CASE REPORT

Vacuum phenomenon in the temporomandibular joint: a clinical, computed tomography and magnetic resonance case report

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A 28-year-old woman presented with a history of clicking and mandibular clenching. She was studied clinically and with axial and coronal CT. The patient was going through a tense emotional period and reported tightening of her teeth (clenching); she was under psychological and neurological treatment for depression including pharmacological therapy. She presented slight pain only at maximum mouth opening at the right temporomandibular joint (TMJ) and in the lateral pole on palpation; there was no coincidence between initial and maximal interocclusal contacts because of premature dental contacts. She showed occlusal group function in the right side and canine guidance in the left side with a right contact of balance, local muscular pain in the right deep masseter muscle and in the superior and middle portion of the right trapezium on palpation. On CT, a spherical area of 3 mm diameter with an average density of −647 HU (SD ± 4.7) was found in the upper and posterior area of the lower space of the right TMJ, together with a thicker lower synovial tissue. This observation was confirmed by MRI. Like other joints, the TMJ could present vacuum phenomenon images inside synovial tissue in the presence of degenerative disease. It is important for radiologists to recognize this rare entity.

Keywords: temporomandibular joint; temporomandibular disorders; vacuum phenomenon; gas; computed tomography

Introduction

Gas in the temporomandibular joint (TMJ) has rarely been reported. Over the last 20 years, only two publications have analysed these findings (Medline 1987–2006).[1–2]

Gas collection in a closed joint space is referred to in the literature as a vacuum phenomenon or cavitation. It was first described in 1942 as a radiographic finding in degenerated intervertebral discs.[3] Later, it was also observed in other human joints such as the metacarpophalangeal joint,[4] cervical and lumbar spine,[5–6] atlanto-odontoid joint,[7] hips,[8] subtalar and tibiotalar joints.[9]

According to the literature, this phenomenon is hypothetically caused by the negative pressure created within the articular cavity, due to the lack of fluid, which attracts gas from surrounding extracellular spaces.[10]

The aim of this report is to describe the clinical, CT and MRI findings of vacuum phenomenon in the TMJ.

Case report

A 28-year-old woman presented with complaints of mandibular noises/clicking which she said had been bothering her for 1.5–2 years. She had not received any previous treatment. Slight pain only manifested at maximum mouth-opening in the right temporomandibular joint (TMJ). She also experienced four or five matutinal headaches per week, which were relieved by the use of non-steroidal anti-inflammatory drugs. She reported waking up with general fatigue, occasionally accompanied by mandibular weariness.

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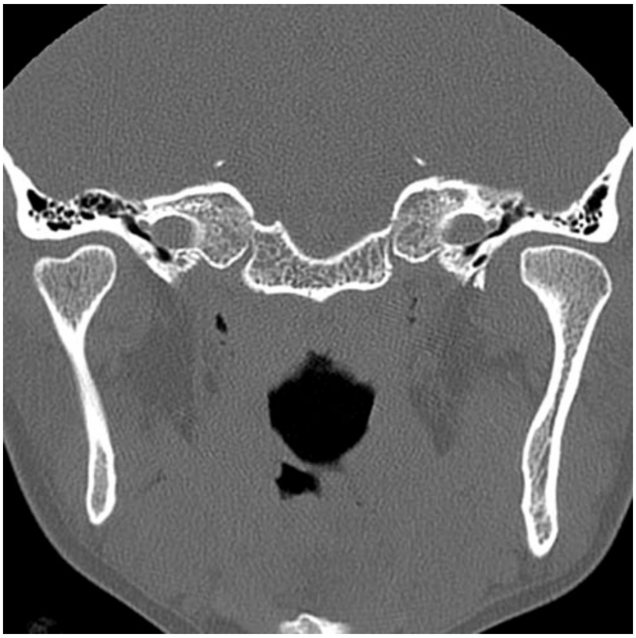


Figure 1 Coronal CT view at closed mouth. The right ramus is shorter than the left and there is a corticated depression on the apex of the right condyle, without cancellous bone modifications

Figure 2 Axial CT slices at standard algorithm, at open mouth, showing the vacuum phenomenon as a frank hypodense spherical area at the posterior surface of the right condylar apex

On physical examination, the woman presented pain when the lateral pole of the right TMJ was touched. She did not have any history of TMJ trauma or puncture. Intraorally, she had complete dentition, bilateral Angle Class I and normal deglutition.

There was no coincidence between her initial and maximal interocclusal contacts (MIC) due to a premature contact between the maxillary and mandibular left first molars). Her active and passive maximum apertures were 36 mm and 43 mm, respectively. She presented group function in the right side and canine guidance in the left side with a right balancing contact. Parafunctional wear facets type II and cervical lesions were observed bilaterally in the maxillary and mandibular canines and premolars.

As a result of palpation, she had local muscular pain in the right deep masseter, and in the superior and middle portion of the right trapezium. She had a bilateral and immediate click upon opening. The patient was going through a tense emotional period and reported tightening of her teeth (clenching); she was under psychological and neurological treatment for depression, including pharmacological therapy.

CT scan technique and findings

The patient was placed in the supine position and examined by axial and coronal scans (HiSpeed; General Electric, Milwaukee, WI). The axial exploration was performed at maximum mouth-opening and coronal slices were carried out at closed mouth with maximal interocclusal contacts.

The TMJ protocols included a 1 mm slice every 1.5 mm in the TMJ at closed mouth and maximum mouth opening (43 mm of interincisive aperture), FOV (field of view) 16.0 cm; algorithm: bone and processed to soft; filter A2; matrix: 512×512 pixels.

The patient was centered in the otic-bipupilar axis and facial midline, where it was observed that the right jaw ramus was slightly shorter in the symmetrical skull base.

The CT scan revealed flattening of both condyle heads and the temporal fossa (Figure 1). The right

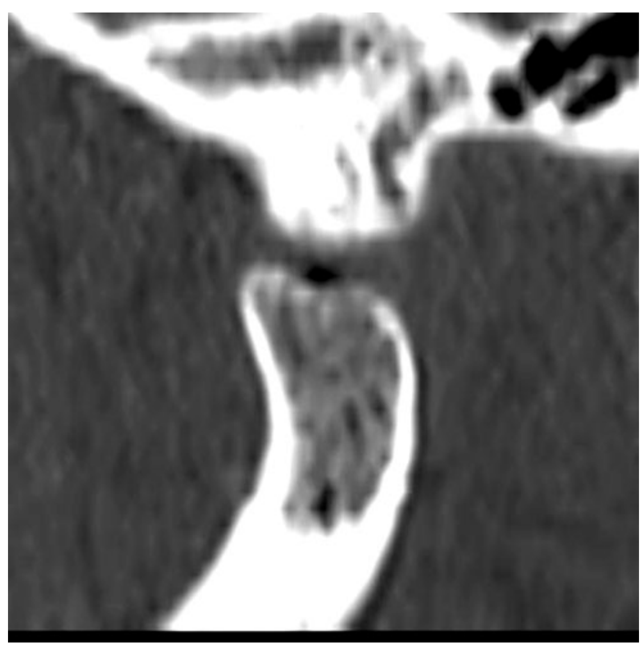


Figure 3 Sagittal reformatted image showing gas superior to the mandibular condyle

condylar apex showed bone concavity associated with the vacuum phenomenon. This depression was partially surrounded by cortical bone, without the presence of lytic areas or cortical irregularities. The cortex was partially thinner and the marrow density was increased at the lateral pole of the right condyle, apparently as a reparative measure.

In the right TMJ a small collection of gas was found, 3 mm in diameter and of low homogeneous density (-647 ± 4.7 HU), located at the upper and posterior area of the inferior joint space (Figures 2 and 3).

On mouth opening, the articular spaces observed in both medial poles were slightly stretched. On mouth closing, they appeared to be of irregular width due to morphological alterations of the condylar heads. The glenoid cavity appeared to be regularly contoured, without osteophytes. Condyle mobility was in the normal range.

MRI technique and findings:
Sagittal dynamic MRI was performed at closed- and open-mouth positions, at 10 mm, 20 mm and 30 mm of interincisive aperture by echo gradient, T_2 weighted and proton density weighted, both 3 mm thick slices (Signa Profile Open 0.2T; General Electric), using Special Filter AAR2.

The TMJ presented frank asymmetry in terms of shape and size between the glenoid cavity and the mandibular condyle, which also appeared to be flattened. The right condyle showed cortical irregularities in its apex (Figure 4).

At closed mouth, it was observed that the joint disc was flattened, with the condylar head placed at its posterior border, with immediate reduction in all of the dynamic working phases studied (Figure 4) .

The MRI image did not reveal evidence of fluid accumulation in the articular spaces. In the left TMJ, at closed mouth, a light compression of the posterior articular space was observed. The head of the mandibular condyle was placed on the posterior border of the articular disc with immediate reduction at 10 mm of interincisive aperture. No metaplastic focus of the retrodiscal ligament was observed.

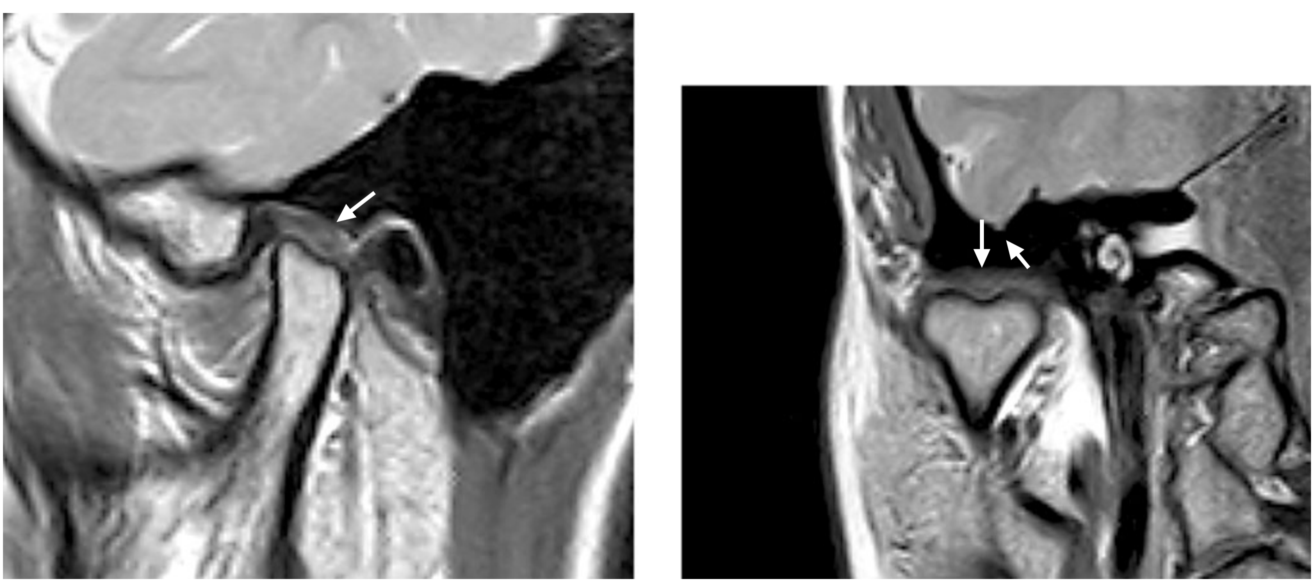
In both TMJs, translational movement dominated rotational movement at 10 mm and 20 mm on mouth opening (interincisive).

Discussion

The presence of air in the joints, or vacuum phenomenon, is not a new concept. It was observed as early as 1910 when Fuiks and Grayson[11] noted the presence of the intraarticular vacuum phenomenon while studying joints under traction. It has been reported that to achieve a separation in the hip joint, a traction force of at least 400 N must be applied, and vacuum phenomenon appeared at between 400 N and 600 N of traction, varying with joint position.[12]

This phenomenon has also been related to trauma or bone fractures, traction forces and degenerative disc disease, degenerative bone surfaces or cartilaginous injury in the joints.[13–18]

Balkissoon[14] and Coulier[19] proposed that the vacuum phenomenon may occur under physiological and pathological circumstances in peripheral joints and in the spine. For instance, in the spine it is located in the intervertebral discs and it is a useful indicator of intervertebral osteochondrosis, spondylosis deformans, Schmorl's nodes and limbus vertebrae. Additionally,



a b

Figure 4 MRI (a) sagittal and (b) coronal views, proton density weighted, of the vacuum phenomenon (arrows) located in the upper and posterior joint space over the bone depression at the closed mouth position vacuum phenomenon may occur within the vertebral bodies, usually related to osteonecrosis.

Traditionally, the gas phenomenon has either been associated with degenerative disease or, more usually, regarded as an adaptation process of the joint tissues, although it could also be explained by structural weakness, or biochemical or genetic disorders. The exact aetiopathogenesis remains uncertain today.

Salpietro et al[15] reported a histological finding of a spherical gas pneumocyst dissected out en bloc by microsurgery. It was located in the spine, between the fourth and fifth lumbar vertebrae and compressing the nerve roots. The wall of the pseudocyst showed the presence of a capsulated fibrous tissue identical to the ligament removed.

In the TMJ, cases of the vacuum phenomenon have also been reported. Hayashi et al[1] reported three cases studied by CT scan, between the ages of 19 years and 26 years, which covers the age our patient.

Additionally, our report agrees with Hayashi's findings that identified a small gas collection on the surface of the mandibular condyle, accompanied by an underlying bone depression.

Likewise, we agree with Hayashi et al[1] and Nakayama et al[2] in accepting morphological changes in condyle structures, after observing corticalization of the condyle depression.

As well as Hayashi et al[1] and Nakayama et al's[2] patients, ours did not report any history of injury, trauma or puncture to the TMJ. The phenomenon was clearly observed at mouth opening, the same as Hayashi and Nakayama reported. This is due to the difficulty of its observation at the closed mouth position because it appears as a flat and thin hypodensity band. This may be confused with the posterior band of the articular disc or with metaplasia of the posterior ligament.

When comparing the performance of CT and MRI images, the vacuum phenomenon was better visualized by CT scan.

In general, we agree that it is important to include open- and closed-mouth positions during CT and MRI examinations to observe the vacuum phenomenon, and in dynamic exploration to provide more possibilities of finding it. The vacuum phenomenon cannot be visualized if the examination does not incorporate a maximal open-mouth sequence.

For all four patients reported at this time, no history of injury or trauma in the oral and maxillofacial region was determined. So, as in other reports,[1–2] we believe that this finding may be the consequence of a degenerative process caused by chronic trauma. Theoretically, it is suggested that stress distracts the articular surfaces which, in addition to no fluid within the articular cavity, creates negative pressure due to the increasing joint space that attracts gas from the surrounding tissues.[10,20]

In conclusion, we might say that the vacuum phenomenon represents a useful MRI or CT finding of critical importance for the understanding, clinical diagnosis, prognosis, and therapeutic implications of the patient involved. For diagnostic radiologists, being aware of the existence of this rare entity may be useful to avoid unnecessary surgery.

References

1. Hayashi T, Ito J, Koyama J. Gas in the temporomandibular joint: computed tomography findings. *Oral Surg Oral Med Oral Pathol Oral Radio Endod* 1998; **86**: 751–754.
2. Nakayama E, Tabata O, Oobu K, Kanda S. Gas phenomenon in the superior space of the temporomandibular joint. Report of a case. *J Oral Maxillofac Surg* 2004; **62**: 107–111.
3. Knutsson F. The vacuum phenomenon in the intervertebral discs. *Acta Radiol* 1942; **23**: 173–179.
4. Roston JB, Haines RW. Cracking in the metacarpophalangeal joint. *J Anat* 1947; **81**: 165–173.
5. Shima Y, Rothman SL, Yasura K, Takahashi S. Degenerative intraspinal cyst of the cervical spine: case report and literature review. *Spine* 2002; **27**: E18–22.
6. Firth RL, Lumbar intraspinal synovial cyst containing gas as a cause for low-back pain. *J Manipulative Physiol Ther* 2000; **23**: 276–278.
7. Zapletal J, Hekster RE, Wilmink JT, Hermans J. Vacuum phenomenon in osteoarthritis of the atlanto-odontoid joint: CT findings. *Skeletal Radiol* 1995; **24**: 131–133.
8. Silver DA, Cassar-Pullicino VN, Morrissey BM, Etherington RJ, McCall IW. Gas-containing ganglia of the hip. *Clin Radiol* 1992; **46**: 257–260.
9. Lee TH, Wapner KL, Mayer DP, Hecht PJ. Computed tomographic demonstration of vacuum phenomenon in the subtalar and tibiotalar joints. *Foot Ankle Int* 1994; **15**: 382–385.
10. Resnick DS, Niwayama G, Guerra J Jr, Vint V, Usselman J. Spinal vacuum phenomena. Anatomical study and review. *Radiology* 1981; **139**: 341–348.
11. Fuiks DM, Grayson CE. Vacuum pneumoarthrography and spontaneous occurrence of gas in the joint spaces. *J Bone Surg Am* 1950; **32A**: 933–938.
12. Arvidsson I. The hip joint: forces needed for distraction and appearance of the vacuum phenomenon. *Scand J Rehabil Med* 1990; **22**: 157–161.
13. Harvey AR, Britton JM, Plant GR. A gas filled intradural cyst associated with disc degeneration. *Spinal Cord* 2000; **38**: 708–710.
14. Balkissoon AR. Radiologic interpretation of vacuum phenomena. *Crit Rev Diagn Imaging* 1996; **37**: 435–460.
15. Salpietro FM, Alafaci C, Collufio D, Passalacqua M, Puglisi E, Tripodo E, et al. Radicular compression by lumbar intraspinal epidural gas pseudocyst in association with lateral disc herniation. Role of the posterior longitudinal ligament. *J Neurosurg Sci* 2002; **46**: 93–95.
16. Miller MD, Osborne JR. Spontaneous vacuum pneumarthrography revisited: the significance of the vacuum phenomenon in the lateral compartment of the knee. *Arthroscopy* 1998; **14**: 576–579.
17. Peh WC, Ooi GC. Vacuum phenomenon in the sacroiliac joints and in association with sacral insufficiency fractures. Incidence and significance. *Spine* 1997; **22**: 2005–2008.
18. Shogry ME, Pope TL Jr. Vacuum phenomenon simulating meniscal or cartilaginous injury of the knee at MR imaging. *Radiology* 1991; **180**: 513–515.
19. Coulier B. The spectrum of vacuum phenomenon and gas in spine. *JBR-BTR* 2004; **87**: 9–16.
20. Resnick D. *Diagnosis of bone and joint disorders* (3rd edn). Philadelphia, PA: Saunders, 1995, p 1377.