

# Cerebrospinal fluid circulation pumped mainly by inhalation

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Dreha-Kulaczewski S, Joseph AA, Merboldt KD, Ludwig HC, Gärtner J, Frahm J. [Inspiration is the major regulator of human CSF flow.](#) *J Neurosci.* 2015 Feb;35(6):2485–91. [PubMed #25673843.](#)

Tags: manual therapy, controversy, biology, treatment, debunkery

## PainSci summary of Dreha-Kulaczewski 2015 ★★★★★?

There has never been any significant controversy over whether cerebrospinal fluid actually moves around (only whether or not it's palpable or can be manipulated, with or without effect/benefit). This is an MRI study of *how* the fluid circulates, and it confidently concludes it's pumped every time you take a breath in: "The present results unambiguously identify inspiration as the most important driving force for CSF flow in humans."

This strongly suggests that the rhythm CST therapists claim to be able to feel is exactly in sync with respiration. Not so exotic! This is just one paper, and it isn't necessarily the last word about the mechanism of CSF circulation, but it does strongly suggest that there is indeed a CSF circulation phenomenon to explain, and it's powered in a straightforward way that probably can't be significantly manipulated by any means other than holding your breath.

~ [Paul Ingraham](#)

## original abstract

The mechanisms behind CSF flow in humans are still not fully known. CSF circulates from its primary production sites at the choroid plexus through the brain ventricles to reach the outer surface of the brain in the subarachnoid spaces from where it drains into venous bloodstream and cervical lymphatics. According to a recent concept of brain fluid transport, established in rodents, CSF from the brain surface also enters the brain tissue along para-arterial routes and exits through paravenous spaces again into subarachnoid compartments. This unidirectional flow is mainly driven by arterial pulsation. To investigate how CSF flow is regulated in humans, we applied a novel real-time magnetic resonance imaging technique at high spatial (0.75 mm) and temporal (50 ms) resolution in healthy human subjects. We observed significant CSF flow exclusively with inspiration. In particular, during forced breathing, high CSF flow was elicited during every inspiration, whereas breath holding suppressed it. Only a minor flow component could be ascribed to cardiac pulsation. **The present results unambiguously identify inspiration as the most important driving force for CSF flow in humans.** Inspiratory thoracic pressure reduction is expected to directly modulate the hydrostatic pressure conditions for the low-resistance paravenous, venous, and lymphatic clearance routes of CSF. Furthermore, the experimental approach opens new clinical opportunities to study the pathophysiology of various forms of hydrocephalus and to design therapeutic strategies in relation to

CSF flow alterations.

## related content

One article on PainScience.com cites Dreha-Kulaczewski 2015 as a source:

- [Does Craniosacral Therapy Work?](#) — Craniosacral therapists make big promises, but their methods have failed to pass every fair scientific test of efficacy or plausibility



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