

The Vacuum Phenomenon in Spinal Imaging

Aleksandr Drozdov, MD, and Shobhana Chaudhari, MD

Volume 59 - Issue 8 - August 2019

Affiliations:

Department of Medicine, NYC Health + Hospitals/Metropolitan, New York, New York

Citation:

Drozdov A, Chaudhari S. The vacuum phenomenon in spinal imaging. *Consultant*. 2019;59(8):254-255.

An 81-year-old woman with a history of type 2 diabetes mellitus and degenerative joint disease was referred to our emergency department (ED) with nausea, intermittent moderate abdominal pain, and bilious vomiting. The patient had a history of chronic lower back pain.

Physical examination revealed mild to moderate right costovertebral angle tenderness. Urinalysis results were suggestive of a urinary tract infection; the blood urea nitrogen level was elevated to 45 mg/dL and the creatinine level was elevated to 1.6 mg/dL. The patient was treated successfully with intravenous antibiotics and was discharged, with follow-up scheduled in the clinic.

During the initial workup in the ED, computed tomography (CT) of the abdomen and pelvis revealed mild right hydroureteronephrosis with no visible stone or obstructing lesion, as well as vacuum phenomena (VP) in the intervertebral disks on the levels L1 through S1 (**Figure**). We have noticed that many internists are not familiar with the interpretation of this finding and its clinical correlation.

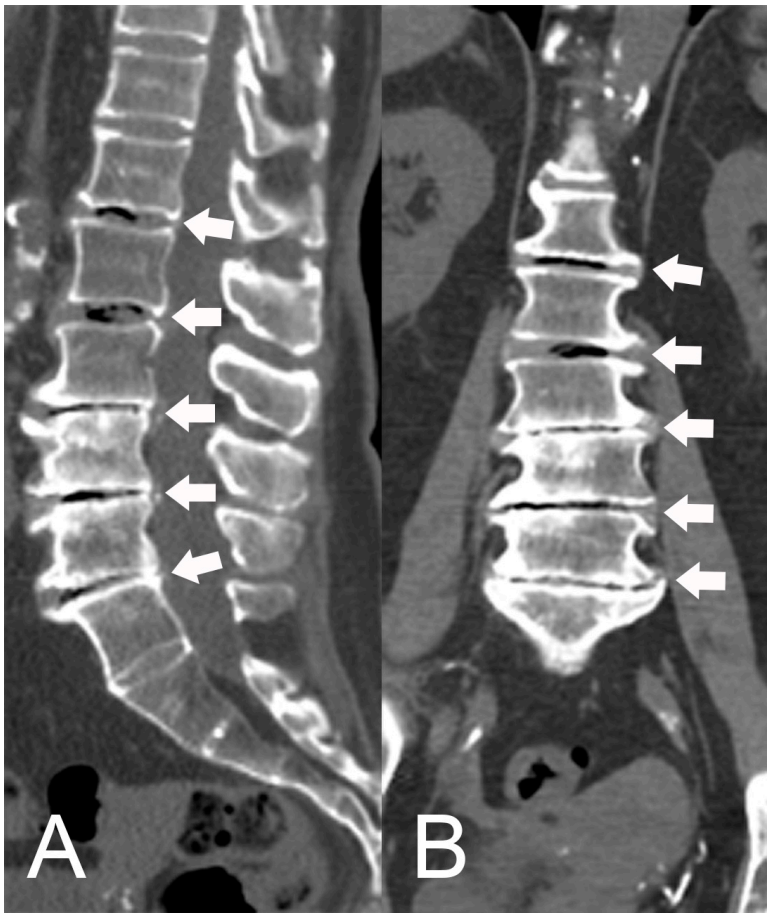


Figure. Abdominal CT reconstructions in sagittal (A) and coronal (B) planes of an 81-year-old woman. The arrows indicate the area of translucency in all intervertebral disks from L1 to S1 vertebrae, consistent with the vacuum phenomenon.

Discussion. In the spine, VP reflects a radiologic symptom of the gaseous collection in an intervertebral disk or in the spinal vertebra itself. This unique finding was first described more than 80 years ago.¹ The prevalence of that sign based on plain spinal images varies from 1% to 3% in the general population to 20% among elderly individuals.²

While “vacuum disk” findings are mostly associated with degenerative disk changes or benign vertebral collapse, the sign might be important due to the association with various underlying medical conditions including spinal infection with gas production.³ Given this association, recognition of this sign in radiologist protocols, understanding the pathogenesis of the finding, and reasonable comparison with clinical data could lead to better outcomes in patient care by encouraging further investigation.

The name of the radiologic sign *vacuum phenomenon* reflects the pathogenesis of the finding. With general activity, the pressure in the disk between vertebrae shifts: It increases when vertebrae move closer to each other and decreases when vertebrae move away from each other. This drop in pressure in a closed space of the intervertebral disk leads to a suction effect that causes the redistribution of the least-soluble gas dissolved in surrounded tissue inside the disk.

This gas is predominantly the nitrogen (90%-92%). One widely known example with a similar effect, when dissolved gas returns to gasiform state, is the rotation of the propeller of a powerboat; it causes the pressure cavitation effect that leads to the formation of air bubbles.⁴

The VP as described in radiologist protocols can be classified into 3 forms: VP in an intervertebral disk, VP in a vertebra, and VP in the spinal canal.

VP in an intervertebral disk is the classic form that is most frequently associated with degenerative disease of the spine.² The second most common event associated with intervertebral disk VP is vertebral collapse.⁵ In one study, the association of VP with benign (osteoporotic) vertebral fractures seemed so clear that the authors even suggested that the presence of this sign might be used as a rationale to avoid a biopsy or additional radiologic studies among patients with suspected malignancies.⁶ However, the specificity of the sign was found to be insufficient. Other authors have shown that VP might be described in association with any cause of collapse, including osteoporosis, multiple myeloma, metastasis, acute trauma, and vertebral osteomyelitis.⁷

One curious observation was made by Kasai and colleagues, who showed that decreased atmospheric barometric pressure may induce back pain among patients with VP.⁸ The researchers hypothesized that as atmospheric pressure declines, the pressure in the disk becomes comparatively high; the effects on surrounding receptors induces pain.⁸

VP in a vertebra is a much more concerning sign compared with VP in an intervertebral disk. Gas inside a vertebra is a common sign of nonunion of vertebral fracture and pseudarthrosis.⁹

VP in the spinal canal is a result of pneumorrhachis. The common source of the air is the continuous degeneration of a spinal disk that leads to gas spread into the spinal canal. The finding is usually incidental and asymptomatic but might also be associated with discogenic pain. Pneumorrhachis is more common among elderly women, likely because of the higher prevalence of severe degenerative spinal changes in this population.¹⁰

The take-home message. After a comprehensive workup, we determined that our patient's VP was associated with degenerative spinal disease.

VP is a relatively common sign about which primary care providers should be aware. When VP is present, attention should focus on the exact location of the gas in the spine, and the possible associated condition should be ascertained in order to provide appropriate clinical intervention if indicated.

References

1. Magnusson M. Über die Bedingungen des Hervortretens der Wirklichen Gelenkspalte auf dem Röntgenbilde. *Acta Radiologica*. 1937;18(5):733-74

2. Resnick D, Niwayama G, Guerra J Jr, Vint V, Usselman J. Spinal vacuum phenomena: anatomical study and review. *Radiology*. 1981;139(2):341-348.
3. Bielecki DK, Sartoris D, Resnick D, Van Lom K, Fierer P, Haghighi P. Intraosseous and intradiscal gas in association with spinal infection: report of three cases. *AJR Am J Roentgenol*. 1986;147(1):83-86.
4. Yanagawa Y, Ohsaka H, Jitsuiki K, et al. Vacuum phenomenon. *Emerg Radiol*. 2016;23(4):377-382.
5. Lafforgue PF, Chagnaud CJ, Daver LM, et al. Intervertebral disk vacuum phenomenon secondary to vertebral collapse: prevalence and significance. *Radiology*. 1994;193(3):853-858.
6. Bhalla S, Reinus WR. The linear intravertebral vacuum: a sign of benign vertebral collapse. *AJR Am J Roentgenol*. 1998;170(6):1563-1569.
7. Feng S-W, Chang M-C, Wu H-T, Yu J-K, Wang S-T, Liu C-L. Are intravertebral vacuum phenomena benign lesions? *Eur Spine J*. 2011;20(8):1341-1348.
8. Kasai Y, Takegami K, Uchida A. Change of barometric pressure influences low back pain in patients with vacuum phenomenon within lumbar intervertebral disc. *J Spinal Disord Tech*. 2002;15(4):290-293.
9. Stallenberg B, Madani A, Burny F, Gevenois PA. The vacuum phenomenon: a CT sign of nonunited fracture. *AJR Am J Roentgenol*. 2001;176(5):1161-1164.
10. Omori K, Ishikawa K, Obinata M, et al. Significance of the vacuum phenomenon in patients with trauma evaluated by whole-body computed tomography. *Am J Emerg Med*. 2015;33(2):282-285.