Analysis of Gas in Vacuum Lumbar Disc

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In three cases in which chemonucleolysis with chymopapain was used for the treatment of back and sciatic pain, gas from the vacuum phenomenon of a degenerated lumbar intervertebral disc was recovered. In one of these, the gas analyzed by gas chromatography contained 90%–92% nitrogen.

The vacuum disc phenomenon, a well known radiologic observation, theoretically results when gas similar to atmospheric or blood gas composition fills fissures within a degenerated disc [1, 2]. We believe this is the first report of aspiration and analysis of gas from a vacuum disc.

Methods and Results

During the past 10 years, discography and intradiscal chymopapain injection, usually following myelography, were performed by one of us (L. T. Ford) as part of a clinical investigation of chemonucleolysis [3–5]. A total of 848 patients with lumbar disc disease were examined, and vacuum phenomena were encountered infrequently. In three cases, a small amount of gas from degenerated discs was recovered through a closed system discography needle. In one patient, the gas recovered from a degenerated fourth lumbar disc was subjected to gas chromatography in the Division of Radiation Sciences at the Mallinckrodt Institute.

The gases were separated in a 1.8 m stainless steel activated charcoal column (0.63 cm outside diameter) operated at room temperature in a Perkin Elmar 820 chromatograph fitted with a hot wire detector and with helium as the carrier (60 mm/min flow rate). The aspirated gas was 90%–92% nitrogen combined with oxygen, carbon dioxide, and other trace gases.

Discussion

In 1910 Fick [6] observed the vacuum phenomenon while studying joints under traction. The vacuum phenomenon in intervertebral discs was described in 1937 by Magnusson [7] who attributed no clinical significance to the phenomenon. In 1942, Knutsson [8] recognized that the finding correlated with disc degeneration. In 1,614 x-ray studies of the lumbosacral spine, Ford and Goodman [9] found intradiscal gas in 3.28% of patients, seen best in stress views obtained standing in extension. Marr [10] detected the phenomenon in 2.026% of 2,419 patients radiographed while lying in flexion. Gershon-Cohen et al. [11] found intradiscal gas in 20.8% of 130 asymptomatic elderly patients. Thus the phenomenon seems to occur with increasing frequency in older people. Extension accentuates the vacuum disc, and flexion may cause it to disappear [1, 7–9, 12].

The vacuum phenomenon is explained by anatomic and physiologic factors. When apposing articular surfaces are distracted, a space is created and its volume must be filled. Since there is insufficient synovial fluid in a normal diarthrodial joint and no fluid in an amphiarthrodial joint to fill the expanded space, gas in the surrounding extracellular fluid leaves solution and occupies the volume created by distraction, thereby producing a vacuum phenomenon. As observed during flexion of the lumbar spine, when soft tissue surfaces return to apposition and obliterate the space, gas resorbs and the vacuum phenomenon usually disappears [8].

Physiologic factors governing gases in the human body include partial pressures, solubility coefficients, and diffusion gradients [13]. Nitrogen, which makes up 78% of the earth's atmosphere, saturates the body but is not metabolized. Oxygen makes up 21% of the atmosphere, but in the body much is removed by metabolic processes before it reaches fat and extracellular fluid. Body distribution and physical properties of nitrogen, oxygen, carbon dioxide, water vapor, and trace gases favor the movement of nitrogen out of and back into solution as articular surfaces are distracted and relaxed. Gas analysis of our vacuum disc sample confirmed greater than 90% nitrogen composition.

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