MRI Analysis of the Combined AOSpine North America and International Studies, Part I: The Prevalence and Spectrum of Pathologies in a Global Cohort of Patients With Degenerative Cervical Myelopathy

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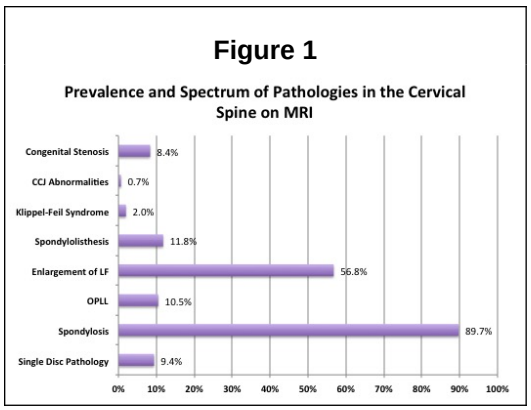
Introduction

Degenerative Cervical Myelopathy (DCM) encompasses a spectrum of age-related conditions which result in progressive spinal cord injury through static and dynamic injury mechanisms. Through detailed review of MRIs from prospective AOSpine multicenter studies, the global prevalence of degenerative cervical pathologies of surgically treated DCM patients is reported.

Figure 1



Methods

MRIs of 458 patients were obtained from North America (n=200), Europe (n=93), Latin America (n=58) and Asia-Pacific (n=107) and assessed for the type of pathology, source of stenosis, level of maximum cord compression, levels of spinal cord compression (SCC), presence of signal changes on T2-weighted images (T2WI) and T1-weighted images, and the levels of T2WI signal change. The proportion of degenerative changes present alongside other diagnoses was computed as well as the prevalence of pathologies per geographical region. The prevalence of degenerative changes was separated by gender and assessed using Chi-square analysis.

Table 1

Diagnosis	Criteria
Isolated Disc Pathology	Single level disc herniation/bulging disc, with no other disc pathology contributing to spinal cord compression at other levels.
Multi-level disc pathology with or without bone changes (Spondylosis)	Spinal cord compression at multiple levels due to multilevel cervical spine degeneration with two or more degenerated discs, with or without associated bony changes.
Ossification of the Posterior Longitudinal Ligament (OPLL)	OPLL appears hypointense on both T1WI and T2WI. Effacement of the CSF anterior to the cord on T2WI as well as spinal cord compression that is contiguous across multiple levels, or in the absence of spondylotic changes, is highly suggestive of ligament pathology.
Ligamentum Flavum buckling, hypertrophy, calcification or ossification	Any posterior enlargement of the ligamentum flavum contributing to stenosis of the cervical canal.
Spondylolisthesis or Subluxation	Anterior or posterior displacement of the vertebral body/bodies in relation to adjacent levels on sagittal imaging.
Klippel-Feil Syndrome	Vertebral levels without a complete disc and a wasp-waist sign. Absent discs due to degenerative autofusion were disregarded.
Craniocervical Junction Abnormalities	Abnormal structural pathologies resulting in spinal cord or brain stem compression.
Congenital Stenosis	Patients with a spinal cord occupation ratio (SCOR) of ≥70% in the spinal canal at non-pathological sites.

Results

Spondylosis was the most frequent cause of SCC (89.7%) and it was frequently accompanied by enlargement of the ligamentum flavum (59.85%). Ossification of the posterior longitudinal ligament (OPLL) was accompanied by spondylosis in 91.7%. Single level disc pathology, OPLL and spondylolisthesis had a prevalence of ~10%. Klippel-Feil Syndrome was observed in 2.0%. Single level pathology was less common in North America, and OPLL was more common and spondylolisthesis less common in Asia-Pacific. Females presented more commonly with single level disc pathology (p=0.013), and males with spondylosis (p=0.017) and enlargement of LF (p=0.012). Globally, C5-6 was the most frequent maximum compressed site (39.7%) and region for T2WI hyperintensity (38.9%). T2WI hyperintensity more commonly presented in males (p<0.001).

Table 1

Patient Characteristics	Male (n=285)	Female (n=173)	Total (n=458)	P-value
Diagnosis				
Single Disc Level	6.7% (n=19)	13.9% (n=24)	9.4% (n=43)	**0.013**
Spondylosis (Multilevel Disc/Bone Pathology)	92.3% (n=263)	85.6% (n=148)	89.7% (n=411)	**0.017**
OPLL	11.9% (n=34)	8.1% (n=14)	10.5% (n=48)	0.212
Enlargement of LF	61.4% (n=175)	49.1% (n=85)	56.8% (n=260)	**0.012**
Spondylolisthesis/Subluxation	10.9% (n=31)	13.3% (n=23)	11.8% (n=54)	0.457
Klippel-Feil Syndrome	2.5% (n=7)	1.2% (n=2)	2.0% (n=9)	N/A
CCJ abnormalities	1.0% (n=3)	0.0% (n=0)	0.7% (n=3)	N/A
Congenital Stenosis (n=310)	9.5% (n=18)	6.6% (n=8)	8.4% (n=26)	0.37
Origin of Stenosis				
Anterior	36.8% (n=105)	46.8% (n=81)	40.6% (n=186)	**0.035**
Anterior and Posterior	62.5% (n=178)	53.2% (n=92)	59.0% (n=270)	**0.054**
Posterior	0.7% (n=2)	0.0% (n=0)	0.4% (n=2)	N/A
Level of Maximum Cord Compression				
CCJ	1.0% (n=3)	0.0%	0.7% (n=3)	N/A
C2-3	0.7% (n=2)	0.6% (n=1)	0.7% (n=3)	N/A
C3-4	25.3% (n=72)	14.4% (n=25)	21.2% (n=97)	**0.007**
C4-5	27.7% (n=79)	26.6% (n=46)	27.3% (n=125)	0.829
C5-6	36.1% (n=103)	45.1% (n=78)	39.5% (n=181)	0.058
C6-7	8.8% (n=25)	13.3% (n=23)	10.5% (n=48)	0.156
C7-T1	0.4% (n=1)	0.0% (n=0)	0.2% (n=1)	N/A
Cervical Levels of Spinal Cord Compression				
CCJ	3.5% (n=10)	2.3% (n=4)	3.1% (n=14)	N/A
C2-3	16.8% (n=48)	10.4% (n=18)	14.4% (n=66)	0.057
C3-4	68.8% (n=196)	53.8% (n=93)	63.1% (n=289)	**0.001**
C4-5	80.0% (n=228)	70.5% (n=122)	76.4% (n=350)	**0.021**
C5-6	87.0% (n=248)	91.9% (n=159)	88.9% (n=407)	0.107
C6-7	60.7% (n=173)	61.8% (n=107)	61.1% (n=280)	0.807
C7-T1	5.3% (n=15)	6.4% (n=11)	5.7% (n=26)	0.623
Number of Compressed Levels				
1	6.7% (n=19)	14.4% (n=25)	9.6% (n=44)	
2	21.0% (n=60)	24.3% (n=42)	22.3% (n=102)	Single vs. Multilevel
3	33.0% (n=94)	26.6% (n=46)	30.6% (n=140)	
4	26.7% (n=76)	23.1% (n=40)	25.3% (n=116)	p=0.008
5	8.8% (n=25)	7.5% (n=13)	8.3% (n=38)	
6	3.5% (n=10)	4.1% (n=7)	3.7% (n=17)	
7	0.4% (n=1)	0.0% (n=0)	0.2% (n=1)	
Signal Intensity of the Spinal Cord				
T2WI Hyperintensity (+) (n=446)	82.4% (n=229)	66.7% (n=112)	76.5% (n=341)	**<0.001**
T1WI Hypointensity (+) (n=423)	19.7% (n=52)	25.2% (n=40)	21.7% (n=92)	0.189
T1WI Hyperintensity (+) (n=423)	0.7% (n=2)	2.55% (n=4)	1.4% (n=6)	N/A
Segments with T2WI Hyperintensity				
CCJ	1.8% (n=5)	1.2% (n=2)	1.5% (n=7)	N/A
C2-3	4.9% (n=14)	3.5% (n=6)	4.4% (n=20)	0.463
C3-4	33.0% (n=94)	19.1% (n=33)	27.7% (n=127)	**0.001**
C4-5	34.7% (n=99)	34.1% (n=59)	34.5% (n=158)	0.890
C5-6	41.8% (n=119)	34.1% (n=59)	38.9% (n=178)	0.103
C6-7	12.3% (n=35)	11.6% (n=20)	12.0% (n=55)	0.818
C7-T1	1.0% (n=3)	1.2% (n=2)	1.1% (n=5)	N/A
Number of Segments with T2WI (+)				
1	52.9% (n=147)	41.1% (n=69)	48.4% (n=216)	
2	16.9% (n=47)	14.9% (n=25)	16.1% (n=72)	Single vs. Multilevel
3	6.5% (n=8)	8.3% (n=14)	7.2% (n=32)	
4	4.3% (n=12)	1.2% (n=2)	3.1% (n=14)	p=0.720
5	1.4% (n=4)	0.0% (n=0)	0.9% (n=4)	
6	0.4% (n=1)	1.2% (n=2)	0.7% (n=3)	

Figure 2

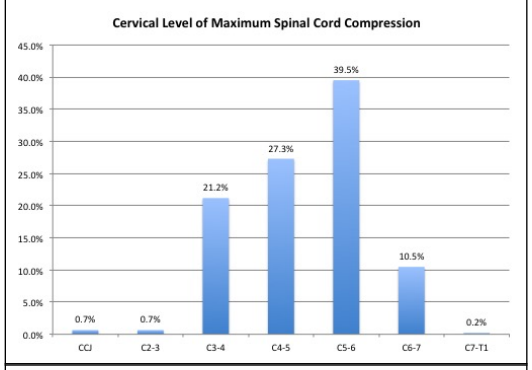


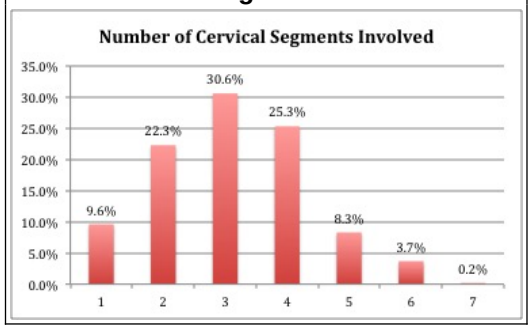
Table 2

Diagnosis	Latin America (n=58)	Europe (n=93)	Asia-Pacific (n=107)	North America (n=200)
Single Disc Level	13.8% (N=8)	11.8% (N=11)	10.3% (N=11)	6.5% (N=13)
Spondylosis	86.2% (N=50)	87.1% (N=81)	86.9% (N=93)	93.5% (N=187)
OPLL	3.5% (N=2)	7.5% (N=7)	29.0% (N=31)	4.0% (N=8)
Enlargement of LF	65.5% (N=38)	48.4% (N=45)	58.9% (N=63)	57.0% (N=114)
Spondylolisthesis/Subluxation	13.8% (N=8)	18.3% (N=17)	1.9% (N=2)	13.5% (N=27)
Klippel-Feil Syndrome	0% (N=0)	1.1% (N=1)	2.8% (N=3)	2.5% (N=5)
CCJ abnormalities	0% (N=0)	1.1% (N=1)	0% (N=0)	1.0% (N=2)
Congenital Stenosis	9.8% (n=4/41)	2.3% (n=1/43)	11.6% (n=8/69)	8.3% (n=13/157)

Table 4

Prevalence of Concomitant Pathology	Presence of Pathology							
	Single Disc Level	Spondylosis	OPLL	Enlargement of LF	Spondylolisthesis	Klippel-Feil Syndrome	CCJ abnormalities	Congenital Stenosis
Single Disc Level	X	0% (n=0)	2.1% (n=1)	5.0% (n=13)	11.1% (n=6)	0% (n=0)	0% (n=0)	0 (n=0)
Spondylosis	0% (n=0)	X	91.67% (n=44)	94.6% (n=246)	87.0% (n=47)	100% (n=9)	66.7% (n=2)	100% (n=26)
OPLL	2.3% (n=1)	10.7% (n=44)	X	9.2% (n=24)	3.7% (n=2)	22.2% (n=2)	0% (n=0)	23.1% (n=6)
Enlargement of LF	30.2% (n=13)	59.9% (n=246)	50.00% (n=24)	X	81.5% (n=44)	66.7% (n=6)	100% (n=3)	61.5% N=16
Spondylolisthesis	14.0% (n=6)	11.4% (n=47)	4.2% (n=2)	16.9% (n=44)	X	11.1% (n=1)	33.3% (n=1)	3.9% (n=1)
Klippel-Feil Syndrome	0% (n=0)	2.2% (n=9)	4.2% (n=2)	2.3% (n=9)	1.9% (n=1)	X	0% (n=0)	0% (n=0)
CCJ abnormalities	0% (n=0)	0.5% (n=2)	0% (n=0)	1.2% (n=3)	1.9% (n=1)	0% (n=0)	X	0% (n=0)
Congenital Stenosis (n=310)	0% (n=0)	9.29% (n=26/280)	28.6% (6/21)	8.7% (n=16/183)	2.6% (n=1/38)	0% (n=0)	0% (n=0)	X

Figure 3



Conclusions

DCM pathologies, including OPLL, are highly interrelated and rarely present in isolation. Females presented with milder evidence of DCM on MRI. There are also variances in the spectrum and prevalence of pathologies between geographical regions and these may be due to a multitude of causes.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the differences in the spectrum of DCM that present between genders and geographic regions 2) Discuss how differences in the prevalence between genders may influence surgical decision-making

References

(1) Nouri A et al. Degenerative Cervical Myelopathy: Epidemiology, Genetics and Pathogenesis. Spine (Phila Pa 1976). 2015 Jun 15;40(12):E675-93

(2) Nouri A et al. Magnetic resonance imaging assessment of degenerative cervical myelopathy: a review of structural changes and measurement techniques. Neurosurg Focus 2016;40:E5.