## Title

# Could the sound of an audible release be coming from the synovial fold?

## Author Information

Jerome C J Fryer BSc DC , Private Practice 2-1551 Estevan Rd. Nanaimo BC V9S 3Y3 Canada

778- 441-2243 drjfryer@gmail.com  http://www.drfryer.ca/

## Disclaimer

The views expressed in this article are my own.

## Sources of Support

No support was provided in the writing of this article.

Number of Figures: 1

## Conflict of Interest Declaration:

The origin of the hypothesis occurred during the development and construction of a simulated synovial joint for a lumbar model as acting chief innovations officer for Dynamic Disc Designs Corp. To provide some history on the development process, real cadaveric lumbar vertebrae were cleaned and void of cartilage.  Identical copies of the bone were casted in plastic. The two plastic vertebrae were bonded by an elastomeric 2-part disc. The modeling included a recreation of a smooth hyaline glass-like surface with a sculpted elastomeric ring to mimic the synovial fold shape. This elastomeric ring was adhered to one of the two vertebrae's articular surfaces.  When the elastomeric ring was pressed up against the glass-like surface of the adjacent vertebrae, a distraction force elicited an audible release noise. This sound was very similar to the sound heard in vivo of a typical joint manipulation.  Further testing of different elastomeric material properties in composition and shape of the synovial fold revealed different sound characteristics. At this moment (June 26, 2013) it was hypothesized that the sound of joint manipulation could be the release of the synovial fold from the hyaline surface and responsible for the "snap" noise often elicited in the paraphysiological space in vivo. The mechanism of sound was then thought to behave similar to a suction cup principle releasing from a smooth surface.

I declare that I am the President of Dynamic Disc Designs Corp.

## Abstract:

**Background.** It is often the intent of manipulative treatment to elicit a snapping sound from synovial joints. Although the sound is commonly heard, the specific source of the sound has not been identified. Cavitation is thought to be the sound emitter but this has not been definitively proven.

**Presentation of Hypothesis.** It is proposed here that the sound associated with the classic snapping sound (or often referred to as popping or cracking) of a joint distraction into its paraphysiological space as performed by manipulative therapy is coming from the synovial fold as it releases (in an elastic-like fashion) away from the hyaline cartilage.

**Testing of Hypothesis.** Rapid sequencing MRI with or without sound source localization methodologies and contrast arthrography should help refute or support this new hypothesis.

**Implications.** This new hypothesis challenges current thinking that the sound of an audible release is something other than a cavitation. And more importantly, identifying specific anatomical sound generators of biological sub-tissues in synovial joints will allow better understanding of how we can aid in promoting optimal health to these types of joints. This, in turn, will direct our future treatments to improve clinical outcomes.



Keywords: manipulation, audible release, synovial fold, cavitation, sound, synovial joint

## Background:

An audible snapping sound (more commonly referred to as a pop or crack) is often heard when a synovial joint is manipulated to reach its paraphysiological space. Chiropractors and other manipulation therapists often perform treatments with the intent to elicit this sound to improve joint health. Spinal manipulation has been used for well over a century and has been a large part of the chiropractic profession's identity but the precise biomechanism responsible for the noise generation has not been proven. 1

Generally, the sound of an audible release (along with other joint noises) is quite common. Many onomatopoetic words have been used to subjectively describe these sounds: pop, crack, click, clunk, crepitus, squish, swoosh, as well as many others. A number of theories on what makes these noises are presented in Protapapas and Cymet's 2002 work. These authors reviewed the research on the sounds of joints and concluded that more work is required to determine the sound sources. They write "noises of normal and abnormal joints are built into the structure and to ignore these noises would be foolish". And specific to this paper, Fawkes (2) states in a more recent summary report that much needed research is required to establish the significance of the audible sound in the treatment outcomes and the physiological effects of joint manipulation.

The commonly believed sound source of manipulation continues to be a cavitation process. One of the keystone papers from which this theory evolved was performed in 1971 by Unsworth et al. 3 They imaged metacarpophalangeal joints by x-ray and saw areas of dark contrast between the articular surfaces in only those joints that separated suddenly and made a noise. In addition to this, they also constructed an acrylic synovial joint model made of nylon and Perspex (injected with synovial fluid) and recorded a flash event under view with a high speed cine camera. In this article they believed the cracking noise was generated from a process of cavitation even though their conclusions could not be absolutely definitive.

In 1995, an alternative viewpoint to the noise producer of manipulation (challenging the cavitation theory of sound) came from Raymond Brodeur 4 as he suggested that it was the capsular ligaments responsible for the noise as they snap outwardly. Brodeur proposed that distraction initially results in a reduction of intrarticular pressure (from an already sub-atmospheric intrarticular pressure) and with continued increasing force, the capsule involutes further creating a tensile limit of the capsule. As the capsule reaches this limit, it snaps outwards resulting in the audible release.

The proposed hypothesis in this paper builds on Brodeur's idea but instead of the capsule making the noise, it is proposed here that it is the synovial fold as it releases (like a suction cup would release from a piece of glass) from the hyaline cartilage. It is believed the synovial fold generates the noise rather than the cavitation process or capsular ligaments.

## Hypothesis

The audible release associated with manipulation (i.e., the snapping sound associated with a refractory period) is generated from the elastic recoil of the synovial fold as it releases away from the hyaline cartilage. See Fig.1 As the pressure is reduced between the articular surfaces, the synovial fold is slightly drawn in initially (B) and as more distraction is elicited (C), the fold is held down onto the hyaline surface until it reaches its elastic limit and 'snaps' (D) -- recoiling to its original shape (similar to an elastic suction cup releasing away from a glass surface). This elastic recoil of the synovial fold generates the ‘snapping’ noise. In this scenario, the cavitation (E) is more of a by-product from the sudden hydrodynamic event rather than being the sound generator itself.

## Testing the Hypothesis

Identification of the anatomical sound structures in a synovial joint may be a challenge but use of rapid sequencing imaging modalities could prove as the front runner technology to use. One strategy would be to image a manipulating metacarpalphalangeal joint in vivo with rapid sequencing MRI and if a gas was responsible for the noise, this should be consistently seen one hundred percent of the time. This may not provide immediate support that the synovial fold is responsible for the noise but it would challenge the current theory of cavitation.

Another strategy would be to discern if the sound source is generated from a point source or not through source sound localization instrumentation. If the sound of manipulation is generated from a cavitation process, then this sound source should therefore be a point source. To measure the sound properties as being generated from a non-point source and more so from a ring structure (like the shape of a typical synovial fold) this would challenge current thinking and could potentially support this new hypothesis. Furthermore, to delineate between the synovial fold and synovial fluid, contrast arthrography may be important as seem in Resnick et al. 5 Other methodological strategies may involve ultrasound technology to triangulate the sound source through micro-piezoelectric transducers.

## Some Implications of the Hypothesis

There are several translatable benefits to revealing the specific anatomical sound source (or sources) of manipulation when defined by an audible release. For one, it will help to operationally define the act of manipulation. Identifying the sound structure will help better understand the therapeutic mechanism and possible reasons why clinical outcomes are seen in conditions that seek help from manipulators as well as explain why manipulation may not work for all back conditions. It is believed that with a better understanding of the noise generator we would be better positioned to choose the types of back conditions that would respond favourably.

This hypothesis can also help explain why some joints do not ‘snap’ when manipulated. If this hypothesis were true, a significantly roughened hyaline surface would prevent the synovial fold from releasing in a suction-like fashion. Just as a suction cup releases in an audible way from a piece of glass, the suction may not take place with a roughened surface like that with osteoarthritis. Joints that do not elicit the ‘snap’ may provide us clues of the hyaline surface health. In addition, a joint that does not elicit the ‘snap’ may not be able to geometrically reach the required gapping distance required to lift the fold off from the hyaline surface. Many degenerative synovial joints are limited in their range of motion due to anatomical changes which may not allow significant distraction to occur to generate the distance required to release the fold.

Another important implication of this hypothesis is to help direct future research on the noises of synovial joints. If the synovial fold is found to be the sound source commonly referred to as the ‘pop’ or ‘crack’, this would set the groundwork for understanding *other* anatomical structure sounds like: grinding, clunking, squishing, grating...etc, as often described by patients clinically.

This, in turn, would assist the practitioner in identifying differing tissue structures and not classify all other sounds into one category as "crepitus". Importantly, this hypothesis would offer the practitioner a clinical tool to better understand the clinical case and help in the decision making in both the diagnostic and therapeutic areas of patient joint care.

Additionally, this synovial fold hypothesis will further our understanding why some conditions respond favourably to manipulation and why some do not. If treatment outcomes are not favourable with or without a successful synovial fold release, then this would help direct the practitioner with information regarding the anatomical target and curtail treatment directions of synovial joints. In other words, this would help in the diagnostic case workup. Comparing to other medical interventions, medial branch blocks are performed by pain intervention practitioners prior to ablation procedures. Post hoc manipulation analysis will provide the practitioner with information about the intended effect on joints and guide treatment.

This hypothesis could also better explain the pressures and associated fluid flow from the subchondral bone through the hyaline cartilage and into the joint space. This would help direct future mechanical strategies through regenerative rheology.

Joints that manipulate do emit differing sound characteristics and if this hypothesis is true, it would explain why certain joint sizes produce different sounds of release when manipulated. Unsworth et al. discussed how the sound is dependent on the size of the joint. Different sizes of joints have differing respective shapes and sizes of synovial folds. This new hypothesis would help explain Unsworth's observation plus add to the understanding of why different joints can have differing sound characteristic properties with manipulation.

The event of cavitation is a complex phenomenon and has differing subcategories. If we can begin to understand the mechanisms related to the type of cavitation event that presumably takes place within the joint space after a manipulation, perhaps we can better understand the hydrodynamics of joint manipulation and improve our therapeutic strategies in the future. And if we discern that the noise is not as a result of the cavitation process and more as a result of the fold releasing from the cartilage, it will help in identifying the type of fluid exchanges and related pressures that occurs within the joint space to improve manual strategies as well as other treatments for synovial joints.

This hypothesis challenges the current sound source theory of manipulation. Cavitation may be occurring during the act, but is it exclusively the only source of the sound and does it happen with every audible release? It is believed here that the main (and possibly only) source of the sound of an audible release (as defined by the sound associated with a refractory period) is the mechanism associated with elastic recoil of the synovial fold as it releases away from the hyaline cartilage. This hypothesis is an important question to ask in the ongoing description and future of manipulative science.

## References


1. Protapapas MG , Cymet TC. Joint cracking and popping: Understanding noises that accompany articular release.J Am Osteopath Assoc. 2002; 102: 283-7.

2. Fawkes C. Audible sounds associated with spinal manipulation--a snap-shot summary report (Nov 2012) [http://www.ncor.org.uk/wp-content/uploads/2012/12/Audible_sounds_sm.pdf]

3. Unsworth A, Dowson D, Wright V. ‘Cracking joint’ A bioengineering study of caviation in the metacarpophalangeal joint. Ann. Rheum. Dis.1971; 30: 348-58.

4. Brodeur R. The audible release associated with joint manipulation [review]. J Manipulative Physiol Ther.1995; 18: 155-64.

5. Theumann NH, Pfirrmann CW, Drape JL, Trudell DJ, Resnick D. MR imaging of the metacarpophalangeal joints of the fingers: part 1. Conventional MR imaging and MR arthrographic findings in cadavers. Radiology.2002; 222: 437-45.

*Mar 29. 2014 Additional Notes*: This article (now revised) was submitted to Chiropractic and Manual Therapies on Mar 1, 2014. The result was a rejection. Article resubmitted to JCCA. The result was rejection as a hypothesis paper and Editor recommended a re-write and resubmit as a commentary. A decision was made to self publish. Mar 29.2014.