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Case Report

Patient's Acting on their Own Care: Medical Hypnosis for Perioperative Management in The Awake Craniotomy. Technical Report and Clinical Cases.

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Abstract

The patient as the custodian of their own care is a concept that has been evolving for several years and can help the patient to a better and quicker recovery. Medical Hypnosis (MH) assist the practitioner to reduce the patient's pain and disorders and help the patient to understand, accept, and manage their situation. Recently, this technique has been increasingly used in awake surgery protocols. This paper describes three examples of the successful perioperative management of patients who benefited from an awake craniotomy for tumor resection with the aid of MH. Another case of a patient who had developed post-traumatic stress disorder (PTSD) after an operation without MH is also described.

Keywords
Medical hypnosis; hypnosedation; awake craniotomy; own care; post-traumatic stress disorder

1. Introduction

The concept of the patient-physician partnership has been developing over the years to facilitate the better treatment of chronic diseases [1]. MH could be integrated into the patient's "journey" as a co-adjuvant during anesthesia to promote and enhance a better recovery after brain surgery and improve patient satisfaction.

Awake craniotomy is a type of neurosurgery that mainly aims the maximum surgical resection to reduce the progression of tumors located in an eloquent brain area, prolonging the life of the patient and reducing the secondary neurological deficit. This surgery was initially developed for the surgical removal of the epileptic focus, currently the indications also include the resection of tumors, particularly the diffuse low-grade gliomas (DLGG) [2] or vascular malformations (cavernomas) that are located near or at the functional brain areas (eloquent areas of dominant language or motor areas). To limit the damage to the functional brain structures, the patient is evaluated "being awake", before and during the tumoral resection in the operating room (OR) [2, 3]. The term "awake" used, because classically the patient used to put to "sleep" (under general anesthesia GA), then they were "awake" for the tumor resection and then the return to "sleep" under GA, this kind of anesthesia technique is called the "Asleep-awake-asleep" technique [4].

DLGG is a chronic disease [5], and maximal resection is useful to improve the patient's quality of life (QoL). Some patients need to be operated on more than once following tumor progression.

Marie-Elisabeth Faymonville was the first anesthesiologist to describe the application of hypnosis in the OR [6]. She described a technique called "hypnosedation", which consisted of MH with pharmacological sedation and local or loco-regional anesthesia [6]. This paper highlights the importance of patient collaboration and motivation, while also indicating the need for a close collaboration between the patient, the anesthesiologist, and the surgical team. Before the surgery, the anesthesiologist must establish human contact with the patient, in the form of a real therapeutic relationship with them, and the patient must provide precise details of the event that they would like to live under hypnosis. With this hypnosedation, time distortion is induced, the precautions for which are also described herein. There is a minimal failure rate and conversion to general anesthesia (10:1400), which is frequently associated with a more complex surgery than expected and sometimes due to patient discomfort.

2. Materials and Methods

This paper describes three patients who had undergone awake craniotomy for the excision of DLGG. Two male patients were operated on twice following a tumor recurrence, and one female patient was operated on once without MH. The two male patients benefited from a Hypnosis-Aided Protocol (HAP) for the second surgery. A third patient was also operated on once using the HAP and returned to the hospital once a year to undergo an MH session and has not presented a tumor

recurrence till now. All patients described in the paper gave informed verbal and written consent to publish their data anonymously.

2.1 Preoperative Preparation

Traditionally, the patients' schedule for a surgery involved the administration of anxiolytics (premedication) the night before the surgery and on "D-day" to better control the anxiety generated by the surgery. This was important because anxiety is associated with increased nausea and vomiting after the surgery [7], as well as the increased requirement of anesthetic drugs [8], among others. During the last decade, this practice has been questioned [9] because secondary effects such as prolonged awakening after the discontinuation of anesthetic drugs were observed. In the case of awake craniotomy, such drugs must be avoided, as cognitive disturbances impede the neurological and speech evaluation. However, avoiding premedication does not mean that the patient does not have any anxiety associated with this surgery. Potter and Klimek [10] reported anxiety in 5–50% of the patients during such procedures, so an alternative non-drug strategy is needed. The role of the anesthesiologist during the preoperative phase is vital as a part of the team strategy to better prepare patients for the surgery. Therefore, as a substitute for anxiolytic premedication, anesthesiologists have employed the prescription of a "hypnotic task" [9], inspired by Milton Erickson's Works and Brief Therapies.

In our hospital, a patient who volunteers to work with the HAP is invited to write a hypnotic script before the surgery (hypnotic task).

MH has already been described in the management of cancer patients [11] and can be useful at every step, from the disclosure of bad news through therapeutic communication to surgery and other treatments to prolong the patients' life and their QoL. The benefits of MH in the immune system have already been published [11], the same research group published another study describing the power of hypnotic suggestions used in the perioperative period, which can affect several aspects of patients' outcomes (pain, analgesia, and psychological aspects) [12].

Some papers have already published the use of the HAP in awake craniotomy [13, 14], although they mainly focused on intraoperative MH and preoperative preparation was not always well defined. A recent French publication underlined the utility of optimal preoperative MH in a patient who was scheduled for the resection of an epileptic lesion during an awake craniotomy [15].

Since 2014, 20 to 25 patients/year at our hospital have benefited from an awake craniotomy for the resection of a DLGG, epileptic focus or a cavernoma. Before 2014, there were less than 10 patients/year. Since then, due to the requests of the neurosurgeon to have a dedicated neuro-anesthesiologist for the awake surgery [16], the anesthesiologist (GFPB) was assigned to accomplish that task and find a way to improve the patient's experience during awake craniotomy. After studying numerous papers and training at a reputed French neurosurgical Department (Pr H. Duffau's Department [4, 5]), she convinced herself that she needed new skills to improve patients' experience and collaboration during this particularly challenging surgery, as already described in previous medical papers [10, 13, 14]. Therefore, she decided to complete training in MH to "improve her professional performance" [17].

Over the years, awake craniotomy has been proposed for more patients to reduce the progression of a DLGG [2]. The following cases illustrate the preoperative hypnotic preparation and description of hypnosedation [5] in patients with a DLGG that had undergone an awake craniotomy.

In 2016, a French cohort demonstrated the of MH for awake craniotomy [13], and our anesthesiologist wanted to do the same with her patients. She trained in MH, although it was not enough to convince the neurosurgeons to do the "asleep" steps of the surgery exclusively under hypnosedation and not under general anesthesia. However, one patient (Mr. LC) was interested in the hypnotic interventions for the monitoring insertion and the awake phase (analgesia and anxiety treatment) during his first surgery and auto evaluated his comfort during the entire surgery with a score of 8/10. However, he expressed that the preoperative hypnotic preparation was insufficient (the anesthesiologist met him the day before the surgery during the preanesthetic visit) [18].

In 2018–2019, a study was conducted on the patient experience during awake craniotomy with the help of MH for the invasive monitoring of anesthesia and the awake phase. The results of this study were used by the anesthesiologist to validate the Certificate of Medical Hypnosis awarded by the Francophone Confederation of Medical Hypnosis and Brief Therapies (CFHTB) [19] and concluded that the majority of the patients found MH useful and acknowledged that the preoperative preparation (the day before the surgery) was too short for good preparation.

With these results, a better organization was necessary, so the anesthesiologist convinced the team (neurosurgeons, other anesthesiologists, and medical secretaries) that the patient must have a pre-anesthesia consultation with the same anesthesiologists who were assigned to the patient at the OR. A longer time slot (60 min) was also allocated for the pre-anesthesia consultation, which aimed to better prepare the patients for the surgery, anesthesia, and MH.

This pre-anesthesia consultation was based on Strategic Therapeutics, which aimed to strengthen the therapeutic alliance that would facilitate the hypnotic process during the surgery [20, 21]. The neurosurgeons, psychologist, and speech-language pathologist also suggested to the patients the possibility of performing this type of surgery with the aid of MH, thus sowing curiosity in the minds of the patients about MH.

2.2 Preparation for Medical Hypnosis

An MH practitioner knows that each patient needs a customized preparation. This practice entails asking patients who want to "work" in the theatre with the aid of MH as a part of some preoperative "homework". This specific task consists of creating or writing their hypnotic script. The instructions are given during the pre-anesthesia consultation in the form of one or two pages describing a physical activity or a special activity in which the patient is an expert or has already experienced a memory of something learned (real or imaginary) and is a *souvenir d'apprentissage* in the French form "*Techniques d'Activation de Conscience*" [22]. This is like a "film script" where the patient is the "film director" and the characters are well described; the patient can play the main role and the environment, including the weather, clothes, and so on, must be described [23].

The MH practitioner asks patients to choose a physical activity with physical sensations, as they are going to be touched and thus experience physical sensations during the surgery. Thus, the MH practitioner (GFPB in this study) can integrate these sensations during the hypnotic speech.

Once the script is ready, the patient must send it to the MH practitioner by email a few days before the surgery, so that she can familiarize herself with the content, understand the patients' words to "reinject" them during the hypnosedation, and adapt the script to the different steps of the surgery (monitoring, positioning, loco-regional anesthesia, skin opening, temporal muscle dissection, trepan holes, bone flap opening, and dural opening) [23].

A task prescription consists of prescribing a concrete action during the consultation, which the patient must perform after the consultation. "These actions are based on the kindness and creativity of the therapists" [24]. A therapeutic task differs from a post-hypnotic suggestion because the patient receives the instructions when fully conscious [24].

This "task" is inspired by those that have been already described in brief therapies [25] and has several objectives: 1) focus on a particular pleasant body-mind task before the surgery, 2) diminish anxiety-inducing thoughts, 3) create (or re-create) a body-mind anchoring for preparation for the surgery. The patient is requested to repeat (rehearse) their script several times before D-day [23]. The patient can contact the MH practitioner if they have any questions [18].

To prescribe the task to the patients, one must wait until the end of the consultation. The task is prescribed using a technique called "injunction prescription" [20]. This technique, which is described in the book of Milanese sisters [20], is performed slowly, punctuated, and the instructions are repeated several times. One can reformulate the instructions to repeat the important parts until the patient exhibits signs of "hypnotic capture" (eyes wide open, dilated pupils, even while blinking the eyes, associated with a relaxed posture). The practitioner must lean her body forward while the practitioner is looking at the patient's eyes; this posture highlights the injunction.

2.2.1 Hypnosedation

On the day of the surgery, once the OR is ready for the anesthesia and surgery, the MH is induced at the OR entrance while the patient is still in bed. The induction begins with the usual precautions, using the environment (proprioception, visual, auditory, and kinesthetic sensations), with respiratory pacing and mirroring, adapting the patient's hypnotic script to each phase. Catalepsy of the arm, which will be evaluated during the test phase (contralateral to the brain tumor), is also installed. Some post-hypnotic suggestions are "injected" at this moment once the patient is already in "trance", and they are oriented to:

- The perfect cicatrization of the surgical wound
- An excellent reestablishment after the surgery
- A good neuropsychological performance during the "test phase"
- A reduction in bleeding during the surgery, maintaining only the necessary amount to reassure the surgeon, the minimum necessary for a perfect cicatrization and tissue nourishment [26].
- The creation of "new connections" between the side of the body that is going to be evaluated during the surgery and the brain
- The mobilization of the patient's resources
- Suggestions for autohypnosis

Then, there is a brief interruption for the installation of the patient on the surgery table. At this moment, the patient is asked to remain partly in the hypnotic trance, with another part (dissociation) authorizing "the body" to be lighter for the patient's installation on the table. Each interruption is used to go further deeper into the hypnotic trance, like a computer restarts after the installation of a "new software", which needs to install "new files".

Once in the OR, the patient is monitored with the standard equipment (EKG, noninvasive blood pressure, and pulse oximeter), a facial mask (capnomask) with oxygen is also provided. Then, a venous catheter is placed on the hand on the same side as the tumor localization while the patient is still in trance, and confusing language is associated with increasing comfort [27]. Then, the

intravenous sedation begins with dexmedetomidine (0.3–0.5 $mg*kg^{-1}*h^{-1}$), a hypnotic that acts as a highly selective α-agonist that can provide analgesia and anxiolysis without compromising the airway patency. The drugs take approximately 15 min to start being effective, so the hypnosis deepens to install another venous catheter (planned for norepinephrine if needed), to place the urinary catheter, and intermittent pneumatic compression sleeves. Then, the loco-regional anesthesia is installed, which is a very painful procedure because of the rich innervation of the scalp (trigeminal and cervical plexus branches) also due to the low local anesthetic pH, so the remifentanil infusion is turned on with a target control infusion (0.5–1 $ng*mL^{-1}$). The scalp nerve block (SNB) is injected simultaneously, which acts as a "protector hat" for the patient, like the "hypnotic magic glove" [28].

Once the SNB is installed, the Mayfield™ skull pin holder is placed giving the instructions to the patient to "send the energy to three different points" [13]. Simultaneously, the patient is positioned in a modified supine position (some cushions are placed under the shoulder on the side for the operation) or in a lateral position depending on the localization of the tumor. At this phase of installation, the patient is subjected to a caudal to cranial *body scan* to observe their body, assess each part of their body and improve their position. Then, a consensus is established between the patient, the neurosurgeon, and the anesthesiologist for a better and more secure position. After the installation of the patient, the neurosurgeon records the benchmarks of neuronavigation, following which the Medtronic™ Biespectral Index™ Quatro Monitoring System electrode is placed in the patient's forehead to directly measure the patient's level of consciousness.

After the placement of the surgical drapes, the neurosurgeons begin the surgery with the scalp incision, the hypnosedation is adapted according to the patient's comfort. The hypnotic words are "injected" according to the patient's hypnotic script, and if this is not enough, the sedation drugs are adapted and titrated, particularly during painful stimuli such as skin incision (usually covered by the SNB), temporal muscle detachment (not covered by the SNB), and trepanation and opening of the bone flap. Before opening the dura mater, the sedative drugs are stopped, and the dura mater is given local anesthesia and then opened. At this moment, the patient is reassociated to be "here and now", the patient needs to be ready for neuropsychological evaluation during the brain mapping of the cortical and subcortical pathways. The tumor excision is performed up to a safe margin according to the patient's evaluation. At the end of the tumor excision, the patient can return to the hypnotic state or simply be put under sedation; usually, they are very tired because of the continued evaluation and then fall asleep.

During the postoperative period, the patient is monitored in the Post Anesthesia Care Unit (PACU) for an hour, after which, they are transferred to the Intensive Care Department until the next day.

2.3 The Psychologist's Point of View

On the psychological level, the diagnosis of a brain tumor reactivates certain anxieties (including death and fragmentation) and causes the patient to experience a loss of control. The patients "construct" themselves according to a personality structure, which is the result of adjustments to drives, satisfactions, and frustrations when exposed to their environment and frames of reference. Accompanying a patient throughout their medical journey involves considering two elements, the defense mechanisms to fight against these anxieties and personalities, as well as their interactions, among other factors. The patient will be exposed to different stages, which will cause them to

experience considerable emotional fluctuation. The patient will have to find ways to deal with these with the help of the medical, paramedic, and psychological team, their close ones, including family and friends, and their own internal and external resources (psychological). During an awake craniotomy, patients must deal with their subjective experience, their cognitive functioning, and the level of trauma [29]. Postoperative psychological symptoms correlate with their corresponding preoperative symptoms, which makes psychological support important [29, 30].

As part of the brain injury, the patient will experience a loss of control at each of the following stages:

- During the diagnostic announcement with elements that will be introduced on the psychological level and with emotions that may emerge,
- Exposure to the reaction of relatives,
- Regarding the extent of brain damage,
- During medical examinations,
- Exposure to the proposed treatments and their effects,
- During cognitive assessments with results that are often poorer than the initial functioning,
- During the surgery,
- In the body (often with epileptic seizures),
- While returning home,
- Faced with rehabilitation.

During surgery, additional anxieties may appear regarding self-esteem and confidence. For example, the patient may wonder if they will live up to the expectations and if they can handle the pain.

Simultaneously, awake surgery promises to minimize postsurgical sequelae, which appears to be a positive objective for the patient, who also understands that the quality of their participation and preparation will partly affect the results. Awake craniotomy allows the patient to be active during care and promotes an initial recovery of control. A study by Palese *et al*. has reported that having control over the situation is more important for patients than feelings and emotions [31].

The patient plays a central role during cortical mapping as they are tested during stimulation. The more specific their answer, the more thorough the mapping. However, the patient may also be confronted with a loss of control, particularly in the event of transient aphasia or hemiplegia [32].

Therefore, the main objective of the accompaniment is to return the power to the patient and encourage their action on the progression through different stages, from the announcement of diagnosis to rehabilitation. MH is a complete tool, as besides providing the patient with external resources while mobilizing their own resources, it promotes pain management and personalizes the medical act. Keeping emotions under control has been described as an important psychological factor in awake craniotomy patients [9].

Four of our patients described in this paper underwent awake craniotomy: LC, MP, GV, and AS. GV benefited from a single surgery; LC and MP benefited from two awake surgeries at our facility, with or without MH; AS was operated on awake and without MH.

3. Case Description

Each year, an average of 20–25 patients are operated upon at the neurological hospital under awake craniotomy.

This paper describes four patients with DLGG. Two male patients were operated on twice, secondary to a tumor recurrence; another male patient was operated on once; one female patient was operated on once without MH. The two male patients benefited from a HAP for the second surgery. The third patient was also operated upon once with the HAP and presented to the hospital once a year to undergo an MH session and has not shown tumor recurrence till now.

3.1 The Patient Who Inspired the Authors to Write This Paper

Three months after a second awake craniotomy for the resection of a low-grade astrocytoma, Mr. LC, a 49-year-old man who works in Marketing (considering a reconversion to carpentry), opted for the neuropsychological postoperative evaluation, and surprisingly, some results were better than before the first surgery despite having less brain tissue.

As soon as he knew that his tumor had progressed and second awake neurosurgery was necessary, the patient contacted the anesthesiologist to fix an appointment. He aimed to achieve optimal preoperative hypnotic preparation. He had a good experience with hypnosis during the first surgery but mentioned that the preoperative hypnotic preparation was too short. For this second surgery, he wanted to go further and be more active to be better prepared for MH. He also aimed to avoid general anesthesia and get a better prognosis after the surgery. As he had some time to be prepared (almost three months), he wanted to be ready with the help of autohypnosis.

In 2018, Mr. LC underwent the excision of the left frontal-temporal-insular lesion during an awake craniotomy with an asleep-awake-asleep protocol. The first half of the asleep part of the surgery involved hypnosedation for insertion of the invasive monitoring devices (venous and arterial catheter, urinary catheter) and the loco-regional SNB. After the placement of the Mayfield™ Skull pin and positioning of the patient, he was put under GA using a laryngeal mask. During the awake period, some occasional hypnotic interventions, such as a focus on respiration, reification, and emotional validation [33], were performed to provide more comfort and non-pharmacological analgesia to the patient. Importantly, during the awake phase of the surgery (cortical and subcortical mapping, tumor excision), the patient needs to be conscious to be evaluated, and so, the pharmacological interventions to provide better comfort (particularly opioids) might disrupt the neurophysiological and speech test. Thus, pharmacological analgesia was limited. Although it is believed that the brain “does not hurt”, some papers [19, 34, 35] relating the team experience with patients undergoing an awake craniotomy demonstrate that it is not true. Some structures, such as meninges, perivascular structures, the insula, and deep tissues of the skull base, are rich in pain receptors (trigeminal pathways), and the patient can experience pain, uncomfortable noises, and “weird” sensations during the surgical stimulation or resection of these areas [19, 34, 35]. Mr. LC had an insular extension of this tumor and experienced major pain during the resection in this area, despite having already received a multimodal and pre-emptive analgesia treatment before the craniotomy (loco-regional anesthesia, paracetamol, dexamethasone, and magnesium sulfate). Therefore, hypnotic interventions such as pain reification [33] and focus on respiration were provided to make him more comfortable and let the neurosurgeon continue with the tumor

resection. At the end of the surgical tumor resection, the patient was again put under GA for the dural, cranial, and skin closure.

3.1.1 Preoperative Preparation and Autohypnosis Training

Mr. LC was already practicing MH unknowingly before his first cranial surgery. He used to focus on his breathing to manage some difficult personal situations, as well as playing sports. After the first surgery, he continued focusing on his breathing to "dissociate" his mind, send it to a different place, and observe it from a different point of view, like when it was out of his body during difficulties with his family, car journeys, or during cerebral RMI studies, and used to "turn off a light switch" to better control his epileptic crises despite being under medication (Levetiracetam) for this purpose.

For the preoperative preparation of Mr. LC's second surgery, the anesthesiologist proposed to train him in autohypnosis. As he had already experienced MH during his surgery, she recommended some exercises and the reading of a specific book [36, 37].

He developed a very creative hypnotic script, which was a mix of memories from past hikes. The text contained abundant body sensations (proprioceptive, visual, auditory, and smell). Difficult situations were also described, which are extremely helpful during difficult surgical moments.

Hypnosis-aided awake surgery was successfully achieved. The patient was very well prepared, and his comfort was adjusted with hypnotic word injections, dexmedetomidine, and remifentanil target intravenous infusion, while propofol was just used occasionally as a bolus to treat convulsions during cortical and sub-cortical mapping. GA was avoided.

3.1.2 The Assessment of Mr. LC by the Speech Pathologist

Mr. LC, who was unemployed at the time of surgery, was seen for a speech and language therapy assessment before the second awake surgery. Mr. LC had undergone speech therapy in 2018 and 2019 (metacognitive work, theory of mind, and executive functions), with good recovery of language, even if the communication strategies were still problematic and bothered him in his exchanges. He complained about anomia. During the second postoperative speech therapy check-up after the second surgery, he reported visual disturbances and hallucinations. Mr. LC still complains of fluctuating difficulties in finding the right word (superordinate or subordinate) and proper nouns. He also has difficulties in adapting his speech to the level of understanding and knowledge of his interlocutor (pragmatics) and would like to improve in this area. Therefore, Mr. LC will continue speech therapy with a private speech therapist.

After his surgery, Mr. LC received chemotherapy with Temodal and radiotherapy for 14 months to treat the left insula tumor residue. He attends speech therapy every two weeks and has shown good recovery.

Regarding the speech evaluation three months after the surgery, he complains of persistent right lateral homonymous quadranopsia. The results were quite good, and the speech therapy could be stopped, as suggested by his private speech therapist. However, Mr. LC will continue to stimulate all areas of language (evocation, reading, and writing).

3.1.3 The Psychologist's Point of View on Mr. LC

Mr. LC was a forty-nine-years old male with a partner and no children. He had a left fronto-temporo-insular lesion. The patient's primary complaint was tinnitus, numbness, and the use of vocabulary that surprised him. Before his first awake surgery, the patient was particularly in control and presented statistics on the frequency and intensity of his epileptic seizures. Emotions were hidden, and his personality was more of a schizoid type. We had highlighted vigilance on a possible psychological decompensation in this context. Mr. LC was subjected to MH during his first surgery. He was more serene and less intransigent. Therefore, he asked for hypnosis support during his second surgery. This support helped him to exercise control during the preparation for the surgery, which further refined him. During the postoperative assessments, the patient was particularly open and satisfied despite the diagnosis, as he could remain resilient owing to some old traumas and successful surgery.

The case of Mr. LC shows that the use of MH allowed him to have a tool that matches his desire for control and optimal preparation. What is particularly interesting on a psychological level is that hypnosis finally encouraged letting go of the expression of feelings and emotions, which were particularly repressed during the first surgery. Hypnosis, which promotes creativity, broadening of thought, and intuitiveness, has allowed Mr. LC to experience emotions that until then were probably unknown to him (due to some defense mechanism) and that he could experience in a specific context. Thus, in this case, MH favored the loss of control in the sense of letting go. He changed his fear of not being up to the task with ten-fold motivation and concentration [38].

3.2 Second Patient, Mr. MFP

Mr. MFP, a forty-seven-year-old male patient, was first diagnosed with grade II left oligodendroglioma after an initial generalized epileptic crisis. He was operated on for the first time in 2010 with the asleep-awake-asleep protocol, with general anesthesia being used for the asleep phases. Infection at the surgical site was diagnosed after the surgery, which was successfully treated with antibiotics. He developed a dysexecutive syndrome and continued to work part-time after the first surgery.

In 2019, he noted minor changes in character, such as irritability. At this time, the oligodendroglioma was upgraded to grade III (anaplastic glioma), and a second awake surgery was scheduled.

3.2.1 Visit for Preoperative Anesthesia, Anesthesia, and Surgery

The anesthesiologist and MH practitioner met the patient a day before the surgery. He was evaluated by another anesthesiologist during the pre-anesthesia consultation. After the priming of the therapeutic alliance, she suggested a hypnotic accompaniment during the first phase of the surgery, before the skin incision. After a brief moment of hesitation, the patient accepted and chose the memory of an ABBA concert with his family in Australia. The anesthesiologist agreed and decided to also prepare a playlist with ABBA music for the surgery.

Once in the OR, the patient was induced hypnotically by recalling his memories of the concert, using a multisensorial canal approach, particularly the auditory one (the ABBA music was playing in the background simultaneously; the patient, the surgeon, and the anesthesiologist were also singing

some of the songs). The standard and invasive monitoring devices (venous cannula, urinary catheter, etc.) were placed, and SNB was performed. Simultaneously, post-hypnotic suggestions were "injected", associated with the sedation perfusion. After the insertion of the Mayfield™ skull pins and neuro-navigation system identification, the patient was put under general anesthesia, and a laryngeal mask was inserted. He was then woken up for the neuropsychological tests. During the brain mapping (cortical stimulation), his right arm was temporarily blocked. Then, during the ablation of the surgical tumor, he started having trouble naming objects and developed a right hemiparesis (motor deficit), so the tumor excision was then stopped.

In the immediate postoperative period, he showed persistent severe hemiparesis and began to recover from day 1 (more proximal than distal) under corticosteroids. On day 4, he developed a fever and was put under antibiotics for a week. The cultures did not find the responsible pathogen.

After a period of physical rehabilitation and chemotherapy, the patient returned to work 70% of the time and declared himself more "confident".

3.2.2 Speech and Language Assessment

The patient appeared a little worried about this second surgery. The results of the speech-therapy evaluation (second surgery) indicated a stable performance, with an improvement in some parameters.

During the postoperative period, he remained asthenic and slower, with right hemiplegia that was developing well. Written expression was not offered because of right-hand paresis. The Exade was 85/90 (with two anomia, two semantic paraphasias, and one phonemic). Good reading comprehension (MT86) was observed. The patient needed to work with a speech therapist as a slight evocation disorder persisted.

Four months after surgery, he had one month of speech rehabilitation at a rehabilitation center, with good recovery of language. There was no further speech therapy at discharge. The tumor was finally a grade III oligodendroglioma, for which the first chemotherapy was performed (POLCA protocol). During the last evaluation, the BDAE was not proposed. Written comprehension was not a problem, but the patient complained about his handwriting (for checks and signatures), which was probably related to the postoperative motor disorder.

In summary, a slight evocation disorder persisted, and Mr. MFP did not wish to undertake speech therapy for the time being, as he was already occupied with complementary treatments.

Mr. MFP was contacted during the writing of this paper by the neuropsychologist and the anesthesiologist to evaluate his situation with him and obtain his experience of the two surgeries. The patient had a very positive memory of the second surgery. He even remembered that the entire surgery was under hypnosedation; he remembered the installation of the hypnotic trance, the comfort, the happiness of recalling the ABBA concert, and he connected himself with that important phase of his life with joy. He was asked whether he had a bad memory during surgery, but he could not answer it. During the brain mapping, he developed a motor deficit and did not want to remember it. He said that he had been warned of such situations during the pre-anesthesia visit, so he was prepared for it, and that helped him.

Currently, the patient continues to listen to ABBA songs and does not recall the surgery with this auditory stimulus. However, during the chemotherapy sessions, when the nurse asked him if he

wanted to hear a particular genre of music, he said "I do not care about the music, but please do not put ABBA songs", as he wanted to associate the memories of ABBA songs with happiness.

After the surgery, the patient underwent psychotherapy with a psychologist who was also a hypnotherapist until he thought he did not need it anymore. He also bought some autohypnosis books and started practicing autohypnosis for some time, and then completely stopped it.

The patient identified a change before the second surgery, a type of self-realization.

3.2.3 The Psychologist's Point of View on Mr. MFP

Mr. MFP is 49 years old, married, and without children. He is an insurance executive. He has an anaplastic left frontal oligodendroglioma. Although he had not benefited from MH during his first surgery, he believed that hypnosis was an additional tool at his disposal during the second surgery. According to him, MH facilitated the better management of postoperative fatigue and, consequently, the optimization of his cognitive recovery. He remembered that he did not have the strength to answer the phone after the first operation "as if he were still anesthetized", which was not the case during the second operation. Hypnosis also fostered a positive emotional induction connected to his family circle, and the chosen script (an ABBA concert in Australia) referred to an action that he had not been able to perform. During the surgery, with the aid of hypnosis, he "realized the impossible" while letting go.

The case of Mr. MFP goes in the direction of an option to let go by hypnosis, like for Mr. LC. For the patient, hypnosis facilitated the better management of the administration of anesthetic products, and therefore, less difficulty in postsurgical awakening. He felt less fatigued and more adept at cognitive recovery.

After the second surgery, the patient continued to use autohypnosis to manage some difficult situations, including RMI examinations and difficult family situations, among others.

3.3 Third Patient, Mr. GV

Mr. GV, a 27-year-old patient, was scheduled for the resection of a left frontal low-grade tumor. He met another anesthesiologist at the pre-anesthesia consultation. One week before the surgery, the MH practitioner called the patient to introduce herself to get to know the patient and propose to the patient MH for his awake surgery. Initially, the patient was angry because he did not understand the purpose of the call and why he did not meet the right person at the pre-anesthesia consultation. However, the strategic dialogue helped calm the patient down as he understood the interest of MH for his surgery. The day before the surgery, he met the MH practitioner in person and prepared an amazing and very creative hypnotic script, which described the adventures of a dog called "Tommy", a beautiful Golden retriever. To find his biological parents, Tommy had to cross the United States of America from the East to the West coast. He came across several obstacles, and thanks to several characters (cats, dogs, and other animals), he could achieve his goal. On D-day, the patient played the main role and assigned the role of each character to each of the health providers present in the OR (the anesthesia nurse, scrub nurses, auxiliaries); the surgeon was the director of the orchestra and was responsible for the soundtrack (notably, the surgeon had put on music during the surgery) and the MH practitioner/anesthesiologist was assigned as the film's narrator. His surgery was the first successful awake craniotomy made under hypnosedation at the hospital, no propofol or GA was required, and the patient and the entire surgical team were very

happy and satisfied with the results. During the post-operatory period, the patient developed a minor distal deficit of his right arm secondary to the tumor resection, and physical reeducation was prescribed. The patient returned to work very quickly (a month later). One year later, he contacted the MH practitioner to improve the sensitivity and motor performance of his right arm, as he needed to be more active at work (he used to travel and frequently flew to other countries as part of his job).

A special hypnotic session was scheduled with the MH practitioner. During the session and after the "yes set" sequence, with the help of mirroring hypnotic and strategic dialogue, a right arm levitation was installed. Tommy, the hero of his hypnotic script, "returned" to facilitate the hypnotic work. The post-hypnotic suggestions consisted of the creation of new connections between his right arm and hand with his left brain, new "ways", and a new network for communication. During the session, catalepsy was installed in his right hand, and important diaphoresis was developed. This phenomenon was *ratified*, Tommy was licking his hand, which helped him achieve hypnosis better. A year later, he contacted the MH practitioner again to schedule another hypnotic session, and this time he wanted to improve his asthenia. Once more, the hypnotic trance was induced after the "yes set sequence", mirroring, hypnotic discourse, and catalepsy of the right arm were installed. Post-hypnotic suggestions focused on energy, the capacity to feel better, and the metaphor of "savia nutritiva" was suggested to the patient. This consisted of the visualization of his feet as plant roots, where the plant absorbed the nutrients and the energy needed by it to grow well and flourish. The patient was invited to feel, hear, see, taste, and smell this energy that rose and scattered all over his body with the help of a body scanner. To anchor this energy to his body, a point on his right wrist was identified, which could be used by the patient to reactivate the energy whenever needed, as suggested during another post-hypnotic session.

The patient keeps in touch by mail with the MH practitioner once a year and asks for some exercises that can be performed at home.

The neuropsychological assessment and psychological interview were difficult to establish with Mr. GV, who probably had an atypical personality and a possible frontal behavioral syndrome. The patient did not have a major anxiety disorder and mostly showed a denial or *anosognosia* of his difficulties regarding the surgical situation. Nevertheless, the practice of MH was proposed, and he demonstrated a rich and ultimately well-invested scenario.

The case of this patient shows the extent of the scope of application of MH beyond the manifestation of anxiety and stress related to the loss of control. While the patient was rather "elusive" psychologically during his preoperative preparation by not being able to verbalize his feelings, he was finally channeled and framed using the hypnotic protocol, which helped him to refocus and better manage his frontal behavioral manifestations.

3.4 Fourth Patient: Mrs. SA

Mrs. SA was a 43-year-old, right-handed, married female with two children. She worked as an accountant. The patient presented a right frontal tumor revealed by generalized convulsion crisis. She was seen by the anesthesiologist (GFPB) during the pre-anesthesia consultation. She was worried about the surgery and asked several questions. She was in favor of surgery under the HAP. For organizational reasons, she was managed by another anesthesiologist who was not trained in MH.

The surgery was performed under loco-regional anesthesia (SNB) and sedation. The patient was cooperative but very worried. During the brain mapping, she developed left hemiplegia. After the surgery, she developed PTSD and was evaluated by psychologists who recommended EMDR therapy.

The postoperative language assessment was very limited, and the test had to be stopped because it reminded her of the operating room.

She required additional chemo and radiotherapy, while no postoperative speech evaluation was made three months after the surgery (she was operated on in Dec 2021 and left for a rehabilitation center). The language assessment could only be conducted in Feb 2022, before her discharge. Mrs. SA did not perceive any particular difficulties in language and communication other than a general slowdown. The speech and language evaluation revealed a lexical evocation disorder (already present in the preoperative period) and a minor impairment of metacognition.

3.4.1 The Psychologist's Point of View for Mrs. AS

During the first meeting with the neuropsychologist, Mrs. AS appeared very anxious. She complained of the appearance of cognitive disorders after taking on antiepileptic treatment. Besides managing the diagnosis announcement and the rapid decision of surgery, she experienced major changes at home and reported a loss of control over her emotions, intellectual functioning, and the management of her daily life and interactions. Due to the unavailability of the MH practitioner on D-day, the patient was operated on with the classical asleep-awake-asleep protocol without special preoperative preparation (other than pre-anesthesia consultation) or MH. When she woke up at the beginning of the surgical procedure, the patient appeared quite serene and became involved in the proposed neuropsychological tests. No other tools besides her internal resources and the medical, paramedical, and psychological team present in the OR were available to her. At one point during the brain mapping and following stimulation, the patient completely lost the use of her left arm (motor deficit) and experienced transient aphasia and hemiplegia. As she was unprepared and could not identify what was happening to her without any personal scenario or script, she panicked, and this triggered a real state of post-traumatic stress, verbalizing resulting in the loss of control and leading to the neurosurgeon taking control of her body. Faced with a significant state of anxiety, it was decided to stop the stimulation at an advanced stage, and the patient fell asleep again without having regained full control of her arm. Upon awakening, the state of post-traumatic stress was proven, as the patient was particularly anxious and inaccessible to postoperative evaluations.

The case of Mrs. AS demonstrates the traumatic impact that surgery in the awake condition can generate with the experience of loss of control. The experience of severe anxiety during awake surgery can foster the development of postsurgical PTSD [39]. *The impact on the consequences of the patient's journey is significant, as each procedure or proposal is experienced as an attack. Although we cannot confirm this, a patient who was prepared and working with MH would likely have used and mobilized additional resources before surgery and especially during the surgery. We hypothesize that the loss of control would have been less traumatic with the use of MH.*

4. Discussion

A preoperative preparation with non-pharmacological techniques such as MH is a better alternative to anxiolytic premedication [9].

Visual, verbal, and physical contact with the patient during the awake surgery (such as holding the patient's hand if needed), associated with positive suggestions and encouraging words, and avoiding negative words [40, 41], are beneficial interventions to reduce the feelings of helplessness and cover the basic human psychological needs [9, 41]. The patients used to have positive feedback regarding the investment of the team before and during the surgery. They expressed grateful security due to the presence of the anesthesiologist or MH practitioner during the entire surgery. During the preanesthetic consultation, the anesthesiologist stated several times that she would be in the theatre beside the patient all the time to ensure the comfort, safety, and care of the patient [41]. Also, if MH is not enough to cover those aspects, the sedation will be increased "given only the necessary and no more than necessary", as recommended by the therapeutic communication literature and other papers [30, 32].

Even though awake surgery is generally well tolerated by the patients [42], some patients can develop a post-traumatic stress disorder (PSTD) after the surgery, as observed in the case of Mrs. AS. In the medical literature, this question has already been raised. Rahmani et al. [42] enrolled 28 patients that were scheduled for an awake craniotomy to evaluate their anxiety, depression, and PTSD one week before, as well as one month and six months after the operation. They did not report any exacerbation of anxiety or depression disorder after the surgery; three out of the 28 patients had PTSD symptoms three months after the surgery, while at six months, there was no indication of PTSD.

A German medical team reviewed the patient's responses to awake craniotomy [37]. Their conclusions highlighted that most patients felt well prepared and were highly satisfied overall with the procedure. Up to 30% of the patients in the reviewed studies reported considerable pain, and 10–14% experienced severe anxiety during the procedure, while several patients agreed to undergo another awake craniotomy. PSTD was not observed either shortly or several years after surgery. [37]. The same team studied 16 patients undergoing an awake craniotomy with the help of the Posttraumatic Stress Disorder Inventory [43]. Two patients showed symptoms indicating PSTD, and the authors identified younger age and female sex as the risk factors for this psychological sequela [43].

Even if the patient is not in the operating room to undergo psychotherapy, the trance states and the expanded consciousness that settle in the OR, provide a basis for inner work. The "protective" and benevolent words used by the hypnopractitioner [44] are a precious opportunity for the patient's subconscious to be available and find answers to his/her questions. It is a suspension of time, with a probable reset of the five senses [45]. In this amplified state of consciousness [46], changes, evolution, and acceptance can take place.

The interest for MH supersedes its utility in the operating room; it mobilizes resources because the unconscious mind is presented as a storage space for all the learning that has been already acquired throughout one's life. Hypnosis makes it possible to put the patient, who is "frozen" by the onset of the tumoral disease (passive), into action to be an actor in their own care (active patient) and help them through their bereavement by mobilizing their contribution toward good health and integrity [44].

During the preanesthetic consultation, some patients expressed that they would be afraid of hearing noises and conversations during the surgery. Through a strategic dialogue, the MH practitioner would tell the patient that "the more noise there is, the more comfortable will it be". It was also metaphorically suggested to the patient that they could manage the noise "like the sound of an engineer's console, which is full of equalizers, so that they could choose and focus on what they want to hear on priority, like the voice of the MH practitioner.

Music is another non-pharmacological intervention to manage anxiety during surgery. In a Turkish study [47], 75 patients scheduled for surgery under spinal anesthesia were randomly assigned to either hearing music or the background noise. The patients who listened to music during the surgery were sedated better, had lower anxiety scores, and had higher postoperative satisfaction [47]. Recently, the effect of music in awake craniotomy was also assessed through two types of music (in a major or minor key), and the results confirm the benefits of listening to music in the reduction of anxiety during awake surgery [48]. The authors did not find any adverse reactions to music. The patients also expressed they would prefer to choose their music [48].

In our study, Mr. MFP and Mr. GV listened to music during the surgery. The first patient chose the ABBA concert and was surprised and happy to listen to the music that he liked during the surgery. For the second patient, the music was chosen by the neurosurgeon. Both patients felt comfortable with the music and did not appear anxious during the awake surgery. The exact mechanism of the positive effects of music on anxiety has not been studied yet; maybe, changes in the immune system mediators and the parasympathetic system are involved [48].

Mrs. AS was a young female patient. Our team hypothesized that Mrs. AS may have thought that she was in lesser control and felt abandoned during the surgery, so her basic psychological needs (relationship, control, pleasure gain, self-protection) were not met. These factors have already been reported to be related to the development of post-traumatic stress disorder [41].

Maybe, if she had benefitted from MH during surgery, she would have mobilized her resources to better deal with the neurological post-operatory deficit.

In a French cohort study, the team of Zemmoura and Fournier [13] reported one case of PSTD in a male patient despite the use of hypnosedation. That patient was assessed by a psychiatrist and refused psychotherapy. He positively described the hypnotic experience "and continues to use Medical Hypnosis in his everyday life". Unpleasant moments for the patients were associated with the placement of the skull pin and skin incision, with no association with a neurological postoperative deficit.

Regarding Mr. MFP, he felt like he was still "under anesthesia" after the first surgery and did not have the same feeling after the second one, despite being also given GA (asleep-awake-asleep technique). He probably mobilized his resources with the help of a *Memory Souvenir* to feel better during and after the second surgery/anesthesia.

As this is a descriptive study, it has several limitations. First, few patients that were treated under awake surgery were described. Second, the patients were not assigned randomly to benefit from MH. Third, anxiety scales were not used before and after the surgery to assess the level of the patient's anxiety. Thus, as it is a descriptive manuscript, there are some limitations to the conclusions arising from the study.

5. Conclusions

Awake craniotomy presents a challenge to the health team. The use of non-drug techniques to enhance patient comfort is not only a complement but also a need.

Hypnosedation combined with loco-regional anesthesia for awake craniotomy is well tolerated by patients, diminishing the risk of a lack of cooperation from the patient during the perioperative neuropsychological tests due to the reduced drug intervention, and is probably more effective than an anxiolytic drug. MH helps the patient to be more active in their medical "journey", providing the patient with a new tool to confront difficult situations. The patient becomes active in their care.

Preoperative preparation of the patient using MH requires time, a different medical and paramedical setup, and the availability of an MH practitioner with appropriate training. The therapeutic alliance between the patient and the MH practitioner must be strong to establish a relationship based on trust.

Post-hypnotic suggestions are vital and must be accepted by the patient to be ready for the new "changes", improved comfort, reduction in bleeding, optimal cicatrization, analgesia, and speedy recovery.

MH is a useful tool to help the patient remain ready and calm for the surgery. Thus, it improves the neuropsychological and speech evaluation during awake craniotomy, diminishes the risks associated with general anesthesia (including airway management and Meldenson's syndrome), provides optimal management of anxiety, gives the patient better control over the stress involved (such as being awake in the operating theatre, uncomfortable noises, awkward positions, and developing a neurological deficit following the surgery), and provides a better and faster neurological recovery after surgery.

The basic psychological needs of patients must be addressed with both words, such as security and comfort, and actions that match the patient's right position, such as balancing proxemic distance, physical contact (holding the patient's hand), and respecting the patient, to prevent post-traumatic stress disorder.

The discussion about the psychological aspects is complex. As we have observed in this and previous studies, the success of awake surgery depends on several factors, including the patient's personality, personal history, anxiety management, defense mechanisms, and the location of the lesion. Soon, we propose that our team systematizes the psychological evaluation before and after awake surgery. For this, the evaluations will focus on the depressive and anxious state of the patients with the help of the Beck Depression Inventory [49] or the Hospital Anxiety and Depression Scale [50]. Also, the patients' state of post-traumatic stress with the help of the Impact of Events Scale-Revised [50, 51], as well as the inventory of traumatic life events before brain injury that could be reactivated during awake surgery, need to be evaluated. This detailed and systematic evaluation will facilitate the identification of specific profiles for the better adaptation of patient management in the long term. For example, it has been shown that hypnosis offers a considerable advantage in the presence of an anxiety disorder to control anxiety and cope with a phobogenic event.

Patients tend to return to work soon after surgery with the HAP. For those who need complementary treatment (radiotherapy or chemotherapy), MH can be used to reduce its adverse effects.

Solid teamwork between the patient, surgeon, anesthesiologist, psychologist, speech therapist, and oncologist is essential to better prepare the patient for surgery, anesthesia, possible

neurological postoperative sequelae, and complementary therapy. The anesthesiologist plays a key role during the preoperative and perioperative period and can contribute to the patient-physician partnership; thus, facilitating optimal patient preparation and maximal collaboration during the awake or test phase, especially with the aid of MH.

Patients benefiting from MH were active in their care throughout the preoperative hypnotic task.

Author Contributions

Each author's contributed equally to this work respectively.

Competing Interests

The authors have declared that no competing interests exist.

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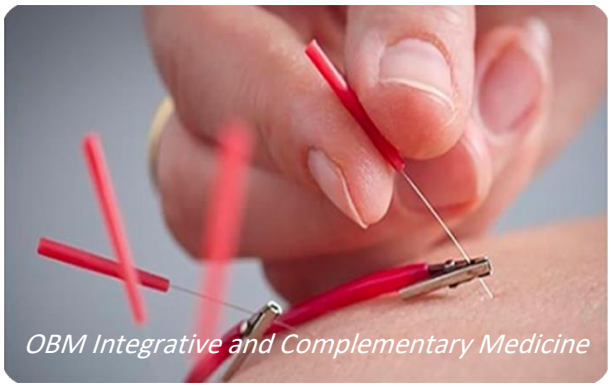

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