JAOA CLINICAL PRACTICE

Joint cracking and popping: Understanding noises that accompany articular release

MARINA G. PROTAPAPAS, DO
TYLER C. CYMET, DO

Articular release is a physiologic event that may or may not be audible. It is seen in patients with healthy joints as well as those with somatic dysfunction. After an articular release, there is a difference in joint spacing—with the release increasing the distance between articular surfaces. Not all noise that emanates from a joint signifies an articular release. A hypothesis about the noise that frequently accompanies this release is offered and includes anatomic, physiologic, and functional models of articular release. Repeated performance of articular release may decrease the occurrence of arthritis. Potential problems from repeated articular release (eg, hypermobility) are also examined.

(Key words: articular release, cervical spine, hypermobility, joint cracking, knuckle cracking, metacarpophalangeal joint, osteoarthritis, osteopathic manipulative treatment, synovial joint)

In most clinical settings, the patient is often more concerned with the obvious, audible change in the joint than is the physician. It is a poorly understood response that is sought by some patients and avoided by others. Articular release is a phenomenon that is widely familiar to osteopathic physicians as well as other practitioners of manual medicine.

Articular release is a repeatable phenomenon that can occur with or without an accompanying noise. It causes a freeing of motion and a release of joint tension (*Figure 1*). However, the physiologic and anatomic explanation for what happens during articular release is not fully understood.

What is known is that articular release occurs when joint motion extends past the physiologic barrier (*Figure 2*). This extension may be accomplished by an outside force—as induced by a physician—or through muscle movement not directly emanating from joint release. The sound, or the noise, is what people notice in articular release; the subjective relief it provides is secondary.

This subjective relief has not been scientifically evaluated, and terminology related to this process is confusing and in need of clarification. In this article, we review the available information on articular release and propose a reason for the physiologic change and the occurrence of sound emanating from the joint.

This physiologic event may be shown to have an important place in manipulation because it produces the effect of joint separation, or gapping of the joint.[1] Osteopathic manipulative treatment techniques, such as facilitated positional release and counterstrain, depend on local and central proprioceptive effects for their effectiveness. Articular release may be part of the necessary response for effective treatment. Patients feel an immediate release and relief, as well as temporary restoration of joint motion.[2]

Articular release and sound

The sound generated by joint manipulation has been classified variously throughout osteopathic medical literature, being referred to as an "articular crack," "articular pop," "clunk," "crepitus," "joint click," "snap," "synovial grind," and "thud," and it has been described as a "grating" sound in the general medical literature (*Figure 3*). The articular release may be accompanied by a loud audible release or a soft joint sound—but it can also be inaudible.

The regions of the body most commonly used to study articular release have been the metacarpophalangeal (MCP) joints and the cervical spine. In much of the literature, methods that have been used to measure the loudness of the "crack" that accompanies articular release have not been clearly described. Those practitioners who do elaborate on study approach have used equipment such as transducers over the skin. In particular, Meal and Scott[2] mention that the method for recording a release is known as "phonoarthrography," in which the joint sound is picked up by an electronic stethoscope and passed through an amplifier to an electrograph (ultraviolet) recorder: "Best results seem to depend on excluding extraneous (or high frequency) sounds in a time frame of 0.04 to 0.06 sec[onds]."

The model of Brodeur describes the sudden joint distraction during manipulation as occurring in a shorter time than that required to complete the stretch reflexes of the periarticular

Dr Protapapas is currently completing her internship at Good Samaritan Hospital in Baltimore, Md, and is moving to Cambridge, Mass, this summer to begin her residency in physical medicine and rehabilitation at Harvard University's Harvard Medical School. Dr Cymet is a section head of family medicine at Sinai Hospital of Baltimore in Maryland. He is also an assistant professor of internal medicine at The Johns Hopkins University School of Medicine in Baltimore, Md.

Address correspondence to Tyler C. Cymet, DO, 6 Tyler Falls Ct Unit A, Baltimore, MD 21209-5227.

E-mail: *tcymet@sinai-balt.com*

muscles. As a result, a high impulse is likely acting on the ligaments and muscles associated with the joint involved. Brodeur's study uses force-displacement curves of the third MCP joint. "A spring balance was used to measure the distraction force applied to the joint."[3] Radiographs were taken at specific joint tension intervals, allowing the joint displacement to be measured. Consequently, this system allowed researchers to generate a force displacement curve, illustrating the sequence pattern of an articular release.

The noises that accompany joint motion have not been studied extensively. It is uncertain whether there is any therapeutic value attached to the crack and, conversely, whether there are any detrimental effects to the patient. This joint release may offer a clue as to the nature of joint pathology. Many theories have been proposed as to the reasons behind this noise. Hembrow[4] states, "Clicks result often from atmospheric pressure correcting a vacuum produced by the traction, or by tendons snapping over." Hutton[5] "describes the articular click as an indication of a bone being put back into place." In 1871, Dr. Wharton Hood[6] attributed this sound "to the snapping of adhesions." Hargrove-Wilson[7] suggests that "the click is due to the breaking of the joint seal, at which time a small bubble of nitrogen is released in the joint." According to Ehrenfeuchter and Nicholas,[8] the facet joint space narrows, causing the synovial fluid to be pushed into an already bulging capsule. Also, Unsworth et al[9] state that the noise emitted from a joint is dependent on the size of the joint.

The primary explanation for this audible noise is that it results from a change occurring at the joint. However, one theory states that the noise may result from by-products of

An **articular release** is a change in joint space. It can be:

- audible or inaudible
- present in a healthy or diseased state
- affected by a change in the external environment (eg, temperature, barometric pressure)
- induced by motion or muscle activity without motion
- the result of a rapid change in joint position

Figure 1. *Properties of articular release.*

muscle activity, such as creatinine phosphate and creatinine kinase, being extruded when the muscle stretches during joint manipulation.[10] However, not much data are available on this mechanism.

The noises of normal and abnormal joints are built into the nature of the structures. To ignore these noises would be foolish, as they might be used to help determine the effectiveness of treatment.

Paradigm: Anatomic model, physiologic model, and functional model of articular release

The articular noises made by a joint vary depending on the size of the joint, section of the body being moved or manipulated, and the previous activity of the joint. A release or crack will not occur without motion. More specifically, the physician's careful manipulation of different joints will vary in com-

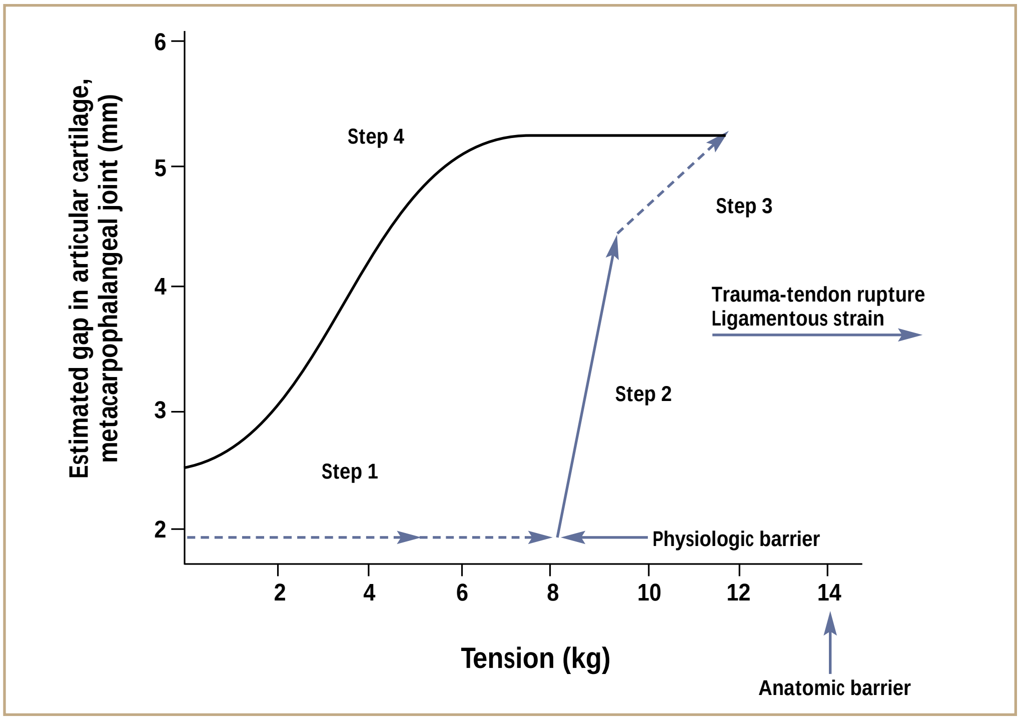

Figure 2. *Hypothetical model of articular release.* Step 1: *Preliminary tension mobilization. Pressure is applied to joint without a change in gap between articular cartilage.* Step 2: *Articular release. A release occurs and a rapid change in gap range results. This step can be audible or inaudible.* Step 3: *Overshoot of release without increase in gap area.* Step 4: *Refractory tension. Reduction in tension with decrease in gap; not returning to baseline reading.*

Term	Definition
articular clunk	A sound similar to a loud thud. This sound is most prevalent in syndesmosis injuries (ie, osteoarthritic joint: sacroiliac or hip joint that may have chronic synovial dryness or eburnation).* This noise may have a single modal sound wave peak on a sound frequency scale.
articular crack	A "breaking" noise that appears as a bimodal sound wave peak on a sound frequency scale.
articular pop	A "popping" noise that can be expressed as a single modal curve on a sound frequency scale.
articular release	A physiologic event that occurs when a joint is positioned past its physiologic barrier—but has not passed through its anatomic barrier—to cause a functional change, resulting in increased freedom of motion for the affected joint. An articular release may be accompanied or unaccompanied by an audible noise. "This maneuver tends to carry certain elements of an articulation beyond the limits of their voluntary and usual range of movement, without however exceeding the range of movement permitted by the anatomy (ie, without producing capsular or ligamentous strain, sprain, or tearing)."†
articular snap	See *ligamentous strum*.
crepitus	A sound that is emitted most frequently when the wrist is placed in lateral extension. This noise was defined by Bejamin M. Sucher, DO, in his examination of the wrist joint in carpal tunnel syndrome.‡
eburnations	See *tendinous clicks*.
ligamentous strum	A sound that occurs as a result of a tense ligament or tendinous (fascia) structure rolling over a bone or solid prominence.
torn adhesion sound	A high-pitched, non-repeatable "tearing" sound. This is often associated with sudden, momentary pain.
tendinous clicks	A sound similar to two hard surfaces being rubbed together.

*Adamson C, Cymet T. Ankle sprains: evaluation, treatment, rehabilitation [review]. *Md Med J.* 1997;46:530-537.
†Sandoz R. The significance of the manipulative crack and of other articular noises. *Ann Swiss Chiro Assoc.* 1969;4:47-68.
‡Sucher BM. Palpitory diagnosis and manipulative management of carpal tunnel syndrome [review]. *J Am Osteopath Assoc.* 1994;94:647-663.

Figure 3. *Terminology used to describe articular release.*

plexity—and in sound—from patient to patient. In much the same way that the sound of a crack will vary according to the type of joint manipulated, so too will the freedom of motion—or the restoration of physiologic function—achieved in that joint as a result of articular release. The noise released from an MCP joint should sound different from the noise released from a joint in the cervical, thoracic, or lumbar vertebrae. Also, the motion obtained by these joints will be of a different magnitude.

So which joints make a noise and which do not? Nordheim[11] believes that the mechanism producing sound as a result of articular release was secondary to the production of a momentary partial vacuum produced by joint separation. The contents of this vacuum are thought to contain water vapor, nitrogen, oxygen, and carbon dioxide under reduced pressure. According to Unsworth et al,[9] the synovial fluid in a joint is composed of 15% gas, 80% of which is carbon dioxide. Roston and Wheeler-Haines[12] verify this composition of joint spacing, stating that the pressure in a joint right before release is –3.5 atm. Atmospheric pressure is 1 atm. Consequently, a 2.5–atm pressure change occurs after joint release, resulting in an audible emission of sound.

Unsworth et al[9] support this argument, introducing the concept of *cavitation*, a term used to describe the formation of vapor and gas bubbles within fluid through local reduction in pressure. The reduction of pressure occurs through a mixture of gas and liquid. The release is initiated by a break in the surface of the gas to the liquid. When the vapor collapses on moving into a region of higher pressure, very high-impact pressures can be generated. Unsworth et al[9] state that cavitation is responsible for the phenomenon of joint cracking. Under subatmospheric pressures, the synovial fluid vaporizes and gas is released from solution. The collapse of the vapor cavities gives rise to the articular noise.

Unsworth et al[9] further state that the occurrence of such a noise is dependent on the joint space. The larger the joint space, the less likely the joint will pop. The smaller the joint space, the more likely it is that the articular release will be audible. "The physical explanation of a thick [synovium] being present between the articulating surface is that the ligaments locating the joint are not strong enough to force the two surfaces together."[9] Unsworth et al[9] found that patients who were unable to relax the muscles near the joint affected could not produce an effective result that led to articular release with audible sound. They also found that "the joint did not open or, at best, opened erratically as the subject attempted to relax at intervals."[9]

Sandoz[13] supports the finding by Unsworth et al, stating that the failure to produce a noise during articular release is due to an inability to relax the muscles. Tension causes a tightening of associated tendons that pass across the affected joint. This tension decreases the chance of obtaining an articular release by preventing the tendons from moving over the joint.

It has been demonstrated in practice that the articular noise can be elicited in joints with passive, indirect, and direct treatment modalities. A joint does not have to be pushed past a barrier forcefully to effect an audible release. A joint can exist in a state of static equilibrium—meaning that if a joint were to remain immobilized (at rest), the gaseous contents in the joint will build up to produce a sound when motion is induced. An audible release may also occur when a joint is already in motion, such as during an indirect or direct treatment of the muscle. In an indirect approach, the antagonist muscle is contracted to release the agonist muscle. In a direct approach, the agonist muscle is placed into its barrier of motion in an attempt to release it. No existing documentation indicates that an audible sound during joint manipulation can be achieved only after taking a joint past its barrier.

Many other explanations in the literature describe why certain joints do not produce a noise during manipulation:

- Unusual shortness of collateral ligaments would prevent a separation sufficient to produce a noise: "We often encounter spines which, under manipulation, give this hard-rubber impression and which do not crack or crack only with utmost difficulty."[13]
- There can be situations in which the bones separate under relatively light tension without cracking. These patients usually exhibit hyperflexion and hyperextension, and their capsules and ligaments appear to be exceptionally lax, possibly allowing an invagination of the soft tissue into the articular cavity under traction.
- There are joints that appear to be in a constant refractory period, as if the joints have already been manipulated and the bones are sufficiently separated.
- Asdonk[14] discusses a tonic barrier of resistance due to the connective tissue present in a joint. He states that the amount of connective tissue present can determine the amount of elasticity that a joint has and can thus determine how much noise a joint produces when it is manipulated.

Each articular release effects a change in the gamma-gain system of the nervous system and allows for the resetting of a muscle's proprioception.[15] Loss of proprioception, which occurs naturally with age, can accelerate joint deterioration.[16] Proprioception can be enhanced with orthosis or the focused exercising of a joint. Exercising and using a joint fully do not lead to faster joint destruction.

Side effects are associated with repeated articular release, however. Too much manipulation of any joint can lead to hypermobility. This condition is more common in women than in men. In a March 2000 oral communication, Eileen L. DiGiovanna, DO, attributed this condition to women's higher levels of estrogen. An increase in estrogen, as occurs during pregnancy, leads to laxity of the ligaments. Such hormonal effects and the effects of repeated manipulation are thought to increase the likelihood of joint hypermobility. Currently, not enough research exists to confirm this hypothesis.

DiGiovanna (oral communication, March 2000) among others recommends that there should be a maximum of three office visits per week for manipulation. A patient receiving manipulation more than three times per week can eventually have hypermobility. Evidence also suggests that repeated use of quinolones can affect ligament integrity, causing ligamentary stress or ligamentous tears.[17] Joint sticking and osteoarthritis are other side effects that are believed to be long-term side effects of too much manipulation.

Discussion

Immediate relief of restricted motion and pain follows articular release. Mennell[18] states that the joint release is a phenomenon that is "dear to the ear of the bone-setter." The noise is often a sign of physiologic change that can be used to determine the effectiveness of an intervention such as manipulation. The articular noise also represents an important element of suggestion for the patient; once a patient hears a noise after an articular release, he or she often assumes the dysfunction is corrected. Sandoz[13] states:

> [A]ny patient readily learns, even without being told, that the crack is a necessary condition for a successful manipulation, and conversely that a failure to obtain the crack means an unsuccessful manipulation. And we must frankly admit that for the manipulator, the crack represents also an important, although not an absolute nor a sufficient, criterion for a good manipulation.

Practitioners use the phenomenon of the articular release with much benefit to their patients. According to Sandoz,[13] regardless of the direction of manipulation to the MCP joint (ie, flexion, extension, traction, adduction, or abduction), there is an overall gain of 5% to 10 % in the range of passive motion in all directions, and a somewhat smaller increase in the range of active motion. "[Sandoz] explained the increase in the range of movement in all directions after an adjustment by the disappearance of the coaptative forces of the joint."[2] Meal and Scott[2] also state that there is a refractory period to a joint and that "it is good practice to rest the patient for 20 minutes after the adjustment because the joint is unstable and therefore susceptible to trauma."

If a second adjustment is attempted after the initial release, the first resistance barrier the examiner will encounter is the anatomic one—beyond which physical damage can occur. Meal and Scott[2] state that if an initial release does not provide sufficient range of motion and an additional adjustment is made, the preference would be to use a slow, mobilizing move. In a case for which two adjustments are needed, it can be assumed that achieving articular release is not the solution to treatment.

If a joint is left undisturbed for 20 minutes, it regains the ability to release, and the cycle can be repeated. The minimum time that Roston and Wheeler-Haines[12] recorded for noise emission was 17 minutes from release; the maximum time for noise emission after release was 22 minutes. Professor Robert Maigne,[19] a French specialist in orthopedic medicine and functional rehabilitation, mentions that the refractory period for spinal articulations ranges from one to several hours.

Although research on the refractory time for articular release of the spine is limited, there is good reason to believe that the refractory periods for the spinal and MCP joints are not much different. This assertion, however, is based on the assumption that the phenomenon of articular release is the same in all joints and that all joint spaces are the same size.

Sandoz[13] states that, to prove the variability of refractory times, an experiment must be conducted under different pressure systems. Such an experiment would require measuring the refractory period of the joint immediately after release and placing the joint area into a compression chamber to increase joint pressure. As Sandoz[13] adds,

> If the refractory period represents the time needed to redissolve the gas bubble into the tissue fluids, it should become shortened when the joint is subjected to increased pressure. A similar decrease in the refractory period should occur when the articulation is cooled with ice packs immediately after cracking.

Clinical aspects of joint cracking

The articular crack occurs for patients in both healthy and diseased states. It can be heard during normal functioning. Either a trained examiner or an untrained brute can induce it.

Is articular release necessary to maintain joint health? There are two possible answers to this question. A person who undergoes habitual cracking does so for the feeling of relief and greater motion in the involved joint. If one were to consider the anatomic and physiologic models solely, one could assume that maintaining motion throughout the joint could lower the likelihood of developing osteoarthritis. On the other hand, the excessive use of a joint could lead to laxity of the ligaments supporting the joint, causing hypermobility or introducing an unnecessary stress that could eventually cause dysfunction.

Swezey and Swezey[20] studied the prevalence of knuckle cracking in geriatric men in comparison to 11-year-old children and found that their data failed to show that cracking leads to degenerative joint disease in the MCP joint in old age. The chief morbid consequence of habitual joint cracking appeared to be the annoyance inflicted on the casual observer.

Castellanos and Axelrod[21] contribute to Swezey and Swezey's hypothesis, finding that although habitual knuckle cracking does not relate to osteoarthritis of the hand, it does relate to decreased hand function. They found that habitual knuckle crackers are more likely to be involved in manual labor, bite their nails, smoke, and drink alcohol.[21] Thus, hand function is not solely dependent on habitual knuckle cracking but also on other external factors, such as job and diet.

Meal and Scott[2] mention that another external factor that may affect the quality of articular release is barometric pressure. It was found that, "when a low pressure system was coming over the area, [people's] joints ... seem to crack more easily, with less tension, and making less noise."[2]

Comment

More rigorous scientific research is needed to determine the specific effects of articular release. Differences exist in the effect of articular release in large joints versus small joints, but it is unknown whether a difference exists in the sounds made during articular release by healthy joints versus ill joints. Future studies may tackle this distinction and may in turn be useful in gauging the effectiveness of manipulation for overall joint health.

References

1. Heilig D. The thrust technique. *J Am Osteopath Assoc*. 1981;81:244-248.

2. Meal GM, Scott RA. Analysis of the joint crack by simultaneous recording of sound and tension. *J Manipulative Physiol Ther*. 1986;9(3):189-195.

3. Brodeur R. The audible release associated with joint manipulation [review]. *J Manipulative Physiol Ther*. 1995;18(3):155-164.

4. Hembrow CH. Symposium. Manipulative treatment. *Med J Aust*. 1967; 1(25):1274-1280. Cited by: Heilig D. The thrust technique. *J Am Osteopath Assoc*. 1981;81:247.

5. Hutton. Symposium. Manipulative treatment. *Med J Aust*. 1967;1(25):1274-1280. Cited by: Heilig D. The thrust technique. *J Am Osteopath Assoc*. 1981;81:247.

6. Hood W. Symposium. Manipulative treatment. *Med J Aust*. 1967;1(25):1274-1280. Cited by: Heilig D. The thrust technique. *J Am Osteopath Assoc*. 1981;81:247.

7. Hargrove-Wilson A. Symposium. Manipulative treatment. *Med J Aust*. 1967;1(25):1274-1280. Cited by: Heilig D. The thrust technique. *J Am Osteopath Assoc*. 1981;81:247.

8. Ehrenfeuchter W, Nicholas AS. Personal communication. Cited by: Heilig D. The thrust technique. *J Am Osteopath Assoc*. 1981;81:247.

9. Unsworth A, Dowson D, Wright V. Cracking joints. A bioengineering study of cavitation in the metacarpophalangeal joint. *Ann Rheum Dis*. 1971;30(4):348-358.

10. Garry JP, McShane JM. Postcompetition elevation of muscle enzyme levels in professional football players. *MedGenMed*. Mar 3 2000;[*sic*]:E4.

11. Nordheim Y. Eine neue Methode, den Gelenkknorpel, besonders die Kniegelenkmenisken, röntgenologisch darzustellen (ohne Zuhilfnahme eingespritzten Kontrastmittels). Fortschr. *Röntgenstr*. 1938;57:479-495. Cited in: Sandoz R. The significance of the manipulative crack and of other articular noises. *Ann Swiss Chiro Assoc*. 1969;4:47-68.

12. Roston TB, Wheeler-Haines R. Cracking in the metacarpophalangeal joint. *J Anat*. 1947;81:165-173. Cited by: Sandoz R. The significance of the manipulative crack and of other articular noises. *Ann Swiss Chiro Assoc*. 1969;4:47-68.

13. Sandoz R. The significance of the manipulative crack and of other articular noises. *Ann Swiss Chiro Assoc*. 1969;4:47-68.

14. Asdonk J. Changes of connective tissue as a cause of the vertebral syndrome [in German]. *Hippokrates*. 1965;36(24):937- 945.

15. Kelso AF. Physiology. In: Northup GW, ed. *Osteopathic Research: Growth and Development*. Chicago, Ill: American Osteopathic Assoc; 1987:66-67.

16. Sharma L, Pai YC. Impaired propioception and osteoarthritis. *Curr Opin Rheumatol*. May 1997;9:253-258.

17. Andriole VT. *The Quinolones*. 2nd ed. San Diego, Calif: Academic Press; 1998:386.

18. Mennell JM. *Joint pain: Diagnosis and treatment using manipulative techniques*. Boston, Mass: Little Brown & Co; 1964:136-137.

19. Maigne R. Les manipulations vertébrales. *Expansion scientifique française*. 1960. Cited in: Sandoz R. The significance of the manipulative crack and of other articular noises. *Ann Swiss Chiro Assoc*. 1969;4:47-68.

20. Swezey RL, Swezey SE. The consequences of habitual knuckle cracking. *West J Medicine*. 1975;122:377-379.

21. Castellanos J, Axelrod D. Effect of habitual knuckle cracking on hand function. *Ann Rheum Dis*. 1990;49:308-309.