

# CLINICAL IMAGING

## Spinal Imaging: Update for the Treating Physical Therapist

Independent Study Course 27.3.3

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CONTINUING PHYSICAL THERAPY EDUCATION

ORTHOPAEDIC  
SECTION

 **APTA**  
American Physical Therapy Association

## REFERENCES

1. American Physical Therapy Association. Vision statement for the physical therapy profession and guiding principles to achieve the vision. [www.apta.org/Vision/](http://www.apta.org/Vision/). Accessed April 24, 2016.
2. Alshami AM. Prevalence of spinal disorders and their relationships with age and gender. *Saudi Med J*. 2015;36(6):725-730. doi: 10.15537/smj.2015.6.11095.
3. Hoy DG, Protani M, De R, Buchbinder R. The epidemiology of neck pain. *Best Pract Res Clin Rheumatol*. 2010;24(6):783-792. doi: 10.1016/j.bepr.2011.01.019.
4. Cassidy JD, Côté P, Carroll LJ, Kristman V. Incidence and course of low back pain episodes in the general population. *Spine (Phila Pa 1976)*. 2005;30(24):2817-2823.
5. Hagen K, Einarsen C, Zwart JA, Svebak S, Bovim G. The co-occurrence of headache and musculoskeletal symptoms amongst 51,050 adults in Norway. *Eur J Neurol*. 2002;9(5):527-533.
6. Rajala U, Keinänen-Kiukaanniemi S, Uusimäki A, Kivelä SL. Musculoskeletal pains and depression in a middle-aged Finnish population. *Pain*. 1995;61(3):451-457.
7. Hoy D, Brooks P, Blyth F, Buchbinder R. The Epidemiology of low back pain. *Best Pract Res Clin Rheumatol*. 2010;24(6):769-781. doi: 10.1016/j.bepr.2010.10.002.
8. Hoy D, March L, Brooks P, et al. Measuring the global burden of low back pain. *Best Pract Res Clin Rheumatol*. 2010;24(2):155-165. doi: 10.1016/j.bepr.2009.11.002.
9. Briggs AM, Bragge P, Smith AJ, Govil D, Straker LM. Prevalence and associated factors for thoracic spine pain in the adult working population: a literature review. *J Occup Health*. 2009;51(3):177-192. Epub 2009 Apr 1.
10. Martin BI, Deyo RA, Mirza SK, et al. Expenditures and health status among adults with back and neck problems. *JAMA*. 2008;299(6):656-664. doi: 10.1001/jama.299.6.656.
11. Henschke N, Maher CG, Refshauge KM, et al. Prognosis in patients with recent onset low back pain in Australian primary care: inception cohort study. *BMJ*. 2008;337:a171. doi: 10.1136/bmj.a171.
12. Hestbaek L, Leboeuf-Yde C, Manniche C. Low back pain: what is the long-term course? A review of studies of general patient populations. *Eur Spine J*. 2003;12(2):149-165. Epub 2003 Jan 28.
13. Freburger JK, Holmes GM, Agans RP, et al. The rising prevalence of chronic low back pain. *Arch Intern Med*. 2009;169(3):251-258. doi: 10.1001/archinternmed.2008.543.
14. Wasiak R, Kim J, Pransky G. Work disability and costs caused by recurrence of low back pain: longer and more costly than in first episodes. *Spine (Phila Pa 1976)*. 2006;31(2):219-225.
15. Ivanova JI, Birnbaum HG, Schiller M, Kantor E, Johnstone BM, Swindle RW. Real-world practice patterns, health-care utilization, and costs in patients with low back pain: the long road to guideline-concordant care. *Spine J*. 2011;11(7):622-632. doi: 10.1016/j.spinee.2011.03.017. Epub 2011 May 20.
16. Bussières AE, Peterson C, Taylor JA. Diagnostic imaging practice guidelines for musculoskeletal complaints in adults—an evidence-based approach: introduction. *J Manipulative Physiol Ther*. 2007;30(9):617-683.
17. Gidwani R, Sinnott P, Avoundjian T, Lo J, Asch SM, Barnett PG. Inappropriate ordering of lumbar spine magnetic resonance imaging: are providers choosing wisely? *Am J Manag Care*. 2016;22(2):e68-76.
18. Franz EW, Bentley JN, Yee PP, et al. Patient misconceptions concerning lumbar spondylosis diagnosis and treatment. *J Neurosurg Spine*. 2015;22(5):496-502. doi: 10.3171/2014.10.SPINE14537. Epub 2015 Feb 27.
19. Ramadorai UE, Hire JM, DeVine JG. Magnetic resonance imaging of the cervical, thoracic, and lumbar spine in children: spinal incidental findings in pediatric patients. *Global Spine J*. 2014;4(4):223-228. doi: 10.1055/s-0034-1387179. Epub 2014 Aug 5.
20. Nakashima H, Yukawa Y, Suda K, Yamagata M, Ueta T, Kato F. Abnormal findings on magnetic resonance images of the cervical spines in 1211 asymptomatic subjects. *Spine (Phila Pa 1976)*. 2015;40(6):392-398. doi: 10.1097/BRS.0000000000000775.
21. Kim SJ, Lee TH, Lim SM. Prevalence of disc degeneration in asymptomatic korean subjects. Part 1: lumbar spine. *J Korean Neurosurg Soc*. 2013;53(1):31-38. doi: 10.3340/jkns.2013.53.1.31. Epub 2013 Jan 31.
22. Matsumoto M, Fujimura Y, Suzuki N, et al. MRI of cervical intervertebral discs in asymptomatic subjects. *J Bone Joint Surg Br*. 1998;80(1):19-24.
23. Cieszanowski A, Maj E, Kuliszewicz P, et al. Non-contrast-enhanced whole-body magnetic resonance imaging in the general population: the incidence of abnormal findings in patients 50 years old and younger compared to older subjects. *PLoS One*. 2014;9(9):e107840. doi: 10.1371/journal.pone.0107840. eCollection 2014.
24. Cohen SP. Epidemiology, diagnosis, and treatment of neck pain. *Mayo Clin Proc*. 2015;90(2):284-299. doi: 10.1016/j.mayocp.2014.09.008.
25. Matsumoto M, Okada E, Ichihara D, et al. Age-related changes of thoracic and cervical intervertebral discs in asymptomatic subjects. *Spine (Phila Pa 1976)*. 2010;35(14):1359-1364. doi: 10.1097/BRS.0b013e3181c17067.
26. Wood KB, Garvey TA, Gundry C, Heithoff KB. Magnetic resonance imaging of the thoracic spine. Evaluation of asymptomatic individuals. *J Bone Joint Surg Am*. 1995;77(11):1631-1638.
27. Wood KB, Blair JM, Apple DM, et al. The natural history of asymptomatic thoracic disc herniations. *Spine (Phila Pa 1976)*. 1997;22(5):525-529; discussion 529-530.
28. Matsumoto M, Okada E, Kaneko Y, et al. Wedging of vertebral bodies at the thoracolumbar junction in asymptomatic healthy subjects on magnetic resonance imaging. *Surg Radiol Anat*. 2011;33(3):223-228. doi: 10.1007/s00276-010-0746-x. Epub 2010 Nov 23.
29. Brinjikji W, Luetmer PH, Comstock B, et al. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. *AJR Am J Neuroradiol*. 2015;36(4):811-816. doi: 10.3174/ajnr.A4173. Epub 2014 Nov 27.
30. Tins BJ, Balain B. Incidence of numerical variants and transitional lumbosacral vertebrae on whole-spine MRI. *Insights Imaging*. 2016;7(2):199-203. doi: 10.1007/s13244-016-0468-7. Epub 2016 Feb 12.
31. Farshad-Amacker NA, Herzog RJ, Hughes AP, Aichmair A, Farshad M. Associations between lumbosacral transitional anatomy types and degeneration at the transitional and adjacent segments. *Spine J*. 2015;15(6):1210-1216. doi: 10.1016/j.spinee.2013.10.029. Epub 2013 Nov 8.
32. Paik NC, Lim CS, Jang HS. Numeric and morphological verification of lumbosacral segments in 8280 consecutive patients. *Spine (Phila Pa 1976)*. 2013;38(10):E573-578. doi: 10.1097/BRS.0b013e31828b7195.
33. Konin GP, Walz DM. Lumbosacral transitional vertebrae: classification, imaging findings, and clinical relevance. *AJR Am J Neuroradiol*. 2010;31(10):1778-1786. doi: 10.3174/ajnr.A2036. Epub 2010 Mar 4.
34. Rankine JJ, Fortune DG, Hutchinson CE, Hughes DG, Main CJ. Pain drawings in the assessment of nerve root compression: a comparative study with lumbar spine magnetic resonance imaging. *Spine (Phila Pa 1976)*. 1998;23(15):1668-1676.
35. Beattie PF, Meyers SP, Stratford P, Millard RW, Hollenberg GM. Associations between patient report of symptoms and anatomic impairment visible on lumbar magnetic resonance imaging. *Spine (Phila Pa 1976)*. 2000;25(7):819-828.
36. Chou R, Fu R, Carrino JA, Deyo RA. Imaging strategies for low-back pain: systematic review and meta-analysis. *Lancet*. 2009;373(9662):463-472. doi: 10.1016/S0140-6736(09)60172-0.
37. Chou R, Qaseem A, Owens DK, Shekelle P. Clinical Guidelines Committee of the American College of Physicians. Diagnostic imaging

- for low back pain: advice for high-value health care from the American College of Physicians. *Ann Intern Med.* 2011;154(3):181-189. doi: 10.7326/0003-4819-154-3-201102010-00008.
38. Chou R, Deyo RA, Jarvik JG. Appropriate use of lumbar imaging for evaluation of low back pain. *Radiol Clin North Am.* 2012;50:569-585. doi: 10.1016/j.rcl.2012.04.005.
39. Sheehan NJ. Magnetic resonance imaging for low back pain: indications and limitations. *Postgrad Med J.* 2010;86(1016):374-378. doi: 10.1136/ard.2009.110973.
40. Webster BS, Choi Y, Bauer AZ, Cifuentes M, Pransky G. The cascade of medical services and associated longitudinal costs due to nonadherent magnetic resonance imaging for low back pain. *Spine (Phila Pa 1976).* 2014;39(17):1433-1440. doi: 10.1097/BRS.0000000000000408.
41. Graves JM, Fulton-Kehoe D, Jarvik JG, Franklin GM. Health care utilization and costs associated with adherence to clinical practice guidelines for early magnetic resonance imaging among workers with acute occupational low back pain. *Health Serv Res.* 2014;49(2):645-665. doi: 10.1111/1475-6773.12098. Epub 2013 Aug 1.
42. Maus T. Imaging the back pain patient. *Phys Med Rehabil Clin N Am.* 2010;21(4):725-766. doi: 10.1016/j.pmr.2010.07.004.
43. Andersen JC. Is immediate imaging important in managing low back pain? *J Athl Train.* 2011;46(1):99-102. doi: 10.4085/1062-6050-46.1.99.
44. Brenner DJ, Hricak H. Radiation exposure from medical imaging: time to regulate? *JAMA.* 2010;304(2):208-209. doi: 10.1001/jama.2010.973.
45. Simpson AK, Whang PG, Jonisch A, Haims A, Grauer JN. The radiation exposure associated with cervical and lumbar spine radiographs. *J Spinal Disord Tech.* 2008;21(6):409-412. doi: 10.1097/BSD.0b013e3181568656.
46. Graves JM, Fulton-Kehoe D, Martin DP, Jarvik JG, Franklin GM. Factors associated with early magnetic resonance imaging utilization for acute occupational low back pain: a population-based study from Washington State workers' compensation. *Spine (Phila Pa 1976).* 2012;37(19):1708-1718.
47. Jarvik JG, Gold LS, Comstock BA, et al. Association of early imaging for back pain with clinical outcomes in older adults. *JAMA.* 2015;313(11):1143-1153. doi: 10.1001/jama.2015.1871.
48. Kleinstück F, Dvorak J, Mannion AF. Are "structural abnormalities" on magnetic resonance imaging a contraindication to the successful conservative treatment of chronic nonspecific low back pain? *Spine (Phila Pa 1976).* 2006;31(19):2250-2257.
49. Royer M, Thomas T, Cesini J, Legrand E. Stress fractures in 2011: practical approach. *Joint Bone Spine.* 2012;79 Suppl 2:S86-90. doi: 10.1016/S1297-319X(12)70013-1.
50. Laker SR, Concannon LG. Radiologic evaluation of the neck: a review of radiography, ultrasonography, computed tomography, magnetic resonance imaging, and other imaging modalities for neck pain. *Phys Med Rehabil Clin N Am.* 2011;22(3):411-428, vii-viii. doi: 10.1016/j.pmr.2011.03.010. Epub 2011 Jun 15.
51. Gruber MA, Kathol M. Cervical spine radiographs in the trauma patient. *Am Fam Physician.* 1999;59(2):331-342.
52. Klein JP. A practical approach to spine imaging. *Continuum (Minneapolis Minn).* 2015;21(1 Spinal Cord Disorders):36-51. doi: 10.1212/CON.0000461083.33500.ec.
53. Offerman SR, Holmes JF, Katzberg RX, Richards JR. Utility of supine oblique radiographs in detecting cervical spine injury. *J Emerg Med.* 2006;30(2):189-195.
54. Freemeyer B, Knopp R, Piche J, Wales L, Williams J. Comparison of five-view and three-view cervical spine series in the evaluation of patients with cervical trauma. *Ann Emerg Med.* 1989;18(8):818-821.
55. Sierink JC, van Lieshout WA, Beenen LF, Schep NW, Vandertop WP, Goslings JC. Systematic review of flexion/extension radiography of the cervical spine in trauma patients. *Eur J Radiol.* 2013;82(6):974-981. doi: 10.1016/j.ejrad.2013.02.009. Epub 2013 Mar 13.
56. Rhee JM, Chapman JR, Norvell DC, Smith J, Sherry NA, Riew KD. Radiological determination of postoperative cervical fusion: a systematic review. *Spine (Phila Pa 1976).* 2015;40(13):974-991. doi: 10.1097/BRS.00000000000000940.
57. Woodring JH, Lee C. Limitations of cervical radiography in the evaluation of acute cervical trauma. *J Trauma.* 1993;34(1):32-39.
58. Mace SE. Emergency evaluation of cervical spine injuries: CT versus plain radiographs. *Ann Emerg Med.* 1985;14(10):973-975.
59. Kirshenbaum KJ, Nadimpalli SR, Fantus R, Cavallino RP. Unsuspected upper cervical spine fractures associated with significant head trauma: role of CT. *J Emerg Med.* 1990;8(2):183-198.
60. Kaneriya PP, Schweitzer ME, Spettell C, Cohen MJ, Karasick D. The cost-effectiveness of oblique radiography in the exclusion of C7-T1 injury in trauma patients. *AJR Am J Roentgenol.* 1998;171(4):959-962.
61. Inaoka T, Ohashi K, El-Khoury GY, Singh H, Berbaum KS. Clinical role of radiography for thoracic spine fractures in daily practice in the MDCT era: a retrospective review of 255 trauma patients. *Jpn J Radiol.* 2012;30(8):617-623. doi: 10.1007/s11604-012-0097-0. Epub 2012 Jul 6.
62. American College of Radiology. ACR-ASSR-SPR-SSR practice parameter for the performance of spine radiography. [www.acr.org/-/media/03586F4164384C6C995E83CE68A5C835.pdf](http://www.acr.org/-/media/03586F4164384C6C995E83CE68A5C835.pdf). Accessed April 24, 2016.
63. Ghobrial GM, Jallo J. Thoracolumbar spine trauma: review of the evidence. *J Neurosurg Sci.* 2013;57(2):115-122.
64. Gamanagatti S, Rathinam D, Rangarajan K, Kumar A, Farooque K, Sharma V. Imaging evaluation of traumatic thoracolumbar spine injuries: Radiological review. *World J Radiol.* 2015;7(9):253-265. doi: 10.4329/wjr.v7.i9.253.
65. Berry GE, Adams S, Harris MB, et al. Are plain radiographs of the spine necessary during evaluation after blunt trauma? Accuracy of screening torso computed tomography in thoracic/lumbar spine fracture diagnosis. *J Trauma.* 2005;59(6):1410-1413; discussion 1413.
66. Karul M, Bannas P, Schoennagel BP, et al. Fractures of the thoracic spine in patients with minor trauma: comparison of diagnostic accuracy and dose of biplane radiography and MDCT. *Eur J Radiol.* 2013;82(8):1273-1277. doi: 10.1016/j.ejrad.2013.01.016. Epub 2013 Feb 17.
67. Crownover BK, Bepko JL. Appropriate and safe use of diagnostic imaging. *Am Fam Physician.* 2013;87(7):494-501.
68. Akbar JJ, Weiss KL, Saafir MA, Weiss JL. Rapid MRI detection of vertebral numeric variation. *AJR Am J Roentgenol.* 2010;195(2):465-466. doi: 10.2214/AJR.09.3997.
69. Scavone JG, Latshaw RF, Weidner WA. Anteroposterior and lateral radiographs: an adequate lumbar spine examination. *AJR Am J Roentgenol.* 1981;136(4):715-717.
70. Kaner T, Oktenoglu T, Sasani M, Ozer AF. L5 vertebrectomy for the surgical treatment of tumoral and traumatic lesions of L5 vertebra. *Orthop Rev (Pavia).* 2012;4(1):e10. doi: 10.4081/or.2012.e10. Epub 2012 Feb 28.
71. Beck NA, Miller R, Baldwin K, et al. Do oblique views add value in the diagnosis of spondylolysis in adolescents? *J Bone Joint Surg Am.* 2013;95(10):e65. doi: 10.2106/JBJS.L.00824.
72. Miller R, Beck NA, Sampson NR, Zhu X, Flynn JM, Drummond D. Imaging modalities for low back pain in children: a review of spondylolysis and undiagnosed mechanical back pain. *J Pediatr Orthop.* 2013;33(3):282-288. doi: 10.1097/BPO.0b013e318287fffb.
73. American College of Radiology. ACR Appropriateness Criteria: Low Back Pain. [www.acrsearch.acr.org/docs/69483/Narrative](http://www.acrsearch.acr.org/docs/69483/Narrative). Accessed April 24, 2016.
74. Leone A, Guglielmi G, Cassar-Pullincino VN, Bonomo L. Lumbar intervertebral instability: a review. *Radiology.* 2007;245(1):62-77.
75. Dvorák J, Panjabi MM, Chang DG, Theiler R, Grob D. Functional radiographic diagnosis of the lumbar spine. Flexion-extension and lateral bending. *Spine (Phila Pa 1976).* 1991;16(5):562-571.
76. White AA, Panjabi MM. *Clinical Biomechanics of the Spine.* 2nd ed. Philadelphia, PA: JB Lippincott; 1990.
77. White JH, Hague C, Nicolaou S, Gee R, Marchinkow LO, Munk PL. Imaging of sacral fractures. *Clin Radiol.* 2003;58(12):914-921.
78. Humphrey CA, Maceroli MA. Fragility fractures requiring special consideration: pelvic insufficiency fractures. *Clin Geriatr Med.*

- 2014;30(2):373-386. doi: 10.1016/j.cger.2014.01.012. Epub 2014 Mar 7.
79. Tsiridis E, Upadhyay N, Giannoudis PV. Sacral insufficiency fractures: current concepts of management. *Osteoporos Int.* 2006;17(12):1716-1725. Epub 2006 Jul 20.
80. Busscher I, Ploegmakers JJ, Verkerke GJ, Veldhuizen AG. Comparative anatomical dimensions of the complete human and porcine spine. *Eur Spine J.* 2010;19(7):1104-1114. doi: 10.1007/s00586-010-1326-9. Epub 2010 Feb 26.
81. Frobin W, Brinckmann P, Biggemann M, Tillotson M, Burton K. Precision measurement of disc height, vertebral height and sagittal plane displacement from lateral radiographic views of the lumbar spine. *Clin Biomech (Bristol, Avon).* 1997;12 Suppl 1:S1-S63.
82. Vijayarath A, Hawkins CM, Hughes DR, Mullins ME, Duszak R Jr. How much do common imaging studies cost? a nationwide survey of radiology trainees. *AJR Am J Roentgenol.* 2015;205(5):929-935. doi: 10.2214/AJR.14.14167.
83. Sasaki K, Hasegawa K, Shimoda H, Keiji I, Homma T. Can recumbent magnetic resonance imaging replace myelography or computed tomography myelography for detecting lumbar spinal stenosis? *Eur J Orthop Surg Traumatol.* 2013;23 Suppl 1:S77-83. doi: 10.1007/s00590-013-1209-y. Epub 2013 Mar 30.
84. Kasdan RB, Howard JL. Neuroimaging of spinal diseases: a pictorial review. *Semin Neurol.* 2008;28(4):570-589. doi: 10.1055/s-0028-1083693. Epub 2008 Oct 8.
85. Mazzie JP, Brooks MK, Gnerre J. Imaging and management of postoperative spine infection. *Neuroimaging Clin N Am.* 2014;24(2):365-374. doi: 10.1016/j.nic.2014.01.003.
86. Ha AS, Petscavage-Thomas JM. Imaging of current spinal hardware: lumbar spine. *AJR Am J Roentgenol.* 2014;203(3):573-581 doi: 10.2214/AJR.13.12217.
87. Petscavage-Thomas JM, Ha AS. Imaging current spine hardware: part 1, cervical spine and fracture fixation. *AJR Am J Roentgenol.* 2014;203(3):394-405. doi: 10.2214/AJR.13.12216.
88. Gruskay JA, Webb ML, Grauer JN. Methods of evaluating lumbar and cervical fusion. *Spine J.* 2014;14(3):531-539. doi: 10.1016/j.spinee.2013.07.459. Epub 2013 Oct 31.
89. D'Hondt A, Cornil A, Bohy P, De Maertelaer V, Gevenois PA, Tack D. Tuning of automatic exposure control strength in lumbar spine CT. *Br J Radiol.* 2014;87(1037):20130707. doi: 10.1259/bjr.20130707. Epub 2014 Mar 10.
90. Tan W, Zhan S, Yang S, Zhuang Y, Cheng R, Zhan H. Reduction of radiation dose in the spiral CT scan of the lumbar spine by the combined use of body mass index (BMI) and automatic exposure control (AEC). *J Xray Sci Technol.* 2014;22(6):697-706. doi: 10.3233/XST-140455.
91. Frush DP. Deciding why and when to use CT in children: a radiologist's perspective. *Pediatr Radiol.* 2014;44 Suppl 3:404-408. doi: 10.1007/s00247-014-3016-y. Epub 2014 Oct 11.
92. Seibert JA. Iterative reconstruction: how it works, how to apply it. *Pediatr Radiol.* 2014;44 Suppl 3:431-439. doi: 10.1007/s00247-014-3102-1. Epub 2014 Oct 11.
93. Tobalem F, Dugert E, Verdun FR, et al. MDCT arthrography of the hip: value of the adaptive statistical iterative reconstruction technique and potential for radiation dose reduction. *AJR Am J Roentgenol.* 2014;203(6):W665-673. doi: 10.2214/AJR.14.12821.
94. Yang CH, Wu TH, Chiou YY, et al. Imaging quality and diagnostic reliability of low-dose computed tomography lumbar spine for evaluating patients with spinal disorders. *Spine J.* 2014;14(11):2682-2690. doi: 10.1016/j.spinee.2014.03.007. Epub 2014 Mar 17.
95. Tack D, Jahnens A, Kohler S, et al. Multidetector CT radiation dose optimisation in adults: short- and long-term effects of a clinical audit. *Eur Radiol.* 2014;24(1):169-175. doi: 10.1007/s00330-013-2994-8. Epub 2013 Aug 29.
96. Wang E, Wang D. Successful treatment of spontaneous intracranial hypotension due to prominent cervical cerebrospinal fluid leak with cervical epidural blood patch. *Pain Med.* 2015;16(5):1013-1018. doi: 10.1111/pme.12418. Epub 2014 Mar 25.
97. Sather MD, Gibson MD, Treves JS. Spinal subarachnoid hemorrhage resulting from lumbar myelography. *AJNR. Am J Neuroradiol.* 2007;28(2):220-221.
98. Chitnis AS, Guh AY, Benowitz I, et al. Outbreak of bacterial meningitis among patients undergoing myelography at an outpatient radiology clinic. *J Am Coll Radiol.* 2012;9(3):185-190. doi: 10.1016/j.jacr.2011.09.018.
99. Lehman LB. Paraparesis during myelography associated with a ruptured thoracic intervertebral disc. *Neurosurgery.* 1989;24(6):912-914.
100. Soliman HM, Arnold PM, Madarang EJ. Post-myelography paraplegia in a woman with thoracic stenosis. *J Spinal Cord Med.* 2013;36(3):247-249. doi: 10.1179/2045772313Y.0000000111.
101. Cordier D, Wasner MG, Gluecker T, Gratzl O, Merlo A. Acute paraplegia after myelography: decompensation of a herniated thoracic disc. *Br J Neurosurg.* 2008;22(5):684-686. doi: 10.1080/02688690801911580.
102. Merwick A, O'Sullivan SS, O'Regan KN, Marks CJ, Ryders DQ, Sweeney BJ. A role for myelography in assessing paraparesis. *Ir Med J.* 2008;101(1):21-22.
103. Song KJ, Choi BW, Kim GH, Kim JR. Clinical usefulness of CT-myelogram comparing with the MRI in degenerative cervical spinal disorders: is CTM still useful for primary diagnostic tool? *J Spinal Disord Tech.* 2009;22(5):353-357. doi: 10.1097/BSD.0b013e31817df78e.
104. Harrel JH, McMenamy JM, Toomay SM, Chason DP. Myelography: a primer. *Curr Probl Diagn Radiol.* 2011;40(4):149-157. doi: 10.1067/j.cpradiol.2010.06.003.
105. Manchikanti L, Dunbar EE, Wargo BW, Shah RV, Derby R, Cohen SP. Systematic review of cervical discography as a diagnostic test for chronic spinal pain. *Pain Physician.* 2009;12(2):305-321.
106. Manchikanti L, Glaser SE, Wolfer L, Derby R, Cohen SP. Systematic review of lumbar discography as a diagnostic test for chronic low back pain. *Pain Physician.* 2009;12(3):541-559.
107. Connor PM, Darden BV 2nd. Cervical discography complications and clinical efficacy. *Spine (Phila Pa 1976).* 1993;18(14):2035-2038.
108. Singh V, Manchikanti L, Onyewu O, et al. An update of the appraisal of the accuracy of thoracic discography as a diagnostic test for chronic spinal pain. *Pain Physician.* 2012;15(6):E757-775.
109. Hebelka H, Nilsson A, Hansson T. Pressure increase in adjacent discs during clinical discography, questions the methods validity. *Spine (Phila Pa 1976).* 2013. [epub ahead of print].
110. Hebelka H, Nilsson A, Ekström L, Hansson T. In vivo discography in degenerate porcine spines revealed pressure transfer to adjacent discs. *Spine (Phila Pa 1976).* 2013;38(25):E1575-1582. doi: 10.1097/01.brs.0000435141.61593.05.
111. Walker J 3rd, El Abd O, Isaac Z, Muzin S. Discography in practice: a clinical and historical review. *Curr Rev Musculoskeletal Med.* 2008;1(2):69-83. doi: 10.1007/s12178-007-9009-9.
112. Sliker CW. Blunt cerebrovascular injuries: imaging with multidetector CT angiography. *Radiographics.* 2008;28(6):1689-1708; discussion 1709-1610. doi: 10.1148/radiographics.2865521.
113. Hagedorn JC 2nd, Emery SE, France JC, Daffner SD. Does CT angiography matter for patients with cervical spine injuries? *J Bone Joint Surg Am.* 2014;96(11):951-955. Epub 2014 Jun 4.
114. Eastman AL, Chason DP, Perez CL, McAnulty AL, Minei JP. Computed tomographic angiography for the diagnosis of blunt cervical vascular injury: is it ready for primetime? *J Trauma.* 2006;60(5):925-929; discussion 929.
115. Jordan E, Choe D, Miller T, Chamathy M, Brook A, Freeman LM. Utility of bone scintigraphy to determine the appropriate vertebral augmentation levels. *Clin Nucl Med.* 2010;35(9):687-691. doi: 10.1097/RLU.0b013e3181e9fb07.
116. De Maeseneer M, Lenchik L, Everaert H, et al. Evaluation of lower back pain with bone scintigraphy and SPECT. *Radiographics.* 1999;19(4):901-912; discussion 912-914.
117. Gates GF. SPECT bone scanning of the spine. *Semin Nucl Med.* 1998;28(1):78-94.
118. Ryan RJ, Gibson T, Fogelman I. The identification of spinal pathology in chronic low back pain using single photon emission computed tomography. *Nucl Med Commun.* 1992;13(7):497-502.

119. McLoughlin LC, O'Kelly F, O'Brien C, et al. The improved accuracy of planar bone scintigraphy by adding single photon emission computed tomography (SPECT-CT) to detect skeletal metastases from prostate cancer. *Ir J Med Sci.* 2016;185(1):101-105. doi: 10.1007/s11845-014-1228-7. Epub 2014 Nov 14.
120. Savelli G, Maffioli L, Maccauro M, De Deckere E, Bombardieri E. Bone scintigraphy and the added value of SPECT (single photon emission tomography) in detecting skeletal lesions. *Q J Nucl Med.* 2001;45(1):27-37.
121. Han LJ, Au-Yong TK, Tong WC, Chu KS, Szeto LT, Wong CP. Comparison of bone single-photon emission tomography and planar imaging in the detection of vertebral metastases in patients with back pain. *Eur J Nucl Med.* 1998;25(6):635-638.
122. Delpassand ES, Garcia JR, Bhadkamkar V, Podoloff DA. Value of SPECT imaging of the thoracolumbar spine in cancer patients. *Clin Nucl Med.* 1995;20(12):1047-1051.
123. Lee I, Budian H, Moon JY, et al. The value of SPECT/CT in localizing pain site and prediction of treatment response in patients with chronic low back pain. *J Korean Med Sci.* 2014;29(12):1711-1716. doi: 10.3346/jkms.2014.29.12.1711. Epub 2014 Nov 21.
124. Matar HE, Navalkissoor S, Berovic M, et al. Is hybrid imaging (SPECT/CT) a useful adjunct in the management of suspected facet joints arthropathy? *Int Orthop.* 2013;37(5):865-870. doi: 10.1007/s00264-013-1811-y. Epub 2013 Feb 15.
125. Harisankar CN, Mittal BR, Bhattacharya A, Singh P, Sen R. Utility of single photon emission computed tomography/computed tomography imaging in evaluation of chronic low back pain. *Indian J Nucl Med.* 2012;27(3):156-163. doi: 10.4103/0972-3919.112720.
126. Sarikaya I, Sarikaya A, Holder LE. The role of single photon emission computed tomography in bone imaging. *Semin Nucl Med.* 2001;31(1):3-16.
127. Reinartz P, Schaffeldt J, Sabri O, et al. Benign versus malignant osseous lesions in the lumbar vertebrae: differentiation by means of bone SPET. *Eur J Nucl Med.* 2000;27(6):721-726.
128. Zukotynski K, Curtis C, Grant FD, Micheli L, Treves ST. The value of SPECT in the detection of stress injury to the pars interarticularis in patients with low back pain. *J Orthop Surg Res.* 2010;5:13. doi: 10.1186/1749-799X-5-13.
129. Trout AT, Sharp SE, Anton CG, Gelfand MJ, Mehlman CT. Spondylolysis and beyond: value of SPECT/CT in evaluation of low back pain in children and young adults. *Radiographics.* 2015;35(3):819-834. doi: 10.1148/radiographics.2015140092.
130. Gum JL, Crawford CH 3rd, Collis PC, Carreon LY. Characteristics associated with active defects in juvenile spondylolysis. *Am J Orthop (Belle Mead NJ).* 2015;44(10):E379-383.
131. Akesson K. New approaches to pharmacological treatment of osteoporosis. *Bull World Health Organ.* 2003;81(9):657-664.
132. Health Quality Ontario. Utilization of DXA bone mineral densitometry in Ontario: an evidence-based analysis. *Ont Health Technol Assess Ser.* 2006;6(20):1-180. Epub 2006 Nov 1.
133. Kanis JA, Oden A, Johnell O, et al. The use of clinical risk factors enhances the performance of BMD in the prediction of hip and osteoporotic fractures in men and women. *Osteoporos Int.* 2007;18(8):1033-1046. Epub 2007 Feb 24.
134. Bernabei R, Martone AM, Ortolani E, Landi F, Marzetti E. Screening, diagnosis and treatment of osteoporosis: a brief review. *Clin Cases Miner Bone Metab.* 2014;11(3):201-207.
135. American College of Radiology. ACR Appropriateness Criteria: Osteoporosis and Bone Mineral Density. <https://acsearch.acr.org/docs/69358/Narrative/>. Accessed March 19, 2017.
136. Lewiecki EM, Bilezikian JP, Binkley N, et al. Update on osteoporosis from the 2014 Santa Fe Bone symposium. *Endocr Res.* 2015;40(2):106-119. doi: 10.3109/07435800.2015.1005746. Epub 2015 Mar 24.
137. Nayak S, Edwards DL, Saleh AA, Greenspan SL. Systematic review and meta-analysis of the performance of clinical risk assessment instruments for screening for osteoporosis or low bone density. *Osteoporos Int.* 2015;26(5):1543-1554. doi: 10.1007/s00198-015-3025-1. Epub 2015 Feb 3.
138. Van der Klift M, De Laet CE, McCloskey EV, Hofman A, Pols HA. The incidence of vertebral fractures in men and women: the Rotterdam Study. *J Bone Miner Res.* 2002;17(6):1051-1056.
139. Sharma U, Stevermer JJ. Bisphosphonate therapy: when not to monitor BMD. *J Fam Pract.* 2009;58(11):594-596.
140. Cosman F, de Beur SJ, LeBoff MS, et al. Clinician's guide to prevention and treatment of osteoporosis. *Osteoporos Int.* 2014;25(10):2359-2381. doi: 10.1007/s00198-014-2794-2. Epub 2014 Aug 15.
141. Schousboe JT, Debold CR. Reliability and accuracy of vertebral fracture assessment with densitometry compared to radiography in clinical practice. *Osteoporos Int.* 2006;17(2):281-289. Epub 2005 Sep 20.
142. Schousboe JT, Shepherd JA, Bilezikian JP, Baim S. Executive summary of the 2013 International Society for Clinical Densitometry Position Development Conference on bone densitometry. *J Clin Densitom.* 2013;16(4):455-466. doi: 10.1016/j.jocd.2013.08.004.
143. Chou SH, Vokes TJ, Ma SL, Costello M, Rosen HR, Schousboe JT. Simplified criteria for selecting patients for vertebral fracture assessment. *J Clin Densitom.* 2014;17(3):386-391. doi: 10.1016/j.jocd.2013.11.003. Epub 2014 Feb 25.
144. Kiesel KB, Uhl TL, Underwood FB, Rodd DW, Nitz AJ. Measurement of lumbar multifidus muscle contraction with rehabilitative ultrasound imaging. *Man Ther.* 2007;12(2):161-166. Epub 2006 Sep 14.
145. Schmidt WA, Backhaus M. What the practising rheumatologist needs to know about the technical fundamentals of ultrasonography. *Best Pract Res Clin Rheumatol.* 2008;22(6):981-999. doi: 10.1016/j.berh.2008.09.013.
146. Smith J, Finnoff JT. Diagnostic and interventional musculoskeletal ultrasound: part 1. Fundamentals. *PM R.* 2009;1(1):64-75. doi: 10.1016/j.pmrj.2008.09.001.
147. Whittaker JL, Teyhen DS, Elliott JM, et al. Rehabilitative ultrasound imaging: understanding the technology and its applications. *J Orthop Sports Phys Ther.* 2007;37(8):434-449.
148. van Holsbeek M, Introcaso JH. Musculoskeletal ultrasonography. *Radiol Clin North Am.* 1992;30(5):907-925.
149. Hebert JJ, Koppenhaver SL, Parent EC, Fritz JM. A systematic review of the reliability of rehabilitative ultrasound imaging for the quantitative assessment of the abdominal and lumbar trunk muscles. *Spine (Phila Pa 1976).* 2009;34(23):E848-856. doi: 10.1097/BRS.0b013e3181ae625c.
150. Stokes M, Rankin G, Newham DJ. Ultrasound imaging of lumbar multifidus muscle: normal reference ranges for measurements and practical guidance on the technique. *Man Ther.* 2005;10(2):116-126. Epub 2004 Nov 18.
151. Pressler JF, Heiss DG, Buford JA, Chidley JV. Between-day repeatability and symmetry of multifidus cross-sectional area measured using ultrasound imaging. *J Orthop Sports Phys Ther.* 2006;36(1):10-18.
152. Hides JA, Richardson CA, Jull GA. Magnetic resonance imaging and ultrasonography of the lumbar multifidus muscle. Comparison of two different modalities. *Spine (Phila Pa 1976).* 1995;20(1):54-58.
153. Sions JM, Teyhen DS, Hicks GE. Criterion validity of ultrasound imaging: assessment of multifidi cross-sectional area in older adults with and without chronic low back pain. *J Geriatr Phys Ther.* 2017;40(2):74-79. doi: 10.1519/JPT.0000000000000073.
154. Sions JM, Smith AC, Hicks GE, Elliott JM. Trunk muscle size and composition assessment in older adults with chronic low back pain: an intra-examiner and inter-examiner reliability study. *Pain Med.* 2016;17(8):1436-1446. doi: 10.1093/pain/pnv023. Epub 2015 Dec 7.
155. Hides JA, Stokes MJ, Saide M, Jull GA, Cooper DH. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. *Spine (Phila Pa 1976).* 1994;19(2):165-172.
156. Hides J, Gilmore C, Stanton W, Bohlscheid E. Multifidus size and symmetry among chronic LBP and healthy asymptomatic subjects. *Man Ther.* 2008;13(1):43-49. Epub 2006 Oct 27.
157. Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. *Spine (Phila Pa 1976).* 1996;21(23):2763-2769.
158. Hides JA, Stanton WR, McMahon S, Sims K, Richardson CA. Effect of stabilization training on multifidus muscle cross-sectional area among

- young elite cricketers with low back pain. *J Orthop Sports Phys Ther.* 2008;38(3):101-108. doi: 10.2519/jospt.2008.2658. Epub 2007 Dec 7.
159. Hodges PW, Richardson CA. Delayed postural contraction of transversus abdominis in low back pain associated with movement of the lower limb. *J Spinal Disord.* 1998;11(1):46-56.
  160. Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis. *Spine (Phila Pa 1976).* 1996;21(22):2640-2650.
  161. MacDonald D, Moseley GL, Hodges PW. People with recurrent low back pain respond differently to trunk loading despite remission from symptoms. *Spine (Phila Pa 1976).* 2010;35(7):818-824. doi: 10.1097/BRS.0b013e3181bc98f1.
  162. MacDonald D, Moseley GL, Hodges PW. Why do some patients keep hurting their back? Evidence of ongoing back muscle dysfunction during remission from recurrent back pain. *Pain.* 2009;142(3):183-188. doi: 10.1016/j.pain.2008.12.002. Epub 2009 Jan 30.
  163. Koppenhaver SL, Parent EC, Teyhen DS, Hebert JJ, Fritz JM. The effect of averaging multiple trials on measurement error during ultrasound imaging of transversus abdominis and lumbar multifidus muscles in individuals with low back pain. *J Orthop Sports Phys Ther.* 2009;39(8):604-611. doi: 10.2519/jospt.2009.3088.
  164. Sions JM, Velasco TO, Teyhen DS, Hicks GE. Ultrasound imaging: intraexaminer and interexaminer reliability for multifidus muscle thickness assessment in adults aged 60 to 85 years versus younger adults. *J Orthop Sports Phys Ther.* 2014;44(6):425-434. doi: 10.2519/jospt.2014.4584. Epub 2014 Apr 25.
  165. Sweeney N, O'Sullivan C, Kelly G. Multifidus muscle size and percentage thickness changes among patients with unilateral chronic low back pain (CLBP) and healthy controls in prone and standing. *Man Ther.* 2014;19(5):433-439. doi: 10.1016/j.math.2014.04.009. Epub 2014 May 9.
  166. Wallwork TL, Stanton WR, Freke M, Hides JA. The effect of chronic low back pain on size and contraction of the lumbar multifidus muscle. *Man Ther.* 2009;14(5):496-500. doi: 10.1016/j.math.2008.09.006. Epub 2008 Nov 21.
  167. Macdonald DA, Dawson AP, Hodges PW. Behavior of the lumbar multifidus during lower extremity movements in people with recurrent low back pain during symptom remission. *J Orthop Sports Phys Ther.* 2011;41(3):155-164. doi: 10.2519/jospt.2011.3410. Epub 2011 Jan 4.
  168. McMeeken JM, Beith ID, Newham DJ, Milligan P, Critchley DJ. The relationship between EMG and change in thickness of transversus abdominis. *Clin Biomech (Bristol, Avon).* 2004;19(4):337-342.
  169. Hodges PW, Pengel LH, Herbert RD, Gandevia SC. Measurement of muscle contraction with ultrasound imaging. *Muscle Nerve.* 2003;27(6):682-692.
  170. Whittaker JL, McLean L, Hodder J, Warner MB, Stokes MJ. Association between changes in electromyographic signal amplitude and abdominal muscle thickness in individuals with and without lumbopelvic pain. *J Orthop Sports Phys Ther.* 2013;43(7):466-477. doi: 10.2519/jospt.2013.4440. Epub 2013 Apr 30.
  171. Teyhen DS, Williamson JN, Carlson NH, et al. Ultrasound characteristics of the deep abdominal muscles during the active straight leg raise test. *Arch Phys Med Rehabil.* 2009;90(5):761-767. doi: 10.1016/j.apmr.2008.11.011.
  172. Teyhen DS, Bluemle LN, Dolbeer JA, et al. Changes in lateral abdominal muscle thickness during the abdominal drawing-in maneuver in those with lumbopelvic pain. *J Orthop Sports Phys Ther.* 2009;39(11):791-798. doi: 10.2519/jospt.2009.3128.
  173. Teyhen DS, Childs JD, Stokes MJ, Wright AC, Dugan JL, George SZ. Abdominal and lumbar multifidus muscle size and symmetry at rest and during contracted states. Normative reference ranges. *J Ultrasound Med.* 2012;31(7):1099-1110.
  174. Van K, Hides JA, Richardson CA. The use of real-time ultrasound imaging for biofeedback of lumbar multifidus muscle contraction in healthy subjects. *J Orthop Sports Phys Ther.* 2006;36(12):920-925.
  175. Akbari A, Khorashadizadeh S, Abdi G. The effect of motor control exercise versus general exercise on lumbar local stabilizing muscles thickness: Randomized controlled trial of patients with chronic low back pain. *J Back Musculoskelet Rehabil.* 2008;21(2):105-112.
  176. Dagenais S, Tricco AC, Haldeman S. Synthesis of recommendations for the assessment and management of low back pain from recent clinical practice guidelines. *Spine J.* 2010;10(6):514-529. doi: 10.1016/j.spinee.2010.03.032.
  177. Georgakopoulos A, Pneumaticos SG, Sipsas NV, Chatzioannou S. Positron emission tomography in spinal infections. *Clin Imaging.* 2015;39(4):553-558. doi: 10.1016/j.clinimag.2015.04.002. Epub 2015 Apr 10.
  178. Arbelaez A, Restrepo F, Castillo M. Spinal infections: clinical and imaging features. *Top Magn Reson Imaging.* 2014;23(5):303-314. doi: 10.1097/RMR.0000000000000032.
  179. Tali ET, Oner AV, Koc AM. Pyogenic spinal infections. *Neuroimaging Clin N Am.* 2015;25(2):193-208. doi: 10.1016/j.nic.2015.01.003.
  180. Laman M, Manning L, Greenhill AR, et al. Predictors of acute bacterial meningitis in children from a malaria-endemic area of Papua New Guinea. *Am J Trop Med Hyg.* 2012;86(2):240-245. doi: 10.4269/ajtmh.2012.11-0312.
  181. Wyatt LH. Spine cancer: a summary and review. *Australas Chiropr Osteopathy.* 2004;12(1):9-17.
  182. Shah LM, Salzman KL. Imaging of spinal metastatic disease. *Int J Surg Oncol.* 2011;2011:769753. doi: 10.1155/2011/769753. Epub 2011 Nov 3.
  183. Ruiz A, Post MJ, Sklar EM, Holz A. MR imaging of infections of the cervical spine. *Magn Reson Imaging Clin N Am.* 2000;8(3):561-580.
  184. Boody BS, Jenkins TJ, Maslak J, Hsu WK, Patel AA. Vertebral osteomyelitis and spinal epidural abscess: an evidence-based review. *J Spinal Disord Tech.* 2015;28(6):E316-327. doi: 10.1097/BSR.0000000000000294.
  185. Tang Q, Xiao H. Analysis of age of onset, pre-existing infections, and features of magnetic resonance imaging results in patients with acute myelitis. *Genet Mol Res.* 2014;13(2):4545-4551. doi: 10.4238/2014.June.17.6.
  186. Johnson K, Gunaratne S, Shaffi M. Pitfalls of triage by imaging in spinal epidural abscess. *Emerg Med Australas.* 2014;26(2):205-206. doi: 10.1111/1742-6723.12205.
  187. Sendi P, Bregenzer T, Zimmerli W. Spinal epidural abscess in clinical practice. *QJM.* 2008;101(1):1-12. Epub 2007 Nov 3.
  188. Van Tassel P. Magnetic resonance imaging of spinal infections. *Top Magn Reson Imaging.* 1994;6(1):69-81.
  189. Maiuri F, Iaconetta G, Gallicchio B, Manto A, Briganti F. Spondylodiscitis. Clinical and magnetic resonance diagnosis. *Spine (Phila Pa 1976).* 1997;22(15):1741-1746.
  190. Slipman CW, Patel RK, Botwin K, et al. Epidemiology of spine tumors presenting to musculoskeletal physiatrists. *Arch Phys Med Rehabil.* 2003;84(4):492-495.
  191. Deyo RA, Diehl AK. Cancer as a cause of back pain: frequency, clinical presentation, and diagnostic strategies. *J Gen Intern Med.* 1988;3(3):230-238.
  192. Swityk MD, Hole KH, Skjeldal S, et al. MRI and neurological findings in patients with spinal metastases. *Acta Radiol.* 2012;53(10):1164-1172. doi: 10.1258/ar.2012.120442. Epub 2012 Oct 9.
  193. Choi D, Crockard A, Bunger C, et al. Review of metastatic spine tumour classification and indications for surgery: the consensus statement of the Global Spine Tumour Study Group. *Eur Spine J.* 2010;19(2):215-222. doi: 10.1007/s00586-009-1252-x. Epub 2009 Dec 29.
  194. Henschke N, Maher CG, Ostelo RW, de Vet HC, Macaskill P, Irwig L. Red flags to screen for malignancy in patients with low-back pain. *Cochrane Database Syst Rev.* 2013;2:CD008686. doi: 10.1002/14651858.CD008686.pub2.
  195. Sciubba DM, Petteys RJ, Dekutoski MB, et al. Diagnosis and management of metastatic spine disease. A review. *J Neurosurg Spine.* 2010;13(1):94-108. doi: 10.3171/2010.3.SPINE09202.
  196. Perrin RG, Laxton AW. Metastatic spine disease: epidemiology, pathophysiology, and evaluation of patients. *Neurosurg Clin N Am.* 2004;15(4):365-373.
  197. Cook C, Ross MD, Isaacs R, Hegedus E. Investigation of nonmechanical findings during spinal movement screening for identifying and/

- or ruling out metastatic cancer. *Pain Pract.* 2012;12(6):426-433. doi: 10.1111/j.1533-2500.2011.00519.x. Epub 2011 Nov 22.
198. Klimo P Jr, Schmidt MH. Surgical management of spinal metastases. *Oncologist.* 2004;9(2):188-196.
  199. Salvo N, Christakis M, Rubenstein J, et al. The role of plain radiographs in management of bone metastases. *J Palliat Med.* 2009;12(2):195-198. doi: 10.1089/jpm.2008.0055.
  200. Ryan PJ, Fogelman I. The bone scan: where are we now? *Semin Nucl Med.* 1995;25(2):76-91.
  201. Shih LY, Chen TH, Lo WH. Skeletal metastasis from occult carcinoma. *J Surg Oncol.* 1992;51(2):109-113.
  202. Palmer E, Henrikson B, McKusick K, Strauss HW, Hochberg F. Pain as an indicator of bone metastasis. *Acta Radiol.* 1988;29(4):445-449.
  203. Anderson KC, Alsina M, Atanackovic D, et al. NCCN guidelines insights: multiple myeloma, version 3.2016. *J Natl Compr Canc Netw.* 2016;14(4):389-400.
  204. Government of Western Australia. Diagnostic Imaging Pathways-Multiple Myeloma. [www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/musculoskeletal/multiple-myeloma](http://www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/musculoskeletal/multiple-myeloma). Accessed April 24, 2016.
  205. Gosfield E 3rd, Alavi A, Kneeland B. Comparison of radionuclide bone scans and magnetic resonance imaging in detecting spinal metastases. *J Nucl Med.* 1993;34(12):2191-2198.
  206. Bilsky MH, Lis E, Raizer J, Lee H, Boland P. The diagnosis and treatment of metastatic spinal tumor. *Oncologist.* 1999;4(6):459-469.
  207. American College of Radiology. ACR Appropriateness Criteria: Primary Bone Tumors. [www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/PrimaryBoneTumors.pdf](http://www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/PrimaryBoneTumors.pdf). Accessed April 24, 2016.
  208. Rossi F, Dragoni S. Acute avulsion fractures of the pelvis in adolescent competitive athletes: prevalence, location and sports distribution of 203 cases collected. *Skeletal Radiol.* 2001;30(3):127-131.
  209. Kalichman L, Kim DH, Li L, Guermazi A, Hunter DJ. Computed tomography-evaluated features of spinal degeneration: prevalence, intercorrelation, and association with self-reported low back pain. *Spine J.* 2010;10(3):200-208. doi: 10.1016/j.spinee.2009.10.018. Epub 2009 Dec 16.
  210. Standaert CJ, Herring SA, Halpern B, King O. Spondylolysis. *Phys Med Rehabil Clin N Am.* 2000;11(4):785-803.
  211. Bono CM. Low-back pain in athletes. *J Bone Joint Surg Am.* 2004;86-A(2):382-396.
  212. Leucht P, Fischer K, Muhr G, Mueller EJ. Epidemiology of traumatic spine fractures. *Injury.* 2009;40(2):166-172. doi: 10.1016/j.injury.2008.06.040. Epub 2009 Feb 23.
  213. American College of Radiology. ACR Appropriateness Criteria: Chronic Neck Pain. [www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/ChronicNeckPain.pdf](http://www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/ChronicNeckPain.pdf). Accessed April 24, 2016.
  214. Government of Western Australia. Diagnostic Imaging Pathways-Neck Pain (Non-Traumatic). [www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/musculoskeletal/non-traumatic-neck-pain](http://www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/musculoskeletal/non-traumatic-neck-pain). Accessed April 24, 2016.
  215. Monticone M, Iovine R, de Sena G, et al. The Italian Society of Physical and Rehabilitation Medicine (SIMFER) recommendations for neck pain. *G Ital Med Lav Ergon.* 2013;35(1):36-50.
  216. Nordin M, Carragee EJ, Hogg-Johnson S, et al. Assessment of neck pain and its associated disorders: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine (Phila Pa 1976).* 2008;33(4 Suppl):S101-122. doi: 10.1097/BRS.0b013e3181644ae8.
  217. Stiell IG, Wells GA, Vandemheen KL, et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. *JAMA.* 2001;286(15):1841-1848.
  218. Hoffman JR, Wolfson AB, Todd K, Mower WR. Selective cervical spine radiography in blunt trauma: methodology of the National Emergency X-Radiography Utilization Study (NEXUS). *Ann Emerg Med.* 1998;32(4):461-469.
  219. Government of Western Australia. Diagnostic Imaging Pathways-Cervical Spine Injury. [www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/bone-and-joint-trauma/cervical-spine-injury](http://www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/bone-and-joint-trauma/cervical-spine-injury). Accessed April 24, 2016.
  220. Childs JD, Cleland JA, Elliott JM, et al. Neck pain: Clinical practice guidelines linked to the International Classification of Functioning, Disability, and Health from the Orthopedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther.* 2008;38(9):A1-A34. Epub 2008 Sep 1.
  221. Stiell IG, Clement CM, Grimshaw J, et al. Implementation of the Canadian C-Spine Rule: prospective 12 centre cluster randomised trial. *BMJ.* 2009;339:b4146. doi: 10.1136/bmj.b4146.
  222. Paxton M, Heal CF, Drobetz H. Adherence to Canadian C-Spine Rule in a regional hospital: a retrospective study of 406 cases. *J Med Imaging Radiat Oncol.* 2012;56(5):514-518. doi: 10.1111/j.1754-9485.2012.02430.x. Epub 2012 Sep 5.
  223. Michaleff ZA, Maher CG, Verhagen AP, Rebbeck T, Lin CW. Accuracy of the Canadian C-spine rule and NEXUS to screen for clinically important cervical spine injury in patients following blunt trauma: a systematic review. *CMAJ.* 2012;184(16):E867-876. doi: 10.1503/cmaj.120675. Epub 2012 Oct 9.
  224. Eagles D, Stiell IG, Clement CM, et al. International survey of emergency physicians' awareness and use of the Canadian Cervical-Spine Rule and the Canadian Computed Tomography Head Rule. *Acad Emerg Med.* 2008;15(12):1256-1261. doi: 10.1111/j.1553-2712.2008.00265.x. Epub 2008 Oct 17.
  225. Touger M, Gennis P, Nathanson N, et al. Validity of a decision rule to reduce cervical spine radiography in elderly patients with blunt trauma. *Ann Emerg Med.* 2002;40(3):287-293.
  226. American College of Radiology. ACR Appropriateness Criteria: Suspected Spine Trauma. 2012; <http://www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/SuspectedSpineTrauma.pdf>. Accessed April 24, 2016.
  227. Weiner S. The actual application of the NEXUS and Canadian C-spine rules by emergency physicians. *Internet J Emerg Med.* 2008;5(2).
  228. Griffith B, Vallee P, Krupp S, et al. Screening cervical spine CT in the emergency department, phase 3: increasing effectiveness of imaging. *J Am Coll Radiol.* 2014;11(2):139-144. doi: 10.1016/j.jacr.2013.05.026. Epub 2013 Sep 11.
  229. Holmes JF, Akkineni R. Computed tomography versus plain radiography to screen for cervical spine injury: a meta-analysis. *J Trauma.* 2005;58(5):902-905.
  230. Platzer P, Hauswirth N, Jaindl M, Chatwani S, Vecsei V, Gaebler C. Delayed or missed diagnosis of cervical spine injuries. *J Trauma.* 2006;61(1):150-155.
  231. Grogan EL, Morris JA Jr, Dittus RS, et al. Cervical spine evaluation in urban trauma centers: lowering institutional costs and complications through helical CT scan. *J Am Coll Surg.* 2005;200(2):160-165.
  232. Phal PM, Riccelli LP, Wang P, Nesbit GM, Anderson JC. Fracture detection in the cervical spine with multidetector CT: 1-mm versus 3-mm axial images. *AJR Am J Neuroradiol.* 2008;29(8):1446-1449. doi: 10.3174/ajrn.11152. Epub 2008 Jun 4.
  233. Mathen R, Inaba K, Munera F, et al. Prospective evaluation of multislice computed tomography versus plain radiographic cervical spine clearance in trauma patients. *J Trauma.* 2007;62(6):1427-1431.
  234. Nguyen GK, Clark R. Adequacy of plain radiography in the diagnosis of cervical spine injuries. *Emerg Radiol.* 2005;11(3):158-161.
  235. Widder S, Doig C, Burrowes P, Larsen G, Hurlbert RJ, Kortbeek JB. Prospective evaluation of computed tomographic scanning for the spinal clearance of obtunded trauma patients: preliminary results. *J Trauma.* 2004;56(6):1179-1184.
  236. Vanguri P, Young AJ, Weber WF, et al. Computed tomographic scan: it's not just about the fracture. *J Trauma Acute Care Surg.* 2014;77(4):604-607. doi: 10.1097/TA.0000000000000407.
  237. Hunter BR, Keim SM, Seupaul RA, Hern G. Are plain radiographs sufficient to exclude cervical spine injuries in low-risk adults? *J Emerg Med.* 2014;46(2):257-263. doi: 10.1016/j.jemermed.2013.08.094. Epub 2013 Dec 14.
  238. Blum CA, Yaghi S. Cervical artery dissection: a review of the epidemiology, pathophysiology, treatment, and outcome. *Arch Neurosci.* 2015;2(4). pii: e26670. Epub 2015 Oct 17.
  239. Desai NK, Kang J, Chokshi FH. Screening CT angiography for pediatric blunt cerebrovascular injury with emphasis on the cervical "seatbelt

- sign". *AJNR Am J Neuroradiol.* 2014;35(9):1836-1840. doi: 10.3174/ajnr.A3916. Epub 2014 Apr 10.
240. Debette S. Pathophysiology and risk factors of cervical artery dissection: what have we learnt from large hospital-based cohorts? *Curr Opin Neurol.* 2014;27(1):20-28. doi: 10.1097/WCO.0000000000000056.
  241. Harrigan MR, Hadley MN, Dhall SS, et al. Management of vertebral artery injuries following non-penetrating cervical trauma. *Neurosurgery.* 2013;72 Suppl 2:234-243. doi: 10.1227/NEU.0b013e31827765f5.
  242. Carroll LJ, Hogg-Johnson S, van der Velde G, et al. Course and prognostic factors for neck pain in the general population: results of the Bone and Joint Decade 2000-2010 Task Force on neck pain and its associated disorders. *Spine (Phila Pa 1976).* 2008;33(4 Suppl):S75-82. doi: 10.1097/BRS.0b013e31816445be.
  243. Sterling M, Jull G, Kenardy J. Physical and psychological factors maintain long-term predictive capacity post-whiplash injury. *Pain.* 2006;122(1-2):102-108. Epub 2006 Mar 9.
  244. Sterling M, Hendrikz J, Kenardy J, et al. Assessment and validation of prognostic models for poor functional recovery 12 months after whiplash injury: a multicentre inception cohort study. *Pain.* 2012;153(8):1727-1734. doi: 10.1016/j.pain.2012.05.004. Epub 2012 Jun 1.
  245. Sterling M, McLean SA, Sullivan MJ, Elliott JM, Buitenhuis J, Kamper SJ. Potential processes involved in the initiation and maintenance of whiplash-associated disorders: discussion paper 3. *Spine (Phila Pa 1976).* 2011;36(25 Suppl):S322-329. doi: 10.1097/BRS.0b013e318238853f.
  246. Curatolo M, Bogduk N, Ivancic PC, McLean SA, Siegmund GP, Winkelstein BA. The role of tissue damage in whiplash-associated disorders: discussion paper 1. *Spine (Phila Pa 1976).* 2011;36(25 Suppl):S309-315. doi: 10.1097/BRS.0b013e318238842a.
  247. Bagley LJ. Imaging of spinal trauma. *Radiol Clin North Am.* 2006;44(1):1-12, vii.
  248. Elliott J, Pedler A, Kenardy J, Galloway G, Jull G, Sterling M. The temporal development of fatty infiltrates in the neck muscles following whiplash injury: an association with pain and posttraumatic stress. *PLoS One.* 2011;6(6):e21194. doi: 10.1371/journal.pone.0021194. Epub 2011 Jun 16.
  249. Elliott JM, Pedler AR, Theodoros D, Jull GA. Magnetic resonance imaging changes in the size and shape of the oropharynx following acute whiplash injury. *J Orthop Sports Phys Ther.* 2012;42(11):912-918. doi: 10.2519/jospt.2012.4280. Epub 2012 Aug 17.
  250. Elliott JM. Are there implications for morphological changes in neck muscles after whiplash injury? *Spine (Phila Pa 1976).* 2011;36(25 Suppl):S205-210. doi: 10.1097/BRS.0b013e3182387f57.
  251. Elliott JM, Pedler AR, Jull GA, Van Wyk L, Galloway GG, O'Leary SP. Differential changes in muscle composition exist in traumatic and nontraumatic neck pain. *Spine (Phila Pa 1976).* 2014;39(1):39-47. doi: 10.1097/BRS.0000000000000033.
  252. Elliott JM, Courtney DM, Rademaker A, Pinto D, Sterling MM, Parrish TB. The rapid and progressive degeneration of the cervical multifidus in whiplash: an MRI study of fatty infiltration. *Spine (Phila Pa 1976).* 2015;40(12):E694-700. doi: 10.1097/BRS.0000000000000891.
  253. Elliott JM, Dewald JP, Hornby TG, Walton DM, Parrish TB. Mechanisms underlying chronic whiplash: contributions from an incomplete spinal cord injury? *Pain Med.* 2014;15(11):1938-1944. doi: 10.1111/pme.12518. Epub 2014 Aug 19.
  254. Elliott JM, Pedler AR, Cowin G, Sterling M, McMahon K. Spinal cord metabolism and muscle water diffusion in whiplash. *Spinal Cord.* 2012;50(6):474-476. doi: 10.1038/sc.2011.17. Epub 2011 Mar 8.
  255. Banic B, Petersen-Felix S, Andersen OK, et al. Evidence for spinal cord hypersensitivity in chronic pain after whiplash injury and in fibromyalgia. *Pain.* 2004;107(1-2):7-15.
  256. Sterling M. Differential development of sensory hypersensitivity and a measure of spinal cord hyperexcitability following whiplash injury. *Pain.* 2010;150(3):501-506. doi: 10.1016/j.pain.2010.06.003. Epub 2010 Jul 1.
  257. Sterling M, Jull G, Vicenzino B, Kenardy J, Darnell R. Physical and psychological factors predict outcome following whiplash injury. *Pain.* 2005;114(1-2):141-148. Epub 2005 Jan 21.
  258. Rebbeck T, Sindhusake D, Cameron ID, et al. A prospective cohort study of health outcomes following whiplash associated disorders in an Australian population. *Inj Prev.* 2006;12(2):93-98.
  259. Elliott JM, Noteboom JT, Flynn TW, Sterling M. Characterization of acute and chronic whiplash-associated disorders. *J Orthop Sports Phys Ther.* 2009;39(5):312-323. doi: 10.2519/jospt.2009.2826.
  260. Myran R, Zwart JA, Kvistad KA, et al. Clinical characteristics, pain, and disability in relation to alar ligament MRI findings. *Spine (Phila Pa 1976).* 2011;36(13):E862-867. doi: 10.1097/BRS.0b013e3181ff1dde.
  261. Siegmund GP, Winkelstein BA, Ivancic PC, Svensson MY, Vasa-vada A. The anatomy and biomechanics of acute and chronic whiplash injury. *Traffic Inj Prev.* 2009;10(2):101-112. doi: 10.1080/15389580802593269.
  262. Anderson SE, Boesch C, Zimmermann H, et al. Are there cervical spine findings at MR imaging that are specific to acute symptomatic whiplash injury? A prospective controlled study with four experienced blinded readers. *Radiology.* 2012;262(2):567-575. doi: 10.1148/radiol.11102115. Epub 2011 Dec 20.
  263. Matsumoto M, Ichihara D, Okada E, et al. Cross-sectional area of the posterior extensor muscles of the cervical spine in whiplash injury patients versus healthy volunteers--10 year follow-up MR study. *Injury.* 2012;43(6):912-916. doi: 10.1016/j.injury.2012.01.017. Epub 2012 Feb 4.
  264. Ulbrich EJ, Aeberhard R, Wetli S, et al. Cervical muscle area measurements in whiplash patients: Acute, 3, and 6 months of follow-up. *J Magn Reson Imaging.* 2012;36(6):1413-1420. doi: 10.1002/jmri.23769. Epub 2012 Aug 3.
  265. Elliott JM, Kerry R, Flynn T, Parrish TB. Content not quantity is a better measure of muscle degeneration in whiplash. *Man Ther.* 2013;18(6):578-582. doi: 10.1016/j.math.2013.02.002. Epub 2013 Mar 5.
  266. Levy HP. Ehlers-Danlos Syndrome, Hypermobility Type. <http://www.ncbi.nlm.nih.gov/books/NBK1279/>. Accessed April 24, 2016.
  267. Lundine KM, Davis G, Rogers M, Staples M, Quan G. Prevalence of adjacent segment disc degeneration in patients undergoing anterior cervical discectomy and fusion based on pre-operative MRI findings. *J Clin Neurosci.* 2014;21(1):82-85. doi: 10.1016/j.jocn.2013.02.039. Epub 2013 Sep 11.
  268. Girard V, Leroux B, Brun V, Bressy G, Sesmat H, Madi K. Post-traumatic lower cervical spine instability: arthrodesis clinical and radiological outcomes at 5 years. *Orthop Traumatol Surg Res.* 2014;100(4):385-388. doi: 10.1016/j.otsr.2014.02.003. Epub 2014 Apr 18.
  269. Milhorat TH, Bolognesi PA, Nishikawa M, McDonnell NB, Francomanno CA. Syndrome of occipitoatlantoaxial hypermobility, cranial settling, and chiari malformation type I in patients with hereditary disorders of connective tissue. *J Neurosurg Spine.* 2007;7(6):601-609.
  270. Hobbs WR, Sponseller PD, Weiss AP, Pyeritz RE. The cervical spine in Marfan syndrome. *Spine (Phila Pa 1976).* 1997;22(9):983-989.
  271. Dede O, Thacker MM, Rogers KJ, et al. Upper cervical fusion in children with Morquio syndrome: intermediate to long-term results. *J Bone Joint Surg Am.* 2013;95(13):1228-1234. doi: 10.2106/JBJS.J.01135.
  272. El-Khoury M, Mourão MA, Tobo A, Battistella LR, Herrero CF, Roberto M. Prevalence of atlanto-occipital and atlantoaxial instability in adults with Down syndrome. *World Neurosurg.* 2014;82(1-2):215-218. doi: 10.1016/j.wneu.2014.02.006. Epub 2014 Feb 14.
  273. Wadhwa R, Mummaneni PV. High cervical instability in adult patients with Down syndrome. *World Neurosurg.* 2015;83(3):332-333. doi: 10.1016/j.wneu.2014.04.072. Epub 2014 May 4.
  274. Ulmer JL, Elster AD, Ginsberg LE, Williams DW 3rd. Klippel-Feil syndrome: CT and MR of acquired and congenital abnormalities of cervical spine and cord. *J Comput Assist Tomogr.* 1993;17(2):215-224.
  275. McLaughlin N, Weil AG, Demers J, Shedd D. Klippel-Feil syndrome associated with a craniocervico-thoracic dermoid cyst. *Surg Neurol Int.* 2013;4(Suppl 2):S61-66. doi: 10.4103/2152-7806.109440. Print 2013.
  276. Arvin B, Fournier-Gosselin MP, Fehlings MG. Os odontoideum: etiology and surgical management. *Neurosurgery.* 2010;66(3 Suppl):22-31. doi: 10.1227/01.NEU.0000366113.15248.07.
  277. Robson KA. Os odontoideum: rare cervical lesion. *West J Emerg Med.* 2011;12(4):520-522. doi: 10.5811/westjem.2011.4.2029.

278. Badve SA, Bhojraj SY, Nene AM, et al. Spinal instability in ankylosing spondylitis. *Indian J Orthop.* 2010;44(3):270-276. doi: 10.4103/0019-5413.65151.
279. McConkey B. Rheumatoid cervical myelopathy. *Br Med J (Clin Res Ed)*. 1982;284(6331):1731-1732.
280. Mukerji N, Todd NV. Cervical myelopathy in rheumatoid arthritis. *Neurol Res Int.* 2011;2011:153628. doi: 10.1155/2011/153628. Epub 2011 Nov 22.
281. Slater H, Briggs AM, Fary RE, Chan M. Upper cervical instability associated with rheumatoid arthritis: what to 'know' and what to 'do'. *Man Ther.* 2013;18(6):615-619. doi: 10.1016/j.math.2013.01.005. Epub 2013 Feb 12.
282. Lee JS, Lee S, Bang SY, et al. Prevalence and risk factors of anterior or atlantoaxial subluxation in ankylosing spondylitis. *J Rheumatol.* 2012;39(12):2321-2326. doi: 10.3899/jrheum.120260. Epub 2012 Oct 1.
283. Li MF, Chiu PC, Weng MJ, Lai PH. Atlantoaxial instability and cervical cord compression in Morquio syndrome. *Arch Neurol.* 2010;67(12):1530. doi: 10.1001/archneurol.2010.308.
284. Wasserman BR, Moskovich R, Razi AE. Rheumatoid arthritis of the cervical spine--clinical considerations. *Bull NYU Hosp Jt Dis.* 2011;69(2):136-148.
285. Kaale BR, Krakenes J, Albrektsen G, Wester K. Whiplash-associated disorders impairment rating: neck disability index score according to severity of MRI findings of ligaments and membranes in the upper cervical spine. *J Neurotrauma.* 2005;22(4):466-475.
286. Krakenes J, Kaale BR. Magnetic resonance imaging assessment of cranivertebral ligaments and membranes after whiplash trauma. *Spine (Phila Pa 1976).* 2006;31(24):2820-2826.
287. Maak TG, Tominaga Y, Panjabi MM, Ivancic PC. Alar, transverse, and apical ligament strain due to head-turned rear impact. *Spine (Phila Pa 1976).* 2006;31(6):632-638.
288. Myran R, Kvistad KA, Nygaard OP, Andresen H, Folvik M, Zwart JA. Magnetic resonance imaging assessment of the alar ligaments in whiplash injuries: a case-control study. *Spine (Phila Pa 1976).* 2008;33(18):2012-2016. doi: 10.1097/BRS.0b013e31817bb0bd.
289. Kim HJ, Tetreault LA, Massicotte EM, et al. Differential diagnosis for cervical spondylotic myelopathy: literature review. *Spine (Phila Pa 1976).* 2013;38(22 Suppl 1):S78-88. doi: 10.1097/BRS.0b013e3182a7eb06.
290. Behrbalk E, Salame K, Regev GJ, Keynan O, Boszczyk B, Lidar Z. Delayed diagnosis of cervical spondylotic myelopathy by primary care physicians. *Neurosurg Focus.* 2013;35(1):E1. doi: 10.3171/2013.3.FOCUS1374.
291. Cook C, Brown C, Isaacs R, Roman M, Davis S, Richardson W. Clustered clinical findings for diagnosis of cervical spine myelopathy. *J Man Manip Ther.* 2010;18(4):175-180. doi: 10.1179/106698110X12804993427045.
292. Cook C, Braga-Baiak A, Pietrobon R, Shah A, Neto AC, de Barros N. Observer agreement of spine stenosis on magnetic resonance imaging analysis of patients with cervical spine myelopathy. *J Manipulative Physiol Ther.* 2008;31(4):271-276. doi: 10.1016/j.jmpt.2008.03.006.
293. Mehdorn HM, Fritsch MJ, Stiller RU. Treatment options and results in cervical myelopathy. *Acta Neurochir Suppl.* 2005;93:177-182.
294. Rhee JM, Heflin JA, Hamasaki T, Freedman B. Prevalence of physical signs in cervical myelopathy: a prospective, controlled study. *Spine (Phila Pa 1976).* 2009;34(9):890-895. doi: 10.1097/BRS.0b013e31819c944b.
295. Sterkova I, Kofler M. Cutaneous silent periods in the assessment of mild cervical spondylotic myelopathy. *Spine (Phila Pa 1976).* 2009;34(1):34-42. doi: 10.1097/BRS.0b013e31818f8be3.
296. Heffez DS, Ross RE, Shade-Zeldow Y, et al. Clinical evidence for cervical myelopathy due to Chiari malformation and spinal stenosis in a non-randomized group of patients with the diagnosis of fibromyalgia. *Eur Spine J.* 2004;13(6):516-523. Epub 2004 Apr 9.
297. American College of Radiology. ACR-ASNR-SCBT-MR Practice parameter for the performance of magnetic resonance imaging (MRI) of the adult spine. [www.acr.org/-/media/ACR/Documents/PGTS/guidelines/MRI\\_Adult\\_Spine.pdf](http://www.acr.org/-/media/ACR/Documents/PGTS/guidelines/MRI_Adult_Spine.pdf). Accessed April 24, 2016.
298. Rodriguez RM, Anglin D, Langdorff MI, et al. NEXUS chest: validation of a decision instrument for selective chest imaging in blunt trauma. *JAMA Surg.* 2013;148(10):940-946. doi: 10.1001/jamasurg.2013.2757.
299. Raja AS, Lanning J, Gower A, et al. Prevalence of chest injury with the presence of NEXUS chest criteria: data to inform shared decision-making about imaging use. *Ann Emerg Med.* 2015;68(2):222-226. doi: 10.1016/j.annemergmed.2015.09.024. Epub 2015 Nov 19.
300. Khoriati AA, Rajakulasingam R, Shah R. Sternal fractures and their management. *J Emerg Trauma Shock.* 2013;6(2):113-116. doi: 10.4103/0974-2700.110763.
301. Horikawa A, Miyakoshi N, Kodama H, Shimada Y. Insufficiency fracture of the sternum simulating myocardial infarction: case report and review of the literature. *Tohoku J Exp Med.* 2007;211(1):89-93.
302. Perez MR, Rodriguez RM, Baumann BM, et al. Sternal fracture in the age of pan-scan. *Injury.* 2015;46(7):1324-1327. doi: 10.1016/j.injury.2015.03.015. Epub 2015 Mar 14.
303. Ziegler DW, Agarwal NN. The morbidity and mortality of rib fractures. *J Trauma.* 1994;37(6):975-979.
304. Ringl H, Lazar M, Töpker M, et al. The ribs unfolded - a CT visualization algorithm for fast detection of rib fractures: effect on sensitivity and specificity in trauma patients. *Eur Radiol.* 2015;25(7):1865-1874. doi: 10.1007/s00330-015-3598-2. Epub 2015 Feb 14.
305. Traub M, Stevenson M, McEvoy S, et al. The use of chest computed tomography versus chest X-ray in patients with major blunt trauma. *Injury.* 2007;38(1):43-47. Epub 2006 Oct 11.
306. Wu WM, Yang Y, Gao ZL, Zhao TC, He WW. Which is better to multiple rib fractures, surgical treatment or conservative treatment? *Int J Clin Exp Med.* 2015;8(5):7930-7936. eCollection 2015.
307. Muham M, Harter J, Weiss C, Winkler H. Severe trauma of the chest wall: surgical rib stabilisation versus non-operative treatment. *Eur J Trauma Emerg Surg.* 2013;39(3):257-265. doi: 10.1007/s00068-013-0262-x. Epub 2013 Feb 16.
308. Glennie RA, Ailon T, Yang K, et al. Incidence, impact, and risk factors of adverse events in thoracic and lumbar spine fractures: an ambispective cohort analysis of 390 patients. *Spine J.* 2015;15(4):629-637. doi: 10.1016/j.spinee.2014.11.016. Epub 2014 Nov 28.
309. Ghobrial GM, Maulucci CM, Maltenfort M, et al. Operative and nonoperative adverse events in the management of traumatic fractures of the thoracolumbar spine: a systematic review. *Neurosurg Focus.* 2014;37(1):E8. doi: 10.3171/2014.4.FOCUS1467.
310. Charles YP, Steib JP. Management of thoracolumbar spine fractures with neurologic disorder. *Orthop Traumatol Surg Res.* 2015;101(1 Suppl):S31-40. doi: 10.1016/j.ostr.2014.06.024. Epub 2015 Jan 7.
311. Government of Western Australia. Diagnostic Imaging Pathways-Thoraco-Lumbar Spine Trauma. [www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/bone-and-joint-trauma/thoraco-lumbar-spine-trauma](http://www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/bone-and-joint-trauma/thoraco-lumbar-spine-trauma). Accessed April 27, 2016.
312. Burns JE, Yao J, Muñoz H, Summers RM. Automated detection, localization, and classification of traumatic vertebral body fractures in the thoracic and lumbar spine at CT. *Radiology.* 2016;278(1):64-73. doi: 10.1148/radiol.2015142346. Epub 2015 Jul 14.
313. Khurana B, Sheehan SE, Sodickson A, Bono CM, Harris MB. Traumatic thoracolumbar spine injuries: what the spine surgeon wants to know. *Radiographics.* 2013;33(7):2031-2046. doi: 10.1148/rg.337135018.
314. Vaccaro AR, Lehman RA Jr, Hurlbert RJ, et al. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. *Spine (Phila Pa 1976).* 2005;30(20):2325-2333.
315. Pizones J, Zúñiga L, Sánchez-Mariscal F, Alvarez P, Gómez-Rice A, Izquierdo E. MRI study of post-traumatic incompetence of posterior ligamentous complex: importance of the supraspinous ligament. Prospective study of 74 traumatic fractures. *Eur Spine J.* 2012;21(11):2222-2231. doi: 10.1007/s00586-012-2403-z. Epub 2012 Jun 22.
316. Wood KB, Li W, Lebl DR, Ploumis A. Management of thoracolumbar spine fractures. *Spine J.* 2014;14(1):145-164. doi: 10.1016/j.spinee.2012.10.041.
317. Nevitt MC, Ettinger B, Black DM, et al. The association of radiographically detected vertebral fractures with back pain and function: a prospective study. *Ann Intern Med.* 1998;128(10):793-800.

318. Old JL, Calvert M. Vertebral compression fractures in the elderly. *Am Fam Physician*. 2004;69(1):111-116.
319. Caffaro MF, Avanzi O. Can the interpedicular distance reliably assess the severity of thoracolumbar burst fractures? *Spine (Phila Pa 1976)*. 2012;37(4):E231-236. doi: 10.1097/BRS.0b013e318237b0cf.
320. Neumann P, Wang Y, Kärrholm J, Malchau H, Nordwall A. Determination of inter-spinous process distance in the lumbar spine. Evaluation of reference population to facilitate detection of severe trauma. *Eur Spine J*. 1999;8(4):272-278.
321. Omidi-Kashani F. Posterior vertebral injury; is this a burst fracture or a flexion-distraction injury? *Arch Bone Jt Surg*. 2014;2(2):114-116. Epub 2014 Jun 15.
322. Fink HA, Milavetz DL, Palermo L, et al. What proportion of incident radiographic vertebral deformities is clinically diagnosed and vice versa? *J Bone Miner Res*. 2005;20(7):1216-1222. Epub 2005 Mar 21.
323. Cooper C, O'Neill T, Silman A. The epidemiology of vertebral fractures. European Vertebral Osteoporosis Study Group. *Bone*. 1993;14 Suppl 1:S89-97.
324. Kendler DL, Bauer DC, Davison KS, et al. Vertebral fractures: clinical importance and management. *Am J Med*. 2016;129(2):221 e1-10. doi: 10.1016/j.amjmed.2015.09.020. Epub 2015 Oct 30.
325. Siminoski K, Jiang G, Adachi JD, et al. Accuracy of height loss during prospective monitoring for detection of incident vertebral fractures. *Osteoporos Int*. 2005;16(4):403-410. Epub 2004 Aug 11.
326. Siminoski K, Warshawski RS, Jen H, Lee K. The accuracy of historical height loss for the detection of vertebral fractures in postmenopausal women. *Osteoporos Int*. 2006;17(2):290-296. Epub 2005 Sep 6.
327. Loke YK, Cavallazzi R, Singh S. Risk of fractures with inhaled corticosteroids in COPD: systematic review and meta-analysis of randomised controlled trials and observational studies. *Thorax*. 2011;66(8):699-708. doi: 10.1136/thx.2011.160028. Epub 2011 May 20.
328. Gonnelli S, Caffarelli C, Maggi S, et al. Effect of inhaled glucocorticoids and beta(2) agonists on vertebral fracture risk in COPD patients: the EOLO study. *Calcif Tissue Int*. 2010;87(2):137-143. doi: 10.1007/s00223-010-9392-x. Epub 2010 Jun 22.
329. American College of Radiology. ACR Appropriateness Criteria: Management of Vertebral Compression Fractures. acsearch.acr.org/docs/70545/Narrative/. Accessed April 27, 2016.
330. Abdel-Wanis ME, Solymar MT, Hasan NM. Sensitivity, specificity and accuracy of magnetic resonance imaging for differentiating vertebral compression fractures caused by malignancy, osteoporosis, and infections. *J Orthop Surg (Hong Kong)*. 2011;19(2):145-150.
331. Kim JH, Kim JI, Jang BH, Seo JG, Kim JH. The comparison of bone scan and MRI in osteoporotic compression fractures. *Asian Spine J*. 2010;4(2):89-95. doi: 10.4184/asj.2010.4.2.89. Epub 2010 Nov 24.
332. Chan JH, Peh WC, Tsui EY, et al. Acute vertebral body compression fractures: discrimination between benign and malignant causes using apparent diffusion coefficients. *Br J Radiol*. 2002;75(891):207-214.
333. Wang MY, Thambuswamy M. Ossification of the posterior longitudinal ligament in non-Asians: demographic, clinical, and radiographic findings in 43 patients. *Neurosurg Focus*. 2011;30(3):E4. doi: 10.3171/2010.12.FOCUS10277
334. Hou X, Sun C, Liu X, et al. Clinical features of thoracic spinal stenosis-associated myelopathy: a retrospective analysis of 427 cases. *Clin Spine Surg*. 2016;29(2):86-89. doi: 10.1097/BSD.0000000000000081.
335. Chen ZQ, Sun CG, Spine Surgery Group of Chinese Orthopedic A. Clinical guideline for treatment of symptomatic thoracic spinal stenosis. *Orthop Surg*. 2015;7(3):208-212. doi: 10.1111/os.12190.
336. Stillerman CB, Chen TC, Couldwell WT, Zhang W, Weiss MH. Experience in the surgical management of 82 symptomatic herniated thoracic discs and review of the literature. *J Neurosurg*. 1998;88(4):623-633.
337. Ahn DK, Lee S, Moon SH, Boo KH, Chang BK, Lee JI. Ossification of the ligamentum flavum. *Asian Spine J*. 2014;8(1):89-96. doi: 10.4184/asj.2014.8.1.89. Epub 2014 Feb 6.
338. Chou R, Qaseem A, Snow V, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Ann Intern Med*. 2007;147(7):478-491.
339. Delitto A, George SZ, Van Dillen LR, et al. Low back pain. *J Orthop Sports Phys Ther*. 2012;42(4):A1-57. doi: 10.2519/jospt.2012.0301. Epub 2012 Mar 30.
340. Postacchini F, Giannicola G, Cinotti G. Recovery of motor deficits after microdiscectomy for lumbar disc herniation. *J Bone Joint Surg Br*. 2002;84(7):1040-1045.
341. Balaji VR, Chin KF, Tucker S, Wilson LF, Casey AT. Recovery of severe motor deficit secondary to herniated lumbar disc prolapse: is surgical intervention important? A systematic review. *Eur Spine J*. 2014;23(9):1968-1977. doi: 10.1007/s00586-014-3371-2. Epub 2014 May 29.
342. Government of Western Australia. Diagnostic Imaging Pathways-Low Back Pain. www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/musculoskeletal/low-back-pain. Accessed April 27, 2016.
343. Fardon DF, Williams AL, Dohring EJ, Murtagh FR, Gabriel Rothman SL, Sze GK. Lumbar disc nomenclature: version 2.0: recommendations of the combined task forces of the North American Spine Society, the American Society of Spine Radiology, and the American Society of Neuroradiology. *Spine (Phila Pa 1976)*. 2014;39(24):E1448-1465. doi: 10.1097/BRS.0b013e3182a8866d.
344. Lao LF, Zhong GB, Li QY, Liu ZD. Kinetic magnetic resonance imaging analysis of spinal degeneration: a systematic review. *Orthop Surg*. 2014;6(4):294-299. doi: 10.1111/os.12137.
345. Kong MH, Hymanson HJ, Song KY, et al. Kinetic magnetic resonance imaging analysis of abnormal segmental motion of the functional spine unit. *J Neurosurg Spine*. 2009;10(4):357-365. doi: 10.3171/2008.12. SPINE08321.
346. Jensen TS, Albert HB, Soerensen JS, Manniche C, Leboeuf-Yde C. Natural course of disc morphology in patients with sciatica: an MRI study using a standardized qualitative classification system. *Spine (Phila Pa 1976)*. 2006;31(14):1605-1612; discussion 1613.
347. Komori H, Okawa A, Haro H, Shinomiya Ki K. Factors predicting the prognosis of lumbar radiculopathy due to disc herniation. *J Orthop Sci*. 2002;7(1):56-61.
348. Carlisle E, Luna M, Tsou PM, Wang JC. Percent spinal canal compromise on MRI utilized for predicting the need for surgical treatment in single-level lumbar intervertebral disc herniation. *Spine J*. 2005;5(6):608-614.
349. Cheung JP, Samartzis D, Shigematsu H, Cheung KM. Defining clinically relevant values for developmental spinal stenosis: a large-scale magnetic resonance imaging study. *Spine (Phila Pa 1976)*. 2014;39(13):1067-1076. doi: 10.1097/BRS.0000000000000335.
350. de Schepper EI, Koes BW, Veldhuizen EF, Oei EH, Bierma-Zeinstra SM, Luijsterburg PA. Prevalence of spinal pathology in patients presenting for lumbar MRI as referred from general practice. *Fam Pract*. 2016;33(1):51-56. doi: 10.1093/fampra/cmv097. Epub 2015 Dec 8.
351. Kim YK, Lee JW, Kim HJ, Yeom JS, Kang HS. Diagnostic advancement of axial loaded lumbar spine MRI in patients with clinically suspected central spinal canal stenosis. *Spine (Phila Pa 1976)*. 2013;38(21):E1342-1347. doi: 10.1097/BRS.0b013e3182a0dfa5.
352. Fukusaki M, Kobayashi I, Hara T, Sumikawa K. Symptoms of spinal stenosis do not improve after epidural steroid injection. *Clin J Pain*. 1998;14(2):148-151.
353. Geisser ME, Haig AJ, Tong HC, et al. Spinal canal size and clinical symptoms among persons diagnosed with lumbar spinal stenosis. *Clin J Pain*. 2007;23(9):780-785.
354. Koc Z, Ozcakir S, Sivrioglu K, Gurbet A, Kucukoglu S. Effectiveness of physical therapy and epidural steroid injections in lumbar spinal stenosis. *Spine (Phila Pa 1976)*. 2009;34(10):985-989. doi: 10.1097/BRS.0b013e31819c0a6b.
355. Hamanishi C, Matukura N, Fujita M, Tomihara M, Tanaka S. Cross-sectional area of the stenotic lumbar dural tube measured from the transverse views of magnetic resonance imaging. *J Spinal Disord*. 1994;7(5):388-393.
356. Melancia JL, Francisco AF, Antunes JL. Spinal stenosis. *Handb Clin Neurol*. 2014;119:541-549. doi: 10.1016/B978-0-7020-4086-3.00035-7.
357. Minamide A, Yoshida M, Maio K. The natural clinical course of lumbar spinal stenosis: a longitudinal cohort study over a minimum of 10 years.

- J Orthop Sci.* 2013;18(5):693-698. doi: 10.1007/s00776-013-0435-9. Epub 2013 Jul 10.
358. Delitto A, Piva SR, Moore CG, et al. Surgery versus nonsurgical treatment of lumbar spinal stenosis: a randomized trial. *Ann Intern Med.* 2015;162(7):465-473. doi: 10.7326/M14-1420.
359. Khan I, Hargunani R, Saifuddin A. The lumbar high-intensity zone: 20 years on. *Clin Radiol.* 2014;69(6):551-558. doi: 10.1016/j.crad.2013.12.012. Epub 2014 Mar 7.
360. Aprill C, Bogduk N. High-intensity zone: a diagnostic sign of painful lumbar disc on magnetic resonance imaging. *Br J Radiol.* 1992;65(773):361-369.
361. Liu C, Cai HX, Zhang JF, Ma JJ, Lu YJ, Fan SW. Quantitative estimation of the high-intensity zone in the lumbar spine: comparison between the symptomatic and asymptomatic population. *Spine J.* 2014;14(3):391-396. doi: 10.1016/j.spinee.2013.06.078. Epub 2013 Oct 17.
362. Manchikanti L, Benyamin RM, Singh V, et al. An update of the systematic appraisal of the accuracy and utility of lumbar discography in chronic low back pain. *Pain Physician.* 2013;16(2 Suppl):SE55-95.
363. Jensen TS, Karppinen J, Sorensen JS, Niinimäki J, Leboeuf-Yde C. Vertebral endplate signal changes (Modic change): a systematic literature review of prevalence and association with non-specific low back pain. *Eur Spine J.* 2008;17(11):1407-1422. doi: 10.1007/s00586-008-0770-2. Epub 2008 Sep 12.
364. Mok FP, Samartzis D, Karppinen J, Fong DY, Luk KD, Cheung KM. Modic changes of the lumbar spine: prevalence, risk factors, and association with disc degeneration and low back pain in a large-scale population-based cohort. *Spine J.* 2016;16(1):32-41. doi: 10.1016/j.spinee.2015.09.060. Epub 2015 Oct 8.
365. Rahme R, Moussa R. The modic vertebral endplate and marrow changes: pathologic significance and relation to low back pain and segmental instability of the lumbar spine. *AJR Am J Neuroradiol.* 2008;29(5):838-842. doi: 10.3174/ajnr.A0925. Epub 2008 Feb 13.
366. Zhang YH, Zhao CQ, Jiang LS, Chen XD, Dai LY. Modic changes: a systematic review of the literature. *Eur Spine J.* 2008;17(10):1289-1299. doi: 10.1007/s00586-008-0758-y. Epub 2008 Aug 27.
367. Baily F, Maigne JY, Genevay S, et al. Inflammatory pain pattern and pain with lumbar extension associated with Modic 1 changes on MRI: a prospective case-control study of 120 patients. *Eur Spine J.* 2014;23(3):493-497. doi: 10.1007/s00586-013-3036-6. Epub 2013 Sep 25.
368. Järvinen J, Karppinen J, Niinimäki J, et al. Association between changes in lumbar Modic changes and low back symptoms over a two-year period. *BMC Musculoskelet Disord.* 2015;16:98. doi: 10.1186/s12891-015-0540-3.
369. Kalichman L, Li L, Kim DH, et al. Facet joint osteoarthritis and low back pain in the community-based population. *Spine (Phila Pa 1976).* 2008;33(23):2560-2565. doi: 10.1097/BRS.0b013e318184ef95.
370. Lakadamyali H, Tarhan NC, Ergun T, Cakir B, Agildere AM. STIR sequence for depiction of degenerative changes in posterior stabilizing elements in patients with lower back pain. *AJR Am J Roentgenol.* 2008;191(4):973-979. doi: 10.2214/AJR.07.2829.
371. Mainka T, Lemburg SP, Heyer CM, Altenschmidt J, Nicolas V, Maier C. Association between clinical signs assessed by manual segmental examination and findings of the lumbar facet joints on magnetic resonance scans in subjects with and without current low back pain: a prospective, single-blind study. *Pain.* 2013;154(9):1886-1895. doi: 10.1016/j.pain.2013.06.018. Epub 2013 Jun 15.
372. Even JL, Chen AF, Lee JY. Imaging characteristics of "dynamic" versus "static" spondylolisthesis: analysis using magnetic resonance imaging and flexion/extension films. *Spine J.* 2014;14(9):1965-1969. doi: 10.1016/j.spinee.2013.11.057. Epub 2013 Dec 18.
373. Williams CM, Henschke N, Maher CG, et al. Red flags to screen for vertebral fracture in patients presenting with low-back pain. *Cochrane Database Syst Rev.* 2013;(1):CD008643. doi: 10.1002/14651858.CD008643.pub2.
374. Mayer JM, Haldeman S, Tricco AC, Dagenais S. Management of chronic low back pain in active individuals. *Curr Sports Med Rep.* 2010;9(1):60-66. doi: 10.1249/JSR.0b013e3181caa9b6.
375. Micheli LJ, Curtis C. Stress fractures in the spine and sacrum. *Clin Sports Med.* 2006;25(1):75-88, ix.
376. Government of Western Australia. Diagnostic Imaging Pathways-Stress Fracture (Suspected). [www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/bone-and-joint-trauma/suspected-stress-fracture](http://www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/musculoskeletal-trauma/bone-and-joint-trauma/suspected-stress-fracture). Accessed April 24, 2016.
377. Leone A, Cianfoni A, Cerase A, Magarelli N, Bonomo L. Lumbar spondylolysis: a review. *Skeletal Radiol.* 2011;40(6):683-700. doi: 10.1007/s00256-010-0942-0. Epub 2010 May 4.
378. Chau AM, Xu LL, Pelzer NR, Gragnaniello C. Timing of surgical intervention in cauda equina syndrome: a systematic critical review. *World Neurosurg.* 2014;81(3-4):640-650. doi: 10.1016/j.wneu.2013.11.007. Epub 2013 Nov 13.
379. Matz PG, Meagher RJ, Lamer T, et al. Guideline summary review: an evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spondylolisthesis. *Spine J.* 2016;16(3):439-448. doi: 10.1016/j.spinee.2015.11.055. Epub 2015 Dec 8.
380. Alferi A, Gazzera R, Prell J, Rollinghoff M. The current management of lumbar spondylolisthesis. *J Neurosurg Sci.* 2013;57(2):103-113.
381. Watters WC 3rd, Bono CM, Gilbert TJ, et al. An evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spondylolisthesis. *Spine J.* 2009;9(7):609-614. doi: 10.1016/j.spinee.2009.03.016. Epub 2009 May 17.
382. McCarthy MJ, Aylott CE, Grevitt MP, Hegarty J. Cauda equina syndrome: factors affecting long-term functional and sphincteric outcome. *Spine (Phila Pa 1976).* 2007;32(2):207-216.
383. Srikantharajah N, Boissaud-Cooke MA, Clark S, Wilby MJ. Does early surgical decompression in cauda equina syndrome improve bladder outcome? *Spine (Phila Pa 1976).* 2015;40(8):580-583. doi: 10.1097/BRS.0000000000000813.
384. Todd NV. Cauda equina syndrome: is the current management of patients presenting to district general hospitals fit for purpose? A personal view based on a review of the literature and a medico-legal experience. *Bone Joint J.* 2015;97-B(10):1390-1394. doi: 10.1302/0301-620X.97B10.35922.
385. Gooding BW, Higgins MA, Calthorpe DA. Does rectal examination have any value in the clinical diagnosis of cauda equina syndrome? *Br J Neurosurg.* 2013;27(2):156-159. doi: 10.3109/02688697.2012.732715. Epub 2012 Nov 1.
386. Domen PM, Hofman PA, van Santrbrink H, Weber WE. Predictive value of clinical characteristics in patients with suspected cauda equina syndrome. *Eur J Neurol.* 2009;16(3):416-419. doi: 10.1111/j.1468-1331.2008.02510.x.
387. McKinley W, Santos K, Meade M, Brooke K. Incidence and outcomes of spinal cord injury clinical syndromes. *J Spinal Cord Med.* 2007;30(3):215-224.
388. Bydon M, Fredrickson V, De la Garza-Ramos R, et al. Sacral fractures. *Neurosurg Focus.* 2014;37(1):E12. doi: 10.3171/2014.5.FOCUS1474.
389. Volpin G, Milgrom C, Goldsher D, Stein H. Stress fractures of the sacrum following strenuous activity. *Clin Orthop Relat Res.* 1989;(243):184-188.
390. Lyders EM, Whitlow CT, Baker MD, Morris PP. Imaging and treatment of sacral insufficiency fractures. *AJR Am J Neuroradiol.* 2010;31(2):201-210. doi: 10.3174/ajnr.A1666. Epub 2009 Sep 17.
391. Zelle BA, Gruen GS, Hunt T, Speth SR. Sacral fractures with neurological injury: is early decompression beneficial? *Int Orthop.* 2004;28(4):244-251. Epub 2004 Apr 22.
392. Gotis-Graham I, McGuigan L, Diamond T, et al. Sacral insufficiency fractures in the elderly. *J Bone Joint Surg Br.* 1994;76(6):882-886.
393. Oh D, Huh SJ. Insufficiency fracture after radiation therapy. *Radiat Oncol J.* 2014;32(4):213-220. doi: 10.3857/roj.2014.32.4.213. Epub 2014 Dec 30.
394. Fujii M, Abe K, Hayashi K, et al. Honda sign and variants in patients suspected of having a sacral insufficiency fracture. *Clin Nucl Med.* 2005;30(3):165-169.
395. Cabarrus MC, Ambekar A, Lu Y, Link TM. MRI and CT of insufficiency fractures of the pelvis and the proximal femur. *AJR Am J Roentgenol.* 2008;191(4):995-1001. doi: 10.2214/AJR.07.3714.

396. Postacchini F, Massobrio M. Idiopathic coccygodynia. Analysis of fifty-one operative cases and a radiographic study of the normal coccyx. *J Bone Joint Surg Am.* 1983;65(8):1116-1124.
397. Fogel GR, Cunningham PY 3rd, Esses SI. Coccygodynia: evaluation and management. *J Am Acad Orthop Surg.* 2004;12(1):49-54.
398. Maigne JY, Pigeau I, Roger B. Magnetic resonance imaging findings in the painful adult coccyx. *Eur Spine J.* 2012;21(10):2097-2104. doi: 10.1007/s00586-012-2202-6. Epub 2012 Feb 22.
399. Kok HK, Mumtaz A, O'Brien C, Kane D, Torreggiani WC, Delaney H. Imaging the patient with sacroiliac pain. *Can Assoc Radiol J.* 2016;67(1):41-51. doi: 10.1016/j.carj.2015.08.001. Epub 2015 Nov 26.
400. Brooks F, Shanbhag V, Ghandour A, et al. Should a lumbar MRI for back pain routinely include the sacro-iliac joint? *Acta Orthop Belg.* 2014;80(4):464-467.
401. Eno JJ, Boone CR, Bellino MJ, Bishop JA. The prevalence of sacroiliac joint degeneration in asymptomatic adults. *J Bone Joint Surg Am.* 2015;97(11):932-936. doi: 10.2106/JBJS.N.01101.
402. Hong SH, Choi JY, Lee JW, Kim NR, Choi JA, Kang HS. MR imaging assessment of the spine: infection or an imitation? *Radiographics.* 2009;29(2):599-612. doi: 10.1148/rg.292085137.
403. Hardin JG. Rheumatic Pain. In: Walker HK, Hall WD, Hurst JW, eds. *Clinical Methods: The History, Physical, and Laboratory Examinations.* 3rd ed. Boston, MA: Butterworths; 1990.
404. Mok CC, Tam LS, Leung MH, et al. Referral strategy for early recognition of axial spondyloarthritis: consensus recommendations from the Hong Kong Society of Rheumatology. *Int J Rheum Dis.* 2013;16(5):500-508. doi: 10.1111/1756-185X.12161.
405. Wendling D, Prati C, Demattei C, Loeuille D, Richette P, Dougados M. Anterior chest wall pain in recent inflammatory back pain suggestive of spondyloarthritis. data from the DESIR cohort. *J Rheumatol.* 2013;40(7):1148-1152. doi: 10.3899/jrheum.121460. Epub 2013 May 15.
406. Braun J, Kiltz U, Sarholz M, Heldmann F, Regel A, Baraliakos X. Monitoring ankylosing spondylitis: clinically useful markers and prediction of clinical outcomes. *Expert Rev Clin Immunol.* 2015;11(8):935-946. doi: 10.1586/1744666X.2015.1052795. Epub 2015 Jun 5.
407. Elyan M, Khan MA. Diagnosing ankylosing spondylitis. *J Rheumatol Suppl.* 2006;78:12-23.
408. Shaikh SA. Ankylosing spondylitis: recent breakthroughs in diagnosis and treatment. *J Can Chiropr Assoc.* 2007;51(4):249-260.
409. Feldtkeller E, Rudwaleit M, Zeidler H. Easy probability estimation of the diagnosis of early axial spondyloarthritis by summing up scores. *Rheumatology (Oxford).* 2013;52(9):1648-1650. doi: 10.1093/rheumatology/keq176. Epub 2013 May 16.
410. Jans L, Jarecko JL, Kaeley GS. Novel imaging modalities in spondyloarthritis. *Best Pract Res Clin Rheumatol.* 2014;28(5):729-745. doi: 10.1016/j.berh.2014.10.006. Epub 2014 Nov 4.
411. Weber U, Pfirrmann CW, Kissling RO, Mackenzie CR, Khan MA. Early spondyloarthritis in an HLA-B27-positive monozygotic twin pair: A highly concordant onset, sites of involvement, and disease course. *J Rheumatol.* 2008;35(7):1464-1466.
412. Hermann KG, Baraliakos X, van der Heijde DM, et al. Descriptions of spinal MRI lesions and definition of a positive MRI of the spine in axial spondyloarthritis: a consensual approach by the ASAS/OMERACT MRI study group. *Ann Rheum Dis.* 2012;71(8):1278-1288. doi: 10.1136/ard.2011.150680. Epub 2012 May 14.
413. Baraliakos X, Davis J, Tsuji W, Braun J. Magnetic resonance imaging examinations of the spine in patients with ankylosing spondylitis before and after therapy with the tumor necrosis factor alpha receptor fusion protein etanercept. *Arthritis Rheum.* 2005;52(4):1216-1223.
414. Bochkova AG, Levshakova AV, Bunchuk NV, Braun J. Spinal inflammation lesions as detected by magnetic resonance imaging in patients with early ankylosing spondylitis are more often observed in posterior structures of the spine. *Rheumatology (Oxford).* 2010;49(4):749-755. doi: 10.1093/rheumatology/kep419. Epub 2010 Jan 18.
415. Canella C, Schau B, Ribeiro E, Sbaffi B, Marchiori E. MRI in seronegative spondyloarthritis: imaging features and differential diagnosis in the spine and sacroiliac joints. *AJR Am J Roentgenol.* 2013;200(1):149-157. doi: 10.2214/AJR.12.8858.
416. Dornia C, Fleck M, Hartung W, Niessen C, Stroszczynski C, Hoffstetter P. Magnetic resonance imaging of the sacroiliac joints in patients with suspected spondyloarthritis—comparison of turbo spin-echo and gradient-echo sequences for the detection of structural alterations. *Rofo.* 2015;36(2):109-114. doi: 10.1055/s-0034-1385264. Epub 2014 Nov 12.
417. Geusens P, De Winter L, Quaden D, et al. The prevalence of vertebral fractures in spondyloarthritis: relation to disease characteristics, bone mineral density, syndesmophytes and history of back pain and trauma. *Arthritis Res Ther.* 2015;17:294. doi: 10.1186/s13075-015-0809-9.
418. Klingberg E, Geijer M, Göthlin J, et al. Vertebral fractures in ankylosing spondylitis are associated with lower bone mineral density in both central and peripheral skeleton. *J Rheumatol.* 2012;39(10):1987-1995. doi: 10.3899/jrheum.120316. Epub 2012 Aug 15.
419. Arnett FC. Seronegative spondylarthropathies. *Bull Rheum Dis.* 1987;37(1):1-12.
420. Klecker RJ, Weissman BN. Imaging features of psoriatic arthritis and Reiter's syndrome. *Semin Musculoskeletal Radiol.* 2003;7(2):115-126.
421. Spadaro A, Lubrano E. Psoriatic arthritis: imaging techniques. *Reumatismo.* 2012;64(2):99-106. doi: 10.4081/reumatismo.2012.99.
422. Punzi L, Frigato M, Frallorando P, Ramonda R. Inflammatory osteoarthritis of the hand. *Best Pract Res Clin Rheumatol.* 2010;24(3):301-312. doi: 10.1016/j berh.2009.12.007.
423. Ahvonen P, Sievers K, Aho K. Arthritis associated with Yersinia enterocolitica infection. *Acta Rheumatol Scand.* 1969;15(3):232-253.
424. Vallet M, Ralston SH. Biology and treatment of Paget's disease of bone. *J Cell Biochem.* 2016;117(2):289-299. doi: 10.1002/jcb.25291. Epub 2015 Sep 3.
425. Zlatkin MB, Lander PH, Hadjipavlou AG, Levine JS. Paget disease of the spine: CT with clinical correlation. *Radiology.* 1986;160(1):155-159.
426. Dohan A, Parlier-Cuau C, Kaci R, Touraine S, Bousson V, Larédo JD. Vertebral involvement in Page's disease: morphological classification of CT and MR appearances. *Joint Bone Spine.* 2015;82(1):18-24. doi: 10.1016/j.jbspin.2014.07.009. Epub 2014 Sep 22.
427. Singer FR. Bone quality in Paget's disease of bone. *Curr Osteoporos Rep.* 2016;14(2):39-42. doi: 10.1007/s11914-016-0303-6.
428. Thompson EM, Strong MJ, Warren G, Wolter RL, Selden NR. Clinical significance of imaging and histological characteristics of filum terminale in tethered cord syndrome. *J Neurosurg Pediatr.* 2014;13(3):255-259. doi: 10.3171/2013.12.PEDS13370. Epub 2014 Jan 3.
429. Worcester EM, Coe FL. Nephrolithiasis. *Prim Care.* 2008;35(2):369-391, vii. doi: 10.1016/j.pop.2008.01.005.
430. Goldfarb DS, Coe FL. Prevention of recurrent nephrolithiasis. *Am Fam Physician.* 1999;60(8):2269-2276.
431. Smith-Bindman R, Aubin C, Bailitz J, et al. Ultrasonography versus computed tomography for suspected nephrolithiasis. *N Engl J Med.* 2014;371(12):1100-1110. doi: 10.1056/NEJMoa1404446.
432. Yadav D, Lowenfels AB. The epidemiology of pancreatitis and pancreatic cancer. *Gastroenterology.* 2013;144(6):1252-1261. doi: 10.1053/j.gastro.2013.01.068.
433. Khatri P, Wu BJ. Back to the basics. *Conn Med.* 2012;76(10):607-608.
434. Hirota M, Shimosegawa T, Kanno A, et al. Distinct clinical features of two patients that progressed from the early phase of chronic pancreatitis to the advanced phase. *Tohoku J Exp Med.* 2012;228(3):173-180.
435. American College of Radiology. ACR Appropriateness Criteria: Acute Pancreatitis. [www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/AcutePancreatitis.pdf](http://www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/AcutePancreatitis.pdf). Accessed April 24, 2016.
436. Hansen NJ. Computed tomographic angiography of the abdominal aorta. *Radiol Clin North Am.* 2016;54(1):35-54. doi: 10.1016/j.rcl.2015.08.005. Epub 2015 Oct 16.
437. Mellnick VM, Heiken JP. The acute abdominal aorta. *Radiol Clin North Am.* 2015;53(6):1209-1224. doi: 10.1016/j.rcl.2015.06.007.
438. American College of Radiology. ACR Appropriateness Criteria: Acute Chest Pain-Suspected Aortic Dissection. <https://acsearch.acr.org/docs/69402/Narrative/>. Accessed April 24, 2016.

439. Fleming C, Whitlock EP, Beil TL, Lederle FA. Screening for abdominal aortic aneurysm: a best-evidence systematic review for the U.S. Preventive Services Task Force. *Ann Intern Med.* 2005;142(3):203-211.
440. Hong H, Yang Y, Liu B, Cai W. Imaging of abdominal aortic aneurysm: the present and the future. *Curr Vasc Pharmacol.* 2010;8(6):808-819.
441. Svensjö S, Björck M, Wanhainen A. Update on screening for abdominal aortic aneurysm: a topical review. *Eur J Vasc Endovasc Surg.* 2014;48(6):659-667. doi: 10.1016/j.ejvs.2014.08.029. Epub 2014 Nov 7.
442. Rubano E, Mehta N, Caputo W, Paladino L, Sinert R. Systematic review: emergency department bedside ultrasonography for diagnosing suspected abdominal aortic aneurysm. *Acad Emerg Med.* 2013;20(2):128-138. doi: 10.1111/acem.12080.
443. Moore CL, Holliday RS, Hwang JQ, Osborne MR. Screening for abdominal aortic aneurysm in asymptomatic at-risk patients using emergency ultrasound. *Am J Emerg Med.* 2008;26(8):883-887. doi: 10.1016/j.ajem.2007.11.030.
444. Desjardins B, Dill KE, Flamm SD, et al. ACR Appropriateness Criteria® pulsatile abdominal mass, suspected abdominal aortic aneurysm. *Int J Cardiovasc Imaging.* 2013;29(1):177-183. doi: 10.1007/s10554-012-0044-2. Epub 2012 May 27.
445. Roshanali F, Mandegar MH, Yousefnia MA, Mohammadi A, Baharvand B. Abdominal aorta screening during transthoracic echocardiography. *Echocardiography.* 2007;24(7):685-688.
446. Starr JE, Halpern V. Abdominal aortic aneurysms in women. *J Vasc Surg.* 2013;57(4 Suppl):3S-10S. doi: 10.1016/j.jvs.2012.08.125.
447. Bergqvist D, Björck M, Wanhainen A. Abdominal aortic aneurysm and new WHO criteria for screening. *Int Angiol.* 2013;32(1):37-41.
448. Björck M, Wanhainen A. Pathophysiology of AAA: heredity vs environment. *Prog Cardiovasc Dis.* 2013;56(1):2-6. doi: 10.1016/j.pcad.2013.05.003. Epub 2013 Jun 21.
449. Takayama T, Yamanouchi D. Aneurysmal disease: the abdominal aorta. *Surg Clin North Am.* 2013;93(4):877-891, viii. doi: 10.1016/j.suc.2013.05.005. Epub 2013 Jul 3.
450. Cronin P, Upchurch GR Jr, Patel HJ, Deeb GM, Kelly AM, Williams DM. Asymmetric expansion of aortic aneurysms on computed tomography imaging. *J Vasc Surg.* 2013;57(2):390-398.e3. doi: 10.1016/j.jvs.2012.08.044. Epub 2012 Nov 20.
451. Van Wyngaarden JJ, Ross MD, Hando BR. Abdominal aortic aneurysm in a patient with low back pain. *J Orthop Sports Phys Ther.* 2014;44(7):500-507. doi: 10.2519/jospt.2014.4935. Epub 2014 Apr 25.
452. Forsdahl SH, Solberg S, Singh K, Jacobsen BK. Abdominal aortic aneurysms, or a relatively large diameter of non-aneurysmal aortas, increase total and cardiovascular mortality: the Tromsø study. *Int J Epidemiol.* 2010;39(1):225-232. doi: 10.1093/ije/dyp320. Epub 2009 Nov 5.
453. Golledge J, Kuivaniemi H. Genetics of abdominal aortic aneurysm. *Curr Opin Cardiol.* 2013;28(3):290-296. doi: 10.1097/HCO.0b013e32835f0d55.
454. Spinner RJ, Hebert-Blouin MN, Maus TP, Atkinson JL, Desy NM, Amrami KK. Evidence that atypical juxtafacet cysts are joint derived. *J Neurosurg Spine.* 2010;12(1):96-102. doi: 10.3171/2009.7.SPINE09257.
455. Jeong GK, Bendo JA. Lumbar intervertebral disc cyst as a cause of radiculopathy. *Spine J.* 2003;3(3):242-246.
456. Choudhri HF, Perling LH. Diagnosis and management of juxtafacet cysts. *Neurosurg Focus.* 2006;20(3):E1.
457. Khan AM, Girardi F. Spinal lumbar synovial cysts. Diagnosis and management challenge. *Eur Spine J.* 2006;15(8):1176-1182. Epub 2006 Jan 27.
458. Khalatbari K, Ansari H. MRI of degenerative cysts of the lumbar spine. *Clin Radiol.* 2008;63(3):322-328. doi: 10.1016/j.crad.2007.05.020. Epub 2007 Sep 7.
459. Yurt A, Sefer M, Aydin M, et al. Surgical management of Juxtafacet cysts in the lumbar spine. *Int J Surg.* 2016;29:9-11. doi: 10.1016/j.ijsu.2016.03.003. Epub 2016 Mar 10.
460. Boviatsis EJ, Stavrinou LC, Kouyialis AT, et al. Spinal synovial cysts: pathogenesis, diagnosis and surgical treatment in a series of seven cases and literature review. *Eur Spine J.* 2008;17(6):831-837. doi: 10.1007/s00586-007-0563-z. Epub 2008 Apr 4.