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Case report

Nucleus accumbens stimulation in pathological obesity

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ABSTRACT

One of the potential treatment methods of obesity is deep brain stimulation (DBS) of nucleus accumbens. We describe the case of 19 years old woman with hypothalamic obesity. She weighted 151.4 kg before DBS and the non-surgical methods proved to be inefficient. She was treated with implantation of DBS electrode to nucleus accumbens bilaterally. Results were measured with body mass index and neuropsychological tests. Follow-up was 14 months. Fourteen months after surgery weight was 138 kg, BMI was 48.3. Neuropsychological test results were intact. The presented case supports the thesis of treatment of obesity with nucleus accumbens stimulation.

1. Introduction

According to WHO, overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. For the classification and definition of overweight and obesity BMI index is used and is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2). BMI greater than or equal to 25 means overweight, BMI greater than or equal to 30 is obesity. Worldwide obesity is a major health problem constituting the fifth leading risk for global deaths [1].

Obesity is preventable by changes in dietary and physical activity patterns. Modification of diet and exercises has important but limited impact on overcome of obesity and overweight [2]. Pharmacologic therapy show rather modest effects and is associated with side effects e.g. orlistat causing gastrointestinal intolerance. Surgical options in management of obesity aim decrease of volume of stomach: bands placed around stomach, sleeve gastrectomy, gastroplasty and gastric bypass surgery creating small stomach pouch. These procedures cause vitamin and protein, microelements deficiencies and have high risk of postoperative complications [3]. Several experimental studies on animals showed beneficial effect of hypothalamic stimulation on reduction of hunger, inhibition of food intake and weight loss [4,5]. Few studies on deep brain stimulation of hypothalamus in humans demonstrated influence on feeding behavior and weight reduction but showed also some adverse effects and followed regain of the weight. Therefore some authors propose another therapeutic approach,

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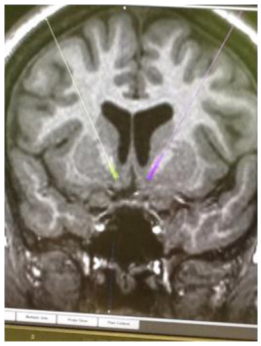


Picture 1 – Planned electrode trajectory on coronal MRI.

to modulate immediate reward circuits, including nucleus accumbens (NAcc) [5–11].

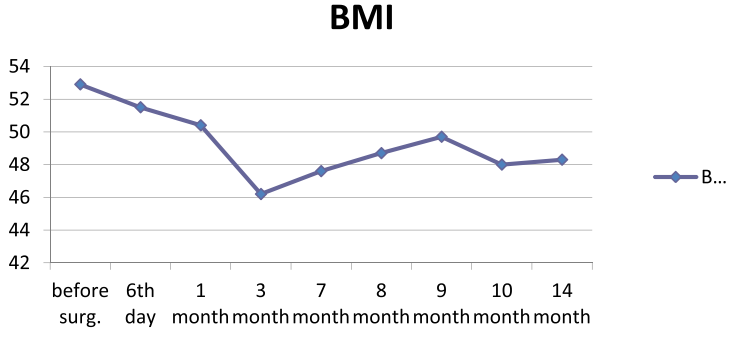
2. Case

We describe the case of 19 years old woman with pathological obesity. She suffered from hypothalamic obesity due to the earlier craniopharyngioma surgery performed in 2004. She had damaged hypothalamus by tumor and surgery. She weighted 151.4 kg before surgery and all of the current non-surgical methods proved to be inefficient. She suffered from glucose intolerance, lumbar spondylosis, low self-assessment and mild depression. The patient was gaining weight, craving for food like an addict for drugs. She was under parental control all the time, even the refrigerator was locked with a padlock. She was qualified for bariatric surgery by her endocrinologist and general surgeons. But the patient and her family had some concerns about bariatric surgery. After approval of the local bioethical committee she was treated with implantation of DBS electrode to nucleus accumbens bilaterally. The follow-up lasted fourteen months.

The target of stimulation was defined bilaterally in nucleus accumbens. The trajectory was planned through the anterolateral part of the anterior limb of internal capsule (Picture 1). Then in general anesthesia both electrodes were inserted alongside the planned trajectories under the control of X-ray. The correct placement of the electrodes was confirmed by intraoperative CT-MRI fusion. In the next stage of the operation the stimulator was implanted in the right subcutaneous subclavian pocket. The procedure lasted about three hours. On the day of surgery the stimulator was turned on. We used in both electrodes bipolar stimulation with polarity (–) to contact one electrode and (+) on the contact 4 electrodes, 208 μs pulse width, frequency 130 Hz, 2 mA stimulation current. The patient very well tolerated the stimulation, there were no side effects of treatment. During her stay at the hospital and at monthly outpatient visits the parameters of stimulation were modified reaching at last the value of 3.75 mA, while keeping the other parameters without alteration. Patient since surgery was under neuropsychological and psychotherapeutic care. She had been monitored on mental state, cognitive performance, and weight control. The process of psychotherapy was to maintain therapeutic effect of surgery. It was focused on patient lifestyle changes, taking into account the context of her family. To assess the severity of depressive symptoms we used Beck Depression Inventory (BDI). The following neuropsychological tests of cognitive performance testing were carried out: Wisconsin Card Sorting Test (WCST), Trail Making Test (TMT), A and B and Interference Test Names and Color Stroop (Stroop Color-Word Interference Test). The neuropsychological examination and measurement of body weight before surgery was performed implantation in the 6th postoperative day, and 1, 3, 7 and 14 months after surgery.

3. Results

Three months after surgery weight was 132 kg, BMI was 46.2. Neuropsychological test results were intact. Weight control and neuropsychological test results before and after the treatment further studies are presented in Picture 2. Prior to surgery the patient weight was 151.4 kg and height 160 cm (BMI – 52, 9). BDI results testify to the presence of mild depressive syndrome, confirming the information obtained from the conversation with the patient. The results of neuropsychological tests before surgery showed a significantly reduced psychomotor speed in a simple visual-spatial task (TMT A) and the reduction of motor parameters, visual-spatial working memory while retaining the ability to combine the two principles of action of her memory (TMT B). Executive functions (WCST), the speed of reading and verbal working memory (Stroop) were normal. After surgery in the other three examinations the progressive loss of body weight of the patient was observed. Three months after the treatment she weighted 19.6 kg less. The decline in body weight was



Picture 2 – Body Mass Index before surgery and in follow-up.