



# Visual Hallucinations with Disembodiment and Self-Motion Illusion on Eye Closure after Brain Cyst Drainage: A Case Report

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## ABSTRACT

### Background

We report the first documented case of visual hallucinations with disembodiment and self-motion illusion on eye closure.

### Clinical presentation

A 71-year-old woman was operated on for a cyst of the left centrum semiovale, adjacent to the precuneus, the posterior cingulate cortex and the splenium of corpus callosum. Two days after, she complained of visual hallucinations occurring on eye closure. She reported reminiscences of landscapes, trees and animals. She had a sensation of floating and moving, flying over the landscapes or walking on lanes. She could stop the hallucinations by opening her eyes. The hallucinations lasted for six days. Pharmacological and neurological possible origins of the hallucinations were explored.

### Conclusion

No direct relation could be found between the pharmacological treatment and the hallucinations. Cerebral volumetric analysis showed a structural reorganization following cyst drainage, which might have conducted to transient hyper excitability of the surrounding structures. The release phenomenon induced by eye closure might have triggered the activation of a distributed network within associative visual, parietal and temporal cortices. The involvement of the splenium and the cingulum is discussed. Furthermore, MRI- and DTI-follow-up suggests that structural reorganization after surgery can be spread over long periods until disappearance of cyst-related deformations. Stabilization of cyst volume, near to zero, was observed after about 2 years.

### Keywords

Cingulum, Disembodiment, Eye Closure, Visual Hallucinations, Self-Motion Illusion, Splenium of Corpus Callosum

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## Case Report

We report the first documented case of visual hallucinations associated with disembodiment and self-motion illusion, observed after brain cyst drainage. Visual hallucinations on eye closure have been previously reported [1-9], but never with disembodiment nor self-motion illusion.

### ■ Case description

A 71-year-old right-handed woman was operated on for a periventricular benign cyst of the left centrum semiovale, facing the left precuneus, posterior cingulate cortex and the splenium of corpus callosum. The cyst was fortuitously discovered 6 years before, and remained asymptomatic until a right inferior quadrantsia appeared. The patient had a history of thyroidectomy and hypertension, and experienced migraines in the past 30 years. Preoperative biological data were within normal ranges. Endoscopic drainage was performed under propofol-induced general anaesthesia, with a navigation-guided entry point in the left superior parietal lobule. Two days after, she complained of hallucinations occurring on eye closure, within the bilateral visual field. She first reported green and red phosphenes. A few hours later, she reported vivid reminiscences of familiar landscapes, trees and animals. She didn't feel like a passive viewer, she was rather active with a sensation of moving through the environment. She felt disembodied, flying over the landscapes with a viewpoint from above, or walking on country lanes. She could stop the hallucinations by opening her eyes. She first was frightened, then get reassured. The hallucinations lasted for six days. The last days, she felt more passive and had to wait a bit after eye closure to see them. At the very end, they were limited to red filaments in her right visual field. She was all the while lucid, well oriented and not delirious. She knew the hallucinations were not real.

We hypothesized that either medications or structural modifications following surgery could have provoked the hallucinations, as she had no history of psychiatric disorders.

In addition, a 44-months MRI longitudinal follow-up was conducted.

The patient has given written informed consent for publication.

## Material and Methods

Medicinal treatment and anaesthesia medication

were screened to detect drugs with potential hallucinogenic effect. Periods of treatment and duration of the pharmacological effect (estimated at 5 half-lives) were compared to the hallucinatory period.

Structural modifications following surgery were investigated with cerebral volumetric analysis. MRI examination was performed the day before surgery (D-1) and seven days after (D7), corresponding to the last day of hallucinations. MRI scans were co-registered and processed using iPlan (BrainLab). D-1 and D7 MRI volumes of brain cyst and surrounding structures were measured for comparison. The precuneus was segmented on sagittal slices with the following limits: anterior, marginal segment of the cingulate sulcus; posterior, parieto-occipital fissure; superior, superior margin of the brain; inferior, subparietal sulcus; medial, midline; lateral: disappearance of subparietal sulcus. The posterior cingulate gyrus (including retrosplenial cortex) was segmented with the following limits: anterior, coronal slice through the posterior commissure; posterior: subparietal sulcus or parallel line to the curvature of the splenium; superior, cingulate and subparietal sulci; inferior: corpus callosum; medial: midline; lateral: disappearance of cingulate sulcus. The splenium of corpus callosum was segmented according to Hofer and Frahm's classification [10].

MRI follow-up was conducted at eight (M8), fifteen (M15), thirty-nine (M39) and forty-four (M44) months after surgery. The MRI examination included DTI in 20 directions at D-1, M8 and M44. Long-term follow-up analysis was conducted with brain cyst volume measurement at each time point and with DTI-based tractography applied to the corpus callosum and the cingulum when data were available.

## Results

Four potential hallucinatory drugs were identified: hydroxyzine (50 mg; 2 preoperative doses at D-1), oxycodone (5 mg; 2 postoperative doses at D0 – day of surgery, and D1), tramadol (100 mg at D1 and D2) and metoprolol-tartrate (200 mg per day, background therapy). None of them was concomitant with the hallucinations (**Figure 1**).

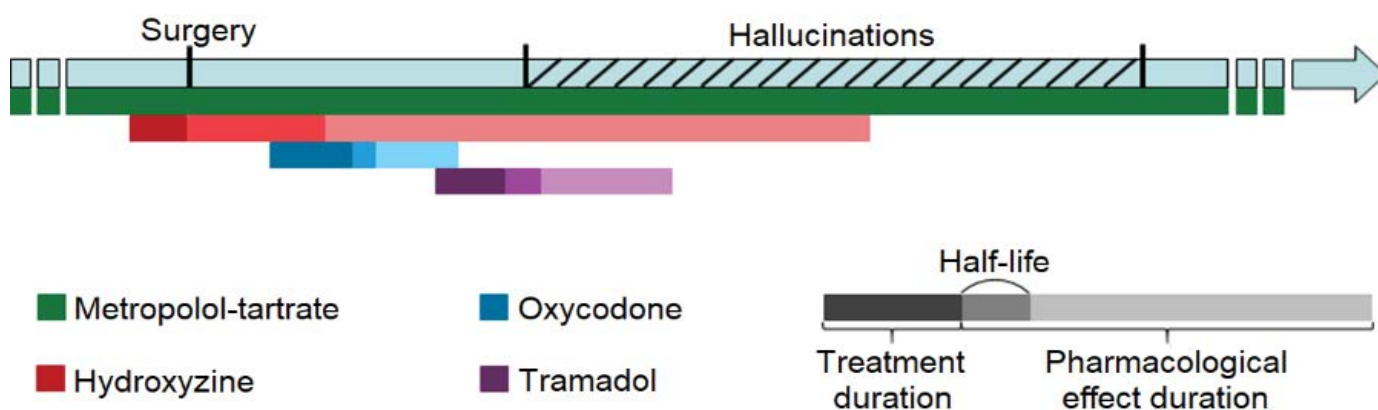
Volumetric analysis between the day before and seven days after surgery showed a decrease of the cyst (-38%) and an increase of neighbouring structures, as a result of decompression: splenium

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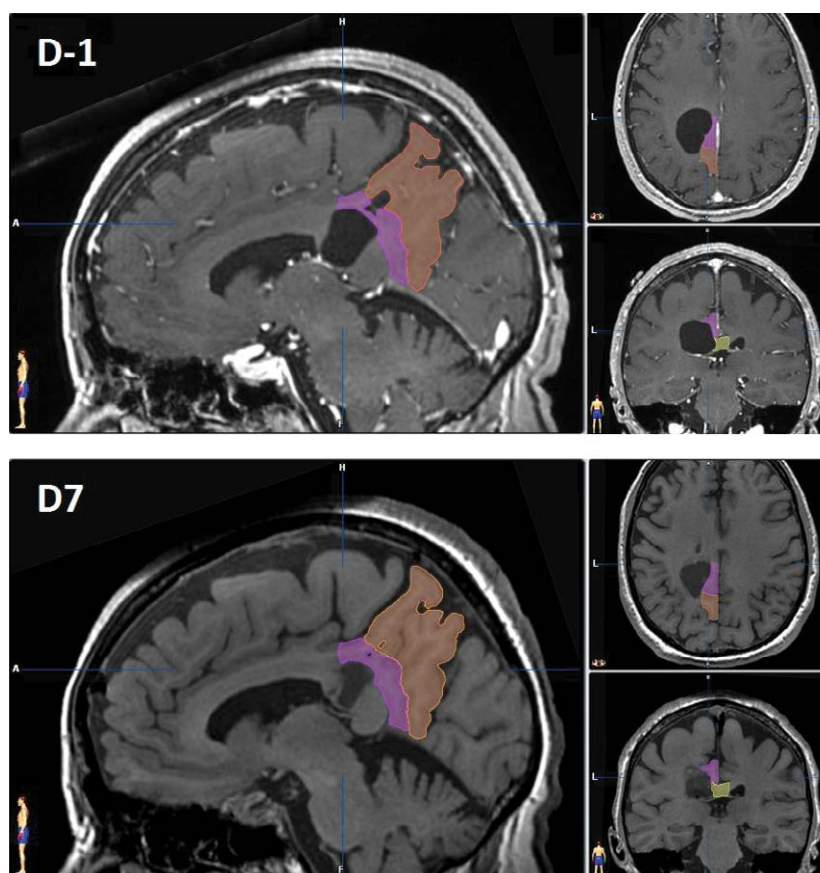
of corpus callosum (+21%), left posterior cingulate cortex (+20%) and left precuneus (+13%) (Figure 2). Right-hemispheric variations were negligible (Table 1).

Long term MRI follow-up analysis showed a decrease of cyst volume over time, from 15.57 cm<sup>3</sup> (D-1) to 9.64 (D7) to 2.4 (M8) to 1.21

(M15) to 0.15 cm<sup>3</sup> (M39 and M44). DTI-based tractography of corpus callosum and cingulum at D-1, M8 and M44 showed that white matter tracts of the splenium and left cingulum were still deviating eight months after surgery, whereas they went back to a regular shape at the end of the follow-up (Figure 3).



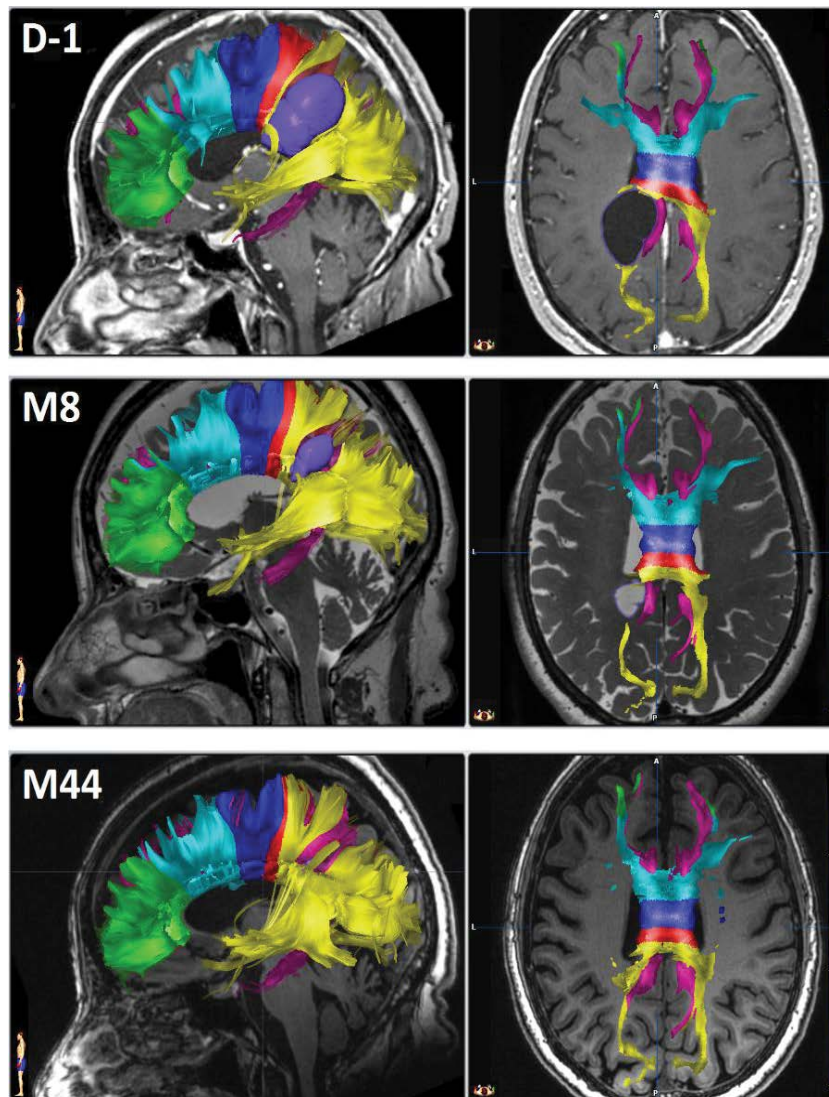
**Figure 1:** Timeline of the surgery, the hallucinatory period and the pharmacological treatment.



**Figure 2:** Contouring of the left precuneus (orange), the left posterior cingulate cortex (pink) and the splenium of corpus callosum (yellow), for volumetric analysis. (D-1) contrast-enhanced T1-weighted MRI acquired the day before surgery. (D7) T1-weighted MRI acquired the last day of the hallucinations.

**Table 1: Volumetric analysis: Volumes of brain cyst and surrounding structures the day before (D-1) and seven days after (D7) surgery, expressed in cm<sup>3</sup>.**

cyst	splenium of the corpus callosum	left posterior cingulate gyrus	left precuneus	right posterior cingulate gyrus	right precuneus
15.57	2.665	3.296	9.106	3.342	9.189
9.643	3.231	3.947	10.318	3.429	9.503



**Figure 3:** DTI-based tractography of bilateral cingulum (pink) and of the corpus callosum segmented according to connected areas<sup>8</sup>: prefrontal (green), premotor and supplementary motor (cyan), motor (blue), sensory (red), occipital, parietal and temporal (yellow). Cyst contours are shown in violet. (D-1) contrast-enhanced T1-weighted MRI acquired the day before surgery. (M8) T2-weighted MRI acquired 8 months after. (M44) T1-weighted MRI acquired 44 months after.

**Outcome**

Five years after cyst drainage, the patient did not recover from quadranosia. She had no recurrence of the hallucinations.

**Discussion**

Previous cases of visual hallucinations occurring

on eye closure have been reported following hip surgery under general anaesthesia [1], local anaesthesia with lidocaine [2,3], atropine administration [4], cardiovascular surgery [5,6], traumatic subdural hematoma in the left occipital region [7], trans-sphenoidal adenomectomy [8] and posterior callosal stroke [9]. The triggering of hallucinations by eye closure can be linked to the “cortical release phenomenon” due to visual

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deafferentation in Charles-Bonnet Syndrome [7]. The eye closure leads to the disruption of afferent visual input, and thus allows the release of visual hallucinations due to spontaneous endogenous neuronal activity in occipital visual cortices. Nonetheless, none of the previously described cases was associated with neither disembodiment nor self-motion illusion. Disembodiment is a feature of out-of-body experiences, involving the temporoparietal junction [11]. Vection or illusion of self-motion can be induced by the stimulation of the precuneus [12,13]. The patient reported visual reminiscences, which can be induced by the stimulation of rhinal cortices within the medial temporal lobe [14]. Thus, the symptomatology of the hallucinations indicates a common involvement of occipital, parietal and temporal cortices. The hallucinations appeared mostly bilaterally, implying a recruitment of both hemispheres. The splenium of corpus callosum connects occipital, parietal and temporal cortical areas [10] (see yellow tracts in **Figure 3**) and thereby is a good candidate in the genesis of these atypical hallucinations. The cingulum, connecting cingulate gyrus, precuneus and medial temporal lobe, might also be involved. Volumetric analysis before and after cyst drainage showed an increase of the cyst surrounding structures. This structural reorganization might have conducted to a transient hyper excitability. The release phenomenon induced by eye closure might have triggered the activation of a distributed network within associative visual, parietal and temporal cortices.

Visual hallucinations are relatively frequent in patients with acute stroke [15], and visual hallucinations on eye closure have been already described in a case of posterior callosal stroke [9]. However, in the present case, it seems unlikely that the hallucinations were related to stroke or epileptic induced stroke, as the MRI scans

acquired the day before surgery and the last day of the hallucinations showed no evidence of stroke. Electroencephalogram was not performed during the hallucinatory period, but the fact that the hallucinations occurred only during eye closure and that there was no postictal-like confusion once she opened her eyes tends to reject the hypothesis of epileptic seizure [16].

No direct relation could be found between the pharmacological treatment, including anaesthesia medication, and the hallucinations. Yet, Tramadol might have exacerbated the phenomenon, as previously observed [17].

Long-term follow-up showed a stabilization of cyst volume, near to zero, between 15 and 39 months after endoscopic surgery. DTI-based tractography analysis showed that the white matter tracts of splenium and cingulum were still deviating eight months after surgery, whereas they went back to a regular shape at the end of the follow-up. These findings suggest that structural reorganization after endoscopic cyst removal can be spread over long periods until disappearance of cyst-related deformations.

A particular attention should be paid to occurrence of hallucinations after neurosurgical procedures in the regions of the precuneus, the posterior cingulate cortex and the splenium of corpus callosum. Patients should be warned, because hallucinations can be very stress-inducing.

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**Conflict of Interest**

The authors declares no conflict of interest

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