

# Neural Plasticity in a Patient with Meningioma: Case Report

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## ABSTRACT

Meningiomas are second most common type of primary brain tumors. Because of their slow growing nature, they don't provoke language impairments even if they are located in a brain areas responsible for language functioning. In this case report we describe an example of language neural plasticity in a patient with meningioma. The patient did not pre-surgically present speech language impairments even though the tumor was located in the left fronto-temporal lobe. After neurosurgery the patient developed apraxia of speech, which progressed to severe sensomotor aphasia caused by intracranial hemorrhage. During intensive speech therapy, an algorithm of recovery from sensomotor aphasia to motor aphasia was observed, followed by further improvement into speech apraxia. After seven days, a mild form of apraxia of speech persisted until hospital discharge. With this case report, we emphasize the importance of intensive speech therapy taking advantage of early neural plasticity.

**KEYWORDS:** meningioma, intensive speech therapy, brain plasticity

## SAŽETAK

NEUROPLASTIČNOST U BOLESNICE S MENINGEOMOM: PRIKAZ SLUČAJA

Meningeomi su druga najčešća vrsta primarnih tumora mozga. Zbog sporog rasta najčešće ne izazivaju jezična oštećenja iako su smješteni u regijama mozga odgovornim za jezično funkcioniranje. U ovom prikazu slučaja opisujemo primjer jezične neuroplastičnosti u bolesnice s meningeomom. Bolesnica preoperativno nije prezentirala jezično-govorni poremećaj iako je tumor bio lokaliziran u lijevom fronto-temporalnom režnju. Nakon neurokirurškog zbrinjavanja tumora, bolesnica je razvila govornu apraksiju koja je napredovala u tešku senzomotornu afaziju zbog intrakranijskog krvarenja. Tijekom intenzivne logopedске terapije uočen je obrazac oporavka senzomotorne afazije prema motornoj afaziji, nakon čega je slijedilo daljnje poboljšanje u govornu apraksiju. Nakon sedam dana, zaostao je samo blagi oblik govorne apraksije. S ovim prikazom slučaja naglašavamo važnost rane intenzivne logopedске terapije koja iskorištava ranu neuroplastičnost.

**KLJUČNE RIJEČI:** meningeom, intenzivna logopedska terapija, neuroplastičnost

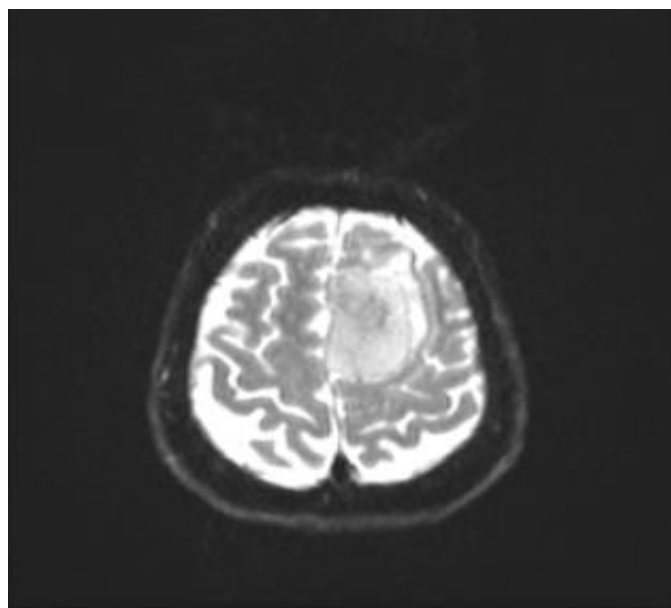
## INTRODUCTION

Meningiomas are primary benign central nervous system tumors with an incidence of 8.25% (1). In nearly half of the patients, meningiomas in the language dominant hemisphere cause language impairment (2). Studies report language impairments are among most frequently reported long-term behavioral consequences of brain tumors (3). The understanding of post-surgical recovery in slow growing benign brain tumors has emerged only recently as a major subject of research (4). Because most meningiomas grow slowly allowing the surrounding tissue and structures to adjust to the neoplasm, most patients don't show symptoms until further stages of disease. Data shows that most speech and language impairments in meningiomas occur post-surgically due to manipulation of vessels and nerves (5). Recent data shows that low-grade brain tumors trigger neural plasticity in language reorganization (6) transferring linguistic functions from damaged to healthy brain areas. The brain can compensate for damage by rerouting neural connections and recruiting other areas to perform the functions of the damaged tissue. A 2008 study also found that pre-surgical aphasia and naming difficulties were a significant predictive factor for post-surgical language impairments. Speech therapy includes early rehabilitation and taking advantage of post-surgical brain plasticity. The aim of this case report was to describe a recovery pattern of a patient with meningioma located in the left fronto-temporal lobe.

## CASE REPORT

We describe a 62-year-old female with a university degree in economics. She was admitted to Department of neurology – Sestre Milosrdnice University Hospital Center because of the sudden inability to speak that lasted for ten minutes. Her family claimed she didn't lose consciousness. For an entire week before admission, she had short periods of word finding difficulties. For the previous month, the patient felt unstable while walking. These symptoms weren't examined prior to this hospitalization. She was previously treated for ulcerous colitis and hypothyroidism. Magnetic resonance imaging (MRI) showed a encapsulated neoplasm 44x30x40 mm located in the left fronto-temporal lobe with a compressive effect on surrounding structures (Picture 1). Found neoplasm had histological features of a meningioma but a further intra-surgical biopsy was needed to determine the final histological pattern. After ten days of hospitalization on Department of neurology, patient was transported with no new neurological deficit to Department of neurosurgery for surgical treatment. Post-surgically our patient presented a motor speech impairment with right hemiplegia. Early language assessment was done by a speech language pathologist. Croatian version of the Comprehensive Aphasia Test (CAT:HR) and apraxia of speech/dysarthria internal assessment materials were conducted. Apraxia of speech was tested using dysdiadochokinesis, which a motor coordination ability test were patients repeatedly pronounce syllables

pa-ta-ka. Positive result means presence of apraxia of speech. We also used a golden standard for diagnosis of dysarthria, which is clinical observation and found no dysarthria in patient's speech. At this point CAT:HR test results were normal. On the third day post-surgically, a deterioration in patient's consciousness was noted with a severe language impairment. Computed tomography (CT) scan showed a new intracranial hemorrhage around the surgically treated area (Picture 2). A new speech language assessment was conducted to diagnose new speech language impairments. Patient now showed impairments both in language comprehension and production with severe apraxia of speech. An intensive speech language therapy protocol had started with therapies every day for 10 days in duration of 30 minutes. Speech therapy focused on improving language comprehension through various picture matching tasks, improving language production through naming and sentence formulation tasks and improving motor speech control through speech planning tasks. During the period of intensive speech therapy, the patient showed a significant improvement in speech and language skills. On the third day post-surgically speech apraxia became a severe form of sensomotor aphasia because of a new intracranial hemorrhage. On the fifth day, the sensory component recovered and became motor aphasia that lasted for three days. Gradually, the patient started naming object and forming simple utterances. CAT:HR showed that she no longer had aphasia. However, speech apraxia persisted in her speech. On the eight day post-surgically only mild apraxia was noted in her speech.



Picture 1. Initial brain MRI



Picture 2. Control CT scan

## DISCUSSION

In this case report we described a patient with meningioma in the left fronto-temporal lobe. Patient showed a circular algorithm of speech language recovery post-surgically while undergoing intense speech language therapy. Post-surgically our patient had speech apraxia that transformed into sensorimotor aphasia because of a new intracranial hemorrhage. As the intracranial hemorrhage regressed and intense speech therapy started language reorganization, sensory language component recovered. Mild language production impairments persisted that further recovered to mild speech apraxia with normal language functioning. Because of high mortality rates available data on patients with meningiomas mostly cover communication and not language impairments after brain tumor surgery. However, language impairments are among the most frequently reported long-term behavioral consequence of brain tumors and greatly impact a person's quality of life and everyday functioning (7). Results found in the available literature are opposed: some imply that language impairments after brain surgery are identified during first post-surgical months and might not be seen later (5,8), whilst others consider those language impairments to be more permanent and in need of intense speech language therapy (3). Ilmberger et al (9) also found that pre-operative aphasia and naming difficulties were a significant predictive factor for post-operative language disturbances. Our patient did not show language or speech impairments until the previous month before hospitalization but did develop severe aphasia and speech apraxia post-surgically. Even though the patient was discharged from the

hospital with only mild speech impairments, we don't know what her speech language status would have been if she didn't undergo intense speech therapy.

Aphasia is common in patients with brain tumors as an early symptom and a post-surgical consequence. A paper from 1989 stated that brain tumor location did not correlate with the emergence of aphasia (10). Research also shows that during the long stage before primary tumor transformation, despite possible slight cognitive disorders (11) most patients don't have any language impairments (12). In a systematic review by Finch and Copland (13) a post-surgical early decline in language function was noted in patients with meningiomas that improved over the period of three months. Another research showed that meningiomas both in right and left-brain hemisphere cause postsurgical shifts and increase in neural plasticity and language activation indicating that brain neoplasms have a widespread influence on the language network (14). Furthermore, latest data focused on finding out what factors could save language disturbances after brain surgery. Some data shows that a higher educational level might act as a protective factor in numerous brain diseases (15). However, in brain tumor population, the link between education and milder language impairment isn't researched. Campanella et al (16) described a cognitive reserve theory that suggests that factors such as intelligence and occupational attainment protect against cognitive decline in individuals with brain tumors. They found that general intelligence is the best predictor of pre-operative language integrity and better post-operative language functioning composure. In our case report the patient was a highly educated individual with a university degree in economics which might imply that education and her general intelligence served her as a protective factor and helped her recover language impairments more rapidly.

Apraxia of speech is a motor speech disorder characterized by impairments in planning of speech movements. The incidence of apraxia of speech in left hemisphere stroke is around 50 to 80%, 30 to 50% in right hemisphere strokes, between 19 and 45% in traumatic brain injuries, about 25% in multiple sclerosis cases, and 90% in dementia patients (17) but there is no data in brain cancer population indicating that it is not that common. A recent case report described a rare clinical entity, pure apraxia of speech resulting from resection of posterior middle frontal gyrus. While not a classical language area, emerging literature supports the role of this area in the production of fluent speech (18). Our patient developed apraxia of speech immediately after surgery, which indicates that it was a consequence of tissue manipulation and damage in the left frontal and temporal part of the brain.

A study from 2021 determined the cut-off distance between the tumor and posterior superior longitudinal fasciculus is 2.75 mm which means the presence or absence of permanent surgery-related language impairments (19). Even though our patient had a meningioma in the left fronto temporal lobe and didn't present language impairments before surgery, she developed aphasia after intracranial hemorrhage in the same affected brain localization.

Intensive early speech therapy takes advantage of early post-surgical neural plasticity. After injury of the peripheral or central nervous system, with functional reshaping underlying a partial or complete clinical recovery, a post-surgical neural plasticity occurs during speech therapy (20). A study showed that language compensation following left temporal resection is explained with the fact that this function is organized with multiple parallel networks (21).

## CONCLUSION

Language restoration after tumor resection is a complex process with different factors affecting its efficiency. We emphasize the importance of early intensive language therapy being one of the restorative factors of language function. Advantage in speech therapy should also be taken from early neural plasticity in patients with primary brain tumors. Further research should focus on all other possible factors affecting language recovery in this population.

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