIS Treatment-based Classification of intervertebral disc pathology

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# BACKGROUND

- Lack of comprehensive treatment-based classification
- Emergence of sophisticated diagnostic imaging - MRI
- Emergence of multiple treatment modalities
- Deficiencies in comparative outcome studies
- Need of standardized approach to prioritize treatment

# PURPOSE

To develop a comprehensive treatment-based classification of spinal lumbar disc disease

# MATERIALS & METHODS

- Review of literature
- Grading of the pathology of intervertebral disc pathology based on morphologic and topographic criteria
- Development of a matrix using pathoanatomic grading & clinical features
- Computation of all possible combinations of disc gradings & clinical features
- Retrospective study of the prevalence of the combinations in clinical situation.

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# METHODS

- Grading of the pathoanatomy of lumbar intervertebral disc, symptoms and signs:

Type of disc ruptures	Location of disc rupture	Radicular pain/sensation/motor/reflex	Back pain
<b>T1 = Acute Intra-annular</b> <b>T2 = Acute Extra-annular</b> <b>T3 = Degenerate globally bulging</b> <b>T4 = Degenerate Intra-annular</b> <b>T5 = Degenerate, Extra-annular/free frag</b>	<b>L1 = Central herniation</b> <b>L2 = Paracentral - PC-Pre-dural</b> <b>L3 = Paracentral - PC-Axillary</b> <b>L4 = Paracentral - PC-Pre-Radicular</b> <b>L5 = Intra- extra foraminal</b>	<b>R0 = None</b> <b>R1 = Mild 1-2, dysasthesia, no motor or reflex deficit</b> <b>R2 = Moderate 3-6, dysasthesia, 4/5 power, ↓ reflex</b> <b>R3 = Severe, 7-10, dysasthesia/numb, 3/5 power, ↓ reflex</b> <b>R4 = Numb/weak 0-2/5 or cauda equina syndrome, No reflex</b>	<b>B0 = None</b> <b>B1 = Minimal - 0-2/10</b> <b>B2 = Moderate – 3-6/10</b> <b>B3 = Severe – 7-9/10</b> <b>B4 = Intractable with spasm - 10</b>

# METHODS

## Matrix of disc pathology and clinical features

	Acute Intra-annular- (T <sub>1</sub> )	Acute-Extra-annular - (T <sub>2</sub> )	Global bulge (T <sub>3</sub> )	Deg Intra-annular (T <sub>4</sub> )	Deg-Extra-annular (T <sub>5</sub> )	
Central herniation (L <sub>1</sub> )	L <sub>1</sub> T <sub>1</sub> B <sub>0</sub> R <sub>0</sub>	L <sub>1</sub> T <sub>2</sub> B <sub>0</sub> R <sub>1</sub>	L <sub>1</sub> T <sub>3</sub> B <sub>0</sub> R <sub>2</sub>	L <sub>1</sub> T <sub>4</sub> B <sub>0</sub> R <sub>3</sub>	L <sub>1</sub> T <sub>5</sub> B <sub>0</sub> R <sub>4</sub>	Back pain – (B <sub>0</sub> )
PC-Pre-dural (L <sub>2</sub> )	L <sub>2</sub> T <sub>1</sub> B <sub>1</sub> R <sub>0</sub>	L <sub>2</sub> T <sub>2</sub> B <sub>1</sub> R <sub>1</sub>	L <sub>2</sub> T <sub>3</sub> B <sub>2</sub> R <sub>2</sub>	L <sub>2</sub> T <sub>4</sub> B <sub>1</sub> R <sub>3</sub>	L <sub>2</sub> T <sub>5</sub> B <sub>1</sub> R <sub>4</sub>	Back pain – (B <sub>1</sub> )
PC-Axillary (L <sub>3</sub> )	L <sub>3</sub> T <sub>1</sub> B <sub>2</sub> R <sub>0</sub>	L <sub>3</sub> T <sub>2</sub> B <sub>2</sub> R <sub>1</sub>	L <sub>3</sub> T <sub>3</sub> B <sub>2</sub> R <sub>2</sub>	L <sub>3</sub> T <sub>4</sub> B <sub>2</sub> R <sub>3</sub>	L <sub>3</sub> T <sub>5</sub> B <sub>2</sub> R <sub>4</sub>	Back pain – (B <sub>2</sub> )
PC-Pre-Radicular –(L <sub>4</sub> )	L <sub>4</sub> T <sub>1</sub> B <sub>3</sub> R <sub>0</sub>	L <sub>4</sub> T <sub>2</sub> B <sub>3</sub> R <sub>1</sub>	L <sub>4</sub> T <sub>3</sub> B <sub>3</sub> R <sub>2</sub>	L <sub>4</sub> T <sub>4</sub> B <sub>3</sub> R <sub>3</sub>	L <sub>4</sub> T <sub>5</sub> B <sub>3</sub> R <sub>4</sub>	Back pain – (B <sub>3</sub> )
Intra- extra foraminal (L <sub>5</sub> )	L <sub>5</sub> T <sub>1</sub> B <sub>4</sub> R <sub>0</sub>	L <sub>5</sub> T <sub>2</sub> B <sub>4</sub> R <sub>1</sub>	L <sub>5</sub> T <sub>3</sub> B <sub>4</sub> R <sub>2</sub>	L <sub>5</sub> T <sub>4</sub> B <sub>4</sub> R <sub>3</sub>	L <sub>5</sub> T <sub>5</sub> B <sub>4</sub> R <sub>4</sub>	Back pain – (B <sub>4</sub> )
	Radicular – (R <sub>0</sub> )	Radicular – (R <sub>1</sub> )	Radicular- (R <sub>2</sub> )	Radicular – (R <sub>3</sub> )	Radicular – CES (R <sub>4</sub> )	

# RESULTS

## 494 Possible Combinations

BASIC DISC CODE	STANDARDIZED DISC CODE	BASIC ALIGNMENT CODE	STANDARDIZING ALIGN CODE	BASIC LIG CODE	STANDARD LIG CODE	BASIC FACET CODE	STANDARD FACET CODE
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D0A000001	0001	D0A000001	0001	D0A0001	L002	D0A0000	L002
D0A000002	0002	D0A000002	0002	D0A0002	L003	D0A0000	L003
D0A000003	0003	D0A000003	0003	D0A0003	L004	D0A0000	L004
D0A000004	0004	D0A000004	0004	D0A0004	L005	D0A0000	L005
D0A000005	0005	D0A000005	0005	D0A0005	L006	D0A0000	L006
D0A000006	0006	D0A000006	0006	D0A0006	L007	D0A0000	L007
D0A000007	0007	D0A000007	0007	D0A0007	L008	D0A0000	L008
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D0A000009	0009	D0A000009	0009	D0A0009	L010	D0A0000	L010
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D0A000011	0011	D0A000011	0011	D0A0011	L012	D0A0000	L012
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# RESULTS

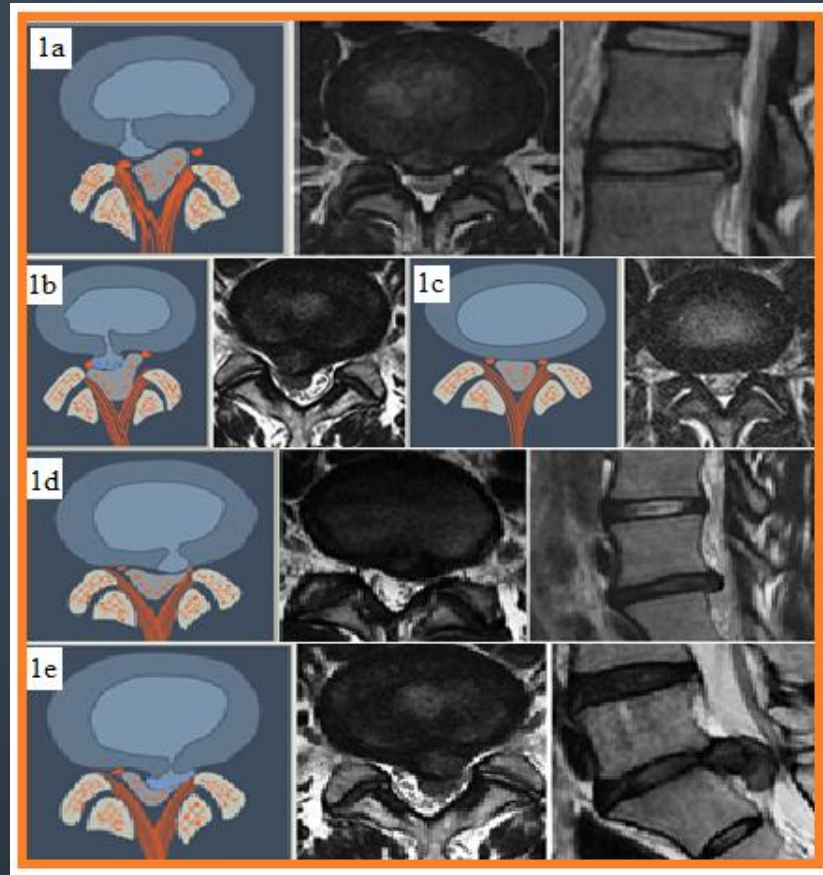


Figure: 1a – Acute intra-annular tear ( $T_1$ ); 1b – Acute extra-annular tear ( $T_2$ ); 1c – Global disc bulge ( $T_3$ ); 1d – Intra-annular herniation, degenerate disc ( $T_4$ ); 1e – Extra-annular herniation, degenerated disc ( $T_5$ )

# RESULTS



Figure 2: (a) - Central herniation (L1); (b) - paracentral-Predural (L2); (c) - paracentral-Axillary (L3); (d) - paracentral-Pre-Radicular (L4); (e) - Intra- extra foraminal (L5).

# RESULTS

## Retrospective Review of MRI Films

- MRI images of 93 patients were studied:
  - Male = 50
  - Female = 43
- Age range 28-79 years.
- Most commonly affected motion-segment L5-S1 = 38 (43.18%)
- Most common morphologic/topographic combination = T3L1 (Degenerate a global bulge) = 37 (42.05%)
- T4L1 represents 20.4%

# RESULTS

Level	Sex				Total	
	M		F			
	#	%	#	%	#	%
L5-S1	17	19.3	21	23.9	38	43.2
L4-5	16	18.2	16	18.2	32	36.4
L3-4	6	6.8	4	4.5	10	11.4
L2-3	4	4.5	1	1.1	5	5.7
L1-2	1	1.1	2	2.3	3	3.4
Total	44	50	44	50	88	100

- L4-5 and L5-S1 disc pathologies represent 79.6% of the total diseased levels.

# RESULTS

Level	Sex				Total	
	M		F			
	#	%	#	%	#	%
T3L1	18	19.4	17	18.3	35	37.6
T4L1	10	10.8	9	9.7	19	20.4
T4L4	7	7.5	5	5.4	12	12.9
T5L4	5	5.4	3	3.2	8	8.6
T4L5	3	3.2	3	3.2	6	6.5
T4L2	4	4.3	1	1.1	5	5.4
T5L2	0	0.0	4	4.3	4	4.3
T5L3	1	1.1	1	1.1	2	2.2
T5L1	1	1.1	0	0.0	1	1.1
T3L4	1	1.1	0	0.0	1	1.1
Total	50	53.8	43	46.2	93	100

**T3L1 and T4-L1 represented 58% of all morphologic/topographic combinations**

# RESULTS

Path/Clin Comb	Sex				Total	
	M		F		#	%
	#	%	#	%		
T3L1B4R2	7	7.5	4	4.3	11	11.8
T3L1B3R2	5	5.4	2	2.2	7	7.5
T4L1B3R2	2	2.2	5	5.4	7	7.5
T4L4B3R2	3	3.2	4	4.3	7	7.5
T5L4B2R3	3	3.2	2	2.2	5	5.4
T4L1B4R2	2	2.2	2	2.2	4	4.3
T3L1B4R3	2	2.2	1	1.1	3	3.2
T4L5B2R2	1	1.1	2	2.2	3	3.2
T3L1B2R1	0	0.0	2	2.2	2	2.2
T3L1B2R3	1	1.1	1	1.1	2	2.2

**Top 10 combinations represent 54.8% of all combinations. Degeneration, back and radicular pain were the hallmark of each combination, as was back pain.**

# RESULTS

## Intra-annular disc pathology

Morphology	Topography	Surgical strategy
<u>Intra-annular herniation:</u>	1. Central: T1, T4	Strategy is to remove the protruding nucleus and preserve the remaining disc with as little additional damage as possible, preferably utilizing an endoscopic approach.
1.	L1	<ol style="list-style-type: none"> <li>Endoscopic transforaminal approach, far posterolateral portal in the disc equator, shallow insertion angle (approaching coronal plane). Disc instrumentation at medial interpedicular line. Intra-discal approach for contained herniation. Trans-epidural approach if preferred. May need foraminoplasty, to facilitate a more central instrumentation.</li> <li>Endoscopic vs. other MIS interlaminar approach</li> <li>Endoscopic trans-iliac approach for some L4-5 and L5-S1 segments.</li> <li>Open posterior approach</li> </ol>
	2. Paracentral	
2.	L2. Predural	<ol style="list-style-type: none"> <li>Endoscopic transforaminal: Far/Medium posterolateral, in the disc equator, instrument disc at mid-interpedicular line. Disc instrumentation at medial interpedicular line. Intra-discal approach for contained herniation. Trans-epidural approach if preferred. May need foraminoplasty, to facilitate central instrumentation.</li> <li>Endoscopic vs other MIS interlaminar approach</li> <li>Endoscopic trans-iliac approach for some L4-5 and L5-S1 segments.</li> <li>Open posterior approach</li> </ol>
3.	L3 Axillary	<ol style="list-style-type: none"> <li>Endoscopic transforaminal: Medium posterolateral. Mid-interpedicular disc instrumentation. Intradiscal/trans-epidural approach. Foraminoplasty may be needed.</li> <li>Endoscopic vs. other MIS interlaminar approach</li> <li>Endoscopic trans-iliac approach for some L4-5 and L5-S1 segments.</li> <li>Open posterior approach.</li> </ol>
4.	L4 Pre-radicular	<ol style="list-style-type: none"> <li>Endoscopic transforaminal: Medium postero-lateral portal. Mid-interpedicular disc instrumentation. intra-discal approach. Identify and protect the traversing nerve.</li> <li>Endoscopic vs. other MIS interlaminar approach</li> <li>Endoscopic trans-iliac approach for some L4-5 and L5-S1 segments.</li> <li>Open posterior approach.</li> </ol>
	3. Intra- /Extraforaminal	<ol style="list-style-type: none"> <li></li> </ol>
5.	L5	<ol style="list-style-type: none"> <li>Endoscopic transforaminal approach. Medium to near postero-lateral portal. Mid-interpedicular discoscopy through hernial summit. . Watch out for the exiting nerve for extraforaminal. Best handled with double portal, unilateral approach.</li> <li>Other MIS transforaminal approach</li> <li>Endoscopic trans-iliac: At L5-S1 level with tall iliac wing</li> <li>Open transforaminal approach (facetectomy)</li> </ol>

# RESULTS

## Extra-annular disc pathology

<u>Extra-annular herniation:</u>	T2, T5 (Apply L1-5 strategy)	The strategy is to remove the free fragment through endoscopic tranforaminal epiduroscopy or endoscopic interlaminar to and to avoid additional trauma to the disc.
1	.Retro annular Displacement (RAD)	<ol style="list-style-type: none"> <li>1. Endoscopic tranforaminal: Far postero-lateral portal in disc equator. Medial interpedicular disc instrumentation if needed. Trans-epidural approach preferred. Will need foraminoplasty with superior articular process shaving.</li> <li>2. Endoscopic vs. other MIS interlaminar approach</li> <li>3. Endoscopic trans-iliac approach for some L4-5 and L5-S1 segments.</li> <li>4. Open posterior approach</li> </ol>
2.	Caudal displacement (CD)	<ol style="list-style-type: none"> <li>1. Endoscopic interlaminar.</li> <li>2. Endoscopic tranforaminal: Far-, medium-posterolateral portal. Caudad trajectory; may need to shave off the SAP and the upper edge of the caudal pedicle as well as the superior end-plate of the caudal vertebra. Trans-epidural/trans-discal approach. Flexible endoscope for tranforaminal approach may avoid some bone excision.</li> <li>3. Endoscopic vs. other MIS interlaminar approach</li> <li>4. Endoscopic trans-iliac approach for some L4-5 and L5-S1 segments.</li> <li>5. Open posterior approach</li> </ol>
3	Rostral displacement (RD)	<ol style="list-style-type: none"> <li>1. Endoscopic interlaminar approach –ipsilateral bi-portal.</li> <li>2. Endoscopic tranforaminal (rigid endoscope): Far lateral portal, cephalad trajectory, trans-epidural/trans-discal, retract nerve root.</li> <li>3. Endoscopic tranforaminal approach (flexible endoscope): Medium posterolateral portal; trans-epidural technique. Will need foraminoplasty (lateral partial facetectomy).</li> <li>4. Endoscopic vs. other MIS interlaminar approach</li> <li>5. Endoscopic trans-iliac approach for some L4-5 and L5-S1 segments.</li> <li>6. Open posterior approach</li> </ol>
4	. Dorsal (retro-dural) displacement (DRD)	<ol style="list-style-type: none"> <li>1. Endoscopic interlaminar approach –ipsilateral bi-portal or other MIS interlaminar approach.</li> <li>2. Endoscopic tranforaminal: Far postero-lateral portal in disc equator, most likely will need foraminoplasty with superior articular process shaving, trans-epidural approach.</li> <li>3. Open posterior approach</li> <li>4. Endoscopic trans-iliac approach at L5-S1 may be necessary.</li> </ol>



# CONCLUSION

- 1. Anatomic treatment-based, universal, disc classification is possible.**
- 2. Anatomic treatment-based classification, will allow standardization of surgical approaches to lumbar disc lesion**
- 3. Anatomic treatment-based classification will simply description of disc pathology, and improve communications between providers**
- 4. Anatomic treatment-based classification will allow accurate comparison of outcome data of different approaches**