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Potentially Overlooked Spinal Conditions: A Baker's Dozen from A Neurosurgeon's Perspective

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During 20 years of operative neurosurgery (including spinal reconstruction) and 15 years of medicolegal consulting experience in brain and spine matters, the author has observed that there are 13 (i.e., a baker's dozen) spine-related conditions (Table 1) that have not infrequently been overlooked by specialists in clinical and medicolegal contexts. As such, awareness of these conditions (or lack thereof) particularly affects aspects of spinal diagnosis, aetiology, and prognostication. For brevity and clarity, the clinicoradiological hallmarks of each condition and its spinal implications, along with key literature references, are presented (listed in alphabetical order in Table 1), in conjunction with their classic imaging (Figures 1-3). The author believes that keeping these conditions at the back of one's mind when medically working up or medicolegally assessing individuals presenting with spinal symptoms and signs can aid in diagnostic and prognostic accuracy, and in an opinion of causation.

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Table 1: A baker's dozen. Clinicoradiological features and spinal implications*.

Condition (Ref.)	Clinicoradiological Features	Associations and Spinal Implications
Adjacent segment disease (ASD) [Fig. AA to EE & ref. 7,9,15]	Accelerated degenerative change in spinal segments adjacent to fused segments. Risk factors: smoking, multiple fused levels.	Pre-existing adjacent segment degeneration may accelerate after surgery. Often requires revision surgery after several years.
Baastrup's disease [Fig. FF, GG & ref. 4]	"Kissing spine syndrome." Bulky adjacent spinous processes in close proximity, soft tissue edema, inflammation, considered degenerative +/- hyperlordosis presence.	Spinal pain, axial not radicular, worse in extension. MRI, CT, SPECT helpful. Surgery may be required if conservative measures fail.
Bertolotti syndrome [Fig. A, B & ref. 13]	Transitional segment at lumbosacral junction with partial or total fusion, enlarged transverse process to sacrum/ilium (prevalence 4-8%).	Low back pain and/or sciatica. Adjacent segment degeneration may accelerate. Bone scan with CT-SPECT helpful, as it can be missed on MRI.

Cerebrospinal fluid (CSF) leak syndrome [Fig. II, KK, LL & ref. 14]	Weak spinal meninges, trauma, meningeal diverticulae, dural rents, extradural CSF. Connective tissue disorders, surgical or traumatic durotomy associations.	Hallmark: Orthostatic headache. Pachymeningeal enhancement, spinal dural cysts. CT-myelography, catheter angiography +/- surgery. Association: Spontaneous intracranial hypotension.
Congenitally narrow spinal canal [Fig. O to Q & ref. 12,17]	Normal diameters categorized by spinal location, gender, and height. Quantification of sac versus canal lengths.	Congenital anomaly associated with accelerated spondylosis. Short pedicles exacerbate degenerative stenosis.
Diffuse idiopathic skeletal hyperostosis (DISH) [Fig. R to V & ref. 18]	Affects 4+ vertebrae, common in the thoracic spine. Associated with male gender (>50), diabetes, hyperlipidemia, gout, rheumatoid arthritis. Differential: ankylosing spondylitis.	Spinal pain, stiffness. Dysphagia and myelopathy may occur. Exacerbates local degenerative stenosis. Bulky anterolateral osteophytes, OPLL, fractures may be seen on CT-SPECT.
Isthmic spondylolisthesis [Fig. W to Z & ref. 5]	Absence or fracture of pars interarticularis. Prevalence: 3-12% in asymptomatic adults, known as pars defect or spondylolysis. Risk: vigorous sports.	Gradual onset low back pain, worsened with extension. Symptomatic in ages 30-50 due to disc degeneration. Surgical intervention often in early 60s.
Klippel-Feil syndrome [Fig. D, E & ref. 10]	Congenital cervical fusion, short neck, low posterior hairline, restricted neck motion, +/- long tract signs. Prevalence: 0.71%.	Accelerates adjacent segment degeneration. Increased risk of degenerative cervical myelopathy.
Kyphoscoliosis-Alordosis [Fig. C, F to L & ref. 1,2,11]	Includes cervical alordosis/kyphosis, thoracic kyphosis, lumbar alordosis, scoliosis. Increased biomechanical forces at inflections. Can be congenital or acquired (trauma, surgery, osteopenia, degeneration).	Spinal pain in affected regions. Scoliosis increases lumbar disc herniation risk. Radiculopathy and myelopathy with bulbar signs may be present.
Obesity [Fig. M, N & ref. 16]	Higher incidents and chronicity of low back pain. BMI 30-35 increases chronic pain risk (x2), BMI >35 with kyphosis and upper torso pain in women (x4).	Associated with osteoarthritis, epidural lipomatosis, sacroiliitis. Longer surgery, increased blood loss, and complication rate in multilevel ACDF surgeries.
Paget's disease of the spine [Fig. HH, JJ & ref. 3]	A metabolic bone disease with osteoblastic and osteoclastic activity. Risk factors: Caucasian race, older age.	Expansion of vertebral bodies, heterogeneous appearance on imaging. Spinal pain, exacerbated spinal stenosis, neurological symptoms. MRI, PET-CT helpful.
Scheuermann's disease [Fig. G, H & ref. 8]	Thoracic kyphosis with feature-prevalence of 18-40% in radiological studies. Triad: Schmorl's nodes, wedged vertebrae, sclerotic endplates.	Structural thoracic kyphosis. May be associated with lumbar hyperlordosis. Thoracic pain +/- neck and lumbar pain.
Smoking accelerated spondylosis [ref. 6]	Impairs spinal tissue vascular supply via atherosclerosis, thrombosis. Causes local hypoxia, inflammation, proteolysis, and cell loss.	Leads to earlier surgery, higher re-operation risk, wound complications, failed fusion/pseudoarthrosis, and chronic spinal pain.

*Abbreviations: ACDF = anterior cervical discectomy fusion. BMI = body mass index. CT = computerized tomography. Figure. = figure (s). MRI = magnetic resonance imaging. OPLL = ossification of the posterior longitudinal ligament. PET = positron emission tomography. Ref. = reference(s) in bibliography. SPECT = single-photon emission computed tomography.

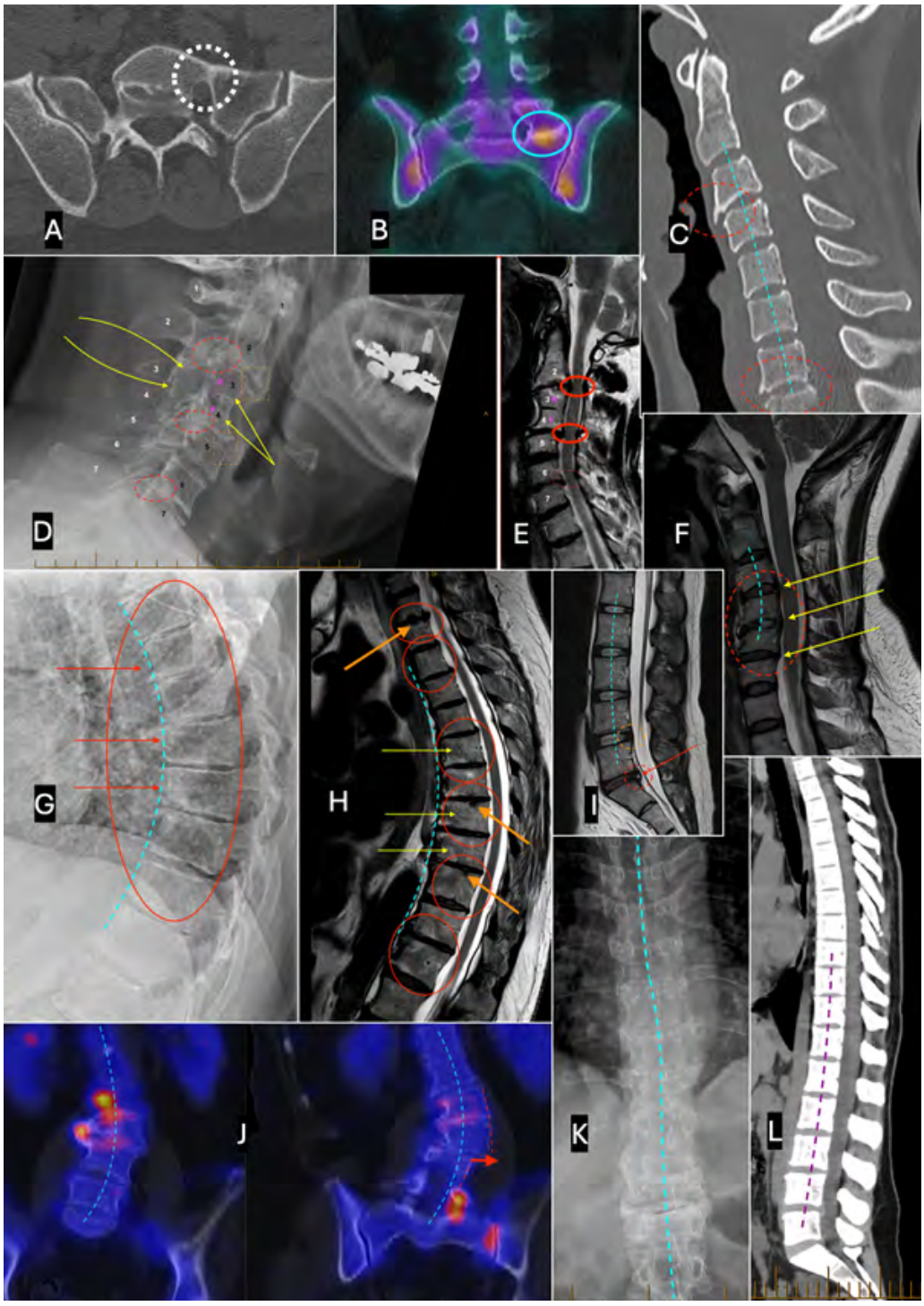

Figure 1. A: Sacroalar bridge on axial CT bone window in Bertolotti syndrome. **B.** CT-SPECT shows increased tracer activity in the Bertolotti pseudoarthrosis. **C.** Early cervical kyphosis on sagittal CT bone window. **D.** Lateral X-ray shows upper cervical congenital fusion, symptomatic in Klippel-Feil syndrome. **E.** Sagittal T2 cervical spine MRI shows adjacent segment degeneration and stenosis immediately above and below the Klippel-Feil autologously fused segment. **F.** Swan-neck kyphotic deformity on sagittal T2 MRI. **G.** Lateral X-ray shows thoracic spine vertebral wedging, exaggerated kyphosis and sclerotic endplates in Scheuermann's disease. **H.** T2 sagittal MRI shows multiple Schmorl's nodes, vertebral body wedging and secondary kyphosis, in addition to thoracic spondylosis, in this patient with symptomatic Scheuermann's disease. **I.** Sagittal T2 MRI shows reduced lumbar lordosis. **J.** Moderately advanced lumbar scoliosis as seen on CT-SPECT with increased tracer activity at mid-lumbar scoliotic inflection point. Notable lateral translation of local vertebrae. **K.** AP thoracolumbar X-ray shows mild scoliosis. **L.** Sagittal thoracolumbar CT shows a relatively straight (alordotic) lumbar spine and subnormal thoracic kyphosis, in the same patient as shown in **K** (i.e., spinal curvature anomalies in both sagittal and coronal planes).

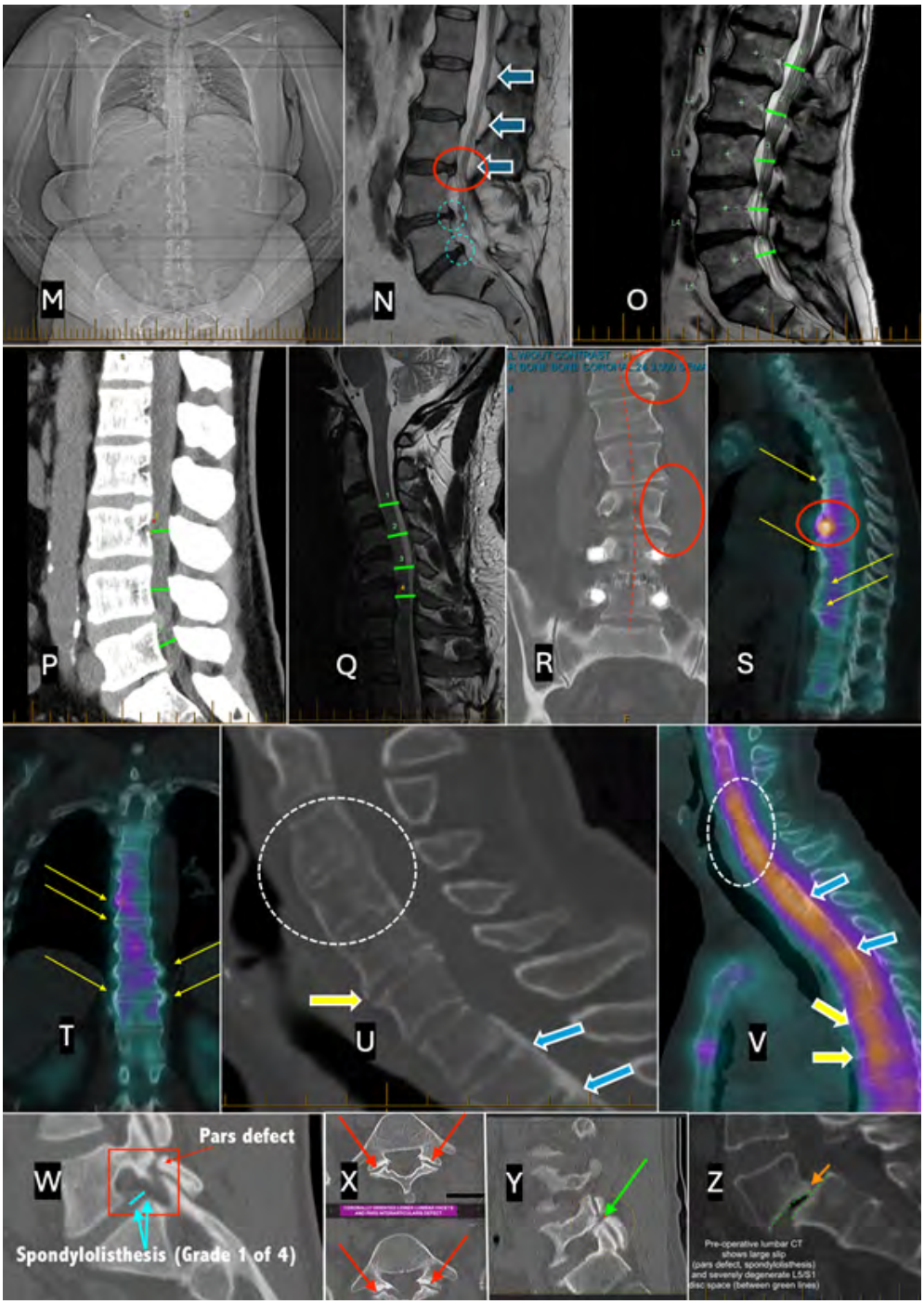

Figure 2. M: AP scout X-ray from a CT study shows obese body habitus and relatively small spinopelvic dimensions compared with body habitus. **N.** Sagittal T2 MRI shows epidural lipomatosis posterior to the cauda equina and secondary exaggeration of spinal stenosis at L3/4. **O.** Sagittal T2 MRI with measurements of the anterior-posterior lumbar spinal canal dimension at various levels, quantitatively confirming a congenitally narrow canal. **P.** Sagittal CT soft tissue window shows a congenitally narrow lumbar spinal canal. **Q**. Sagittal T2 MRI with measurements of the antero-posterior cervical spinal canal dimension at various levels confirms it is congenitally narrow. **R.** Coronal CT bone window shows lateral disc-osteophytic projections in the imaged thoracolumbar spine, which were part of this patient's diffuse idiopathic skeletal hyperostosis (DISH). **S & T.** Same DISH patient whose CT is shown in **R**, but this time imaged via bone scan with CT-SPECT. Note contiguous anterior and lateral bulky osteophytes, with increased tracer activity in one of the mid-thoracic osteophytes. **U & V.** Sagittal CT (**U**) and sagittal CT-SPECT (**V**) from a patient who has ankylosing spondylitis (a differential diagnosis of DISH) with a radiological appearance of syndesmophytosis (not bulky osteophytosis) as well as ossification of the posterior longitudinal ligament (which is also seen in DISH). **W.** Sagittal CT bone window shows Meyerding grade I spondylolisthesis at L5/S1 from a L5 pars defect (bilateral). **X.** Axial CT bone window adjacent slices show coronally oriented lower lumbar facet joints around the region of this patient's pars defect (**Y**), anatomical findings that are synergistic in isthmic spondylolisthesis. **Z.** Meyerding grade II isthmic spondylolisthesis with vacuum phenomenon in the severely desiccated L5/S1 disc.

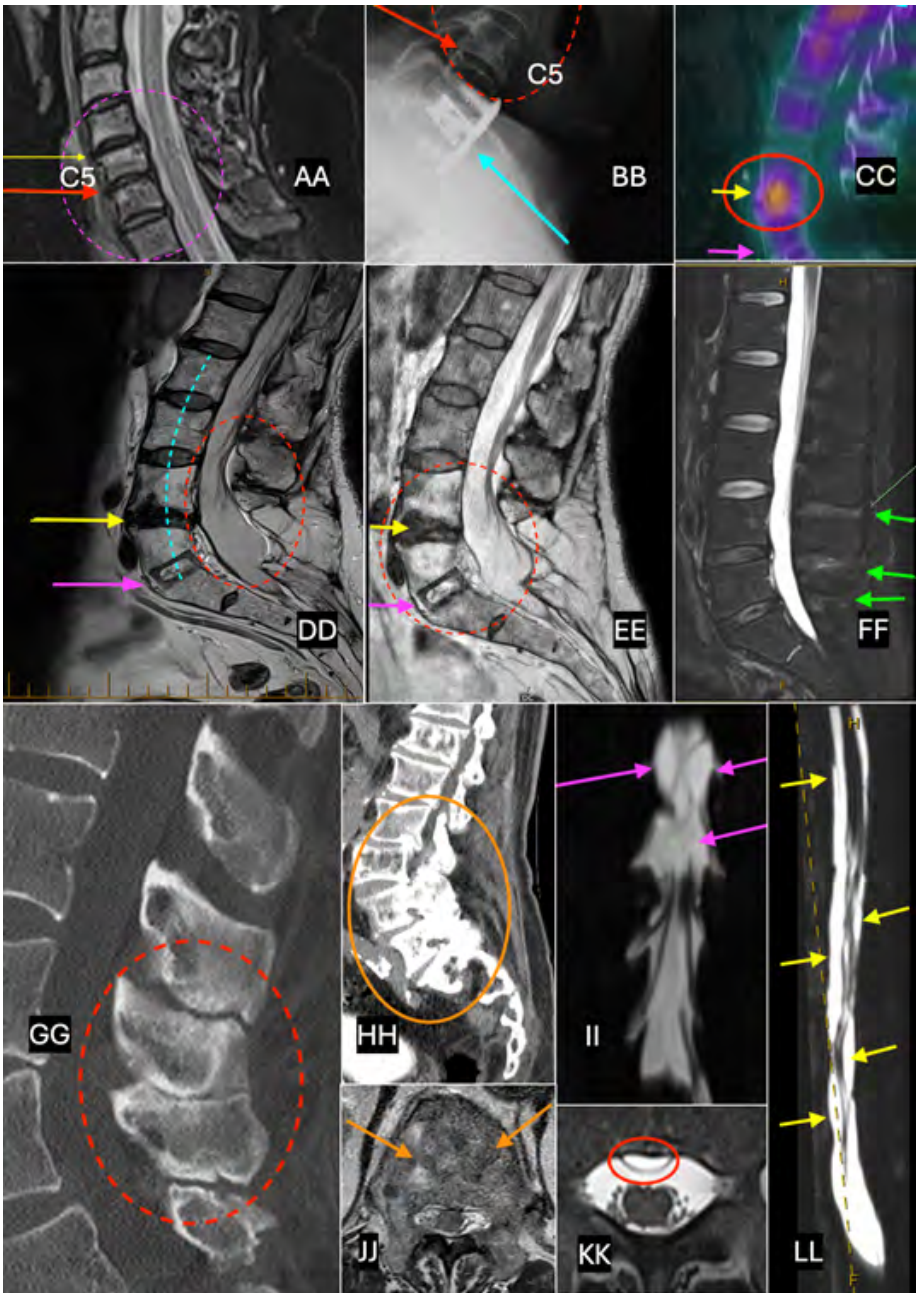

Figure 3. AA: Sagittal MRI shows C5/6 disc to be desiccated in a patient who had a symptomatic C6/7 lateral disc herniation (not evident in this slice). **BB.** Following C6/7 anterior cervical discectomy and fusion (ACDF) in the same patient shown in **AA**, the C5/6 disc, which had evidence of adjacent segment degeneration before the ACDF, is now likely to degenerate faster as part of adjacent segment disease. **CC-EE.** Images from another patient via lumbar CT-SPECT (**CC**) and serial lumbar MRI (**DD & EE**) show structural and physiological evidence of progressive adjacent segment disease at L4/5, immediately above an interbody cage used for L5/S1 surgical arthrodesis. **FF.** Sagittal MRI short tau inversion recovery (STIR) sequence shows hyperintensity in the lower lumbar interspinous regions of a patient with Baastrup's disease, consistent with inflammation and local calcinosis. **GG.** Sagittal CT bone window shows "kissing" spinous processes, bulky and pseudo-arthrosed, in a patient with symptomatic Baastrup's disease. **HH.** Sagittal CT soft tissue window shows heterogenous signal in the bony structures of a patient with Paget's disease of the spine. **II.** Lumbar coronal MRI slice shows multifocal cystic extradural cerebrospinal fluid (CSF) collections in a patient with symptomatic CSF leakage/spontaneous intracranial hypotension (SIH). **JJ.** Axial lumbar MRI slice shows expanded and heterogenous vertebral body and other bony elements in a patient with Paget's disease of the spine. **KK.** Axial lumbar MRI shows an extradural CSF collection in a patient with symptomatic SIH. **LL.** Sagittal MRI shows multifocal CSF collections in the same patient as shown in **II**.

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