

# Frontal Lobe Syndrome

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Frontal lobe is the largest of all lobes with a surface area covering one-third of each hemisphere. The three major areas in each lobe are dorsolateral aspect, medial aspect, and inferior orbital aspect. Blood supply is by anterior and middle cerebral arteries. Motor cortex consists of primary, premotor, supplementary, frontal eye field, and Broca's speech area. Prefrontal cortex (PFC) is formed by dorsolateral, ventromedial, orbitofrontal, and anterior cingulate.

Frontal lobe syndrome (FLS) is defined as a behavioural profile that follows severe, diffuse bilateral damage to the frontal lobe and includes disturbances in voluntary action, speech initiation, and sustained interest or affect, apathico-akinetic-abulic syndrome. FLS reflects damage to the prefrontal regions of the frontal lobe. It is characterised by deterioration in behaviour and personality in a previously normal individual. Behavioural and personality changes are usually observed after a neoplastic or traumatic frontal lobe lesion. The patient may become sociopathic, boastful, hypomanic, uninhibited, exhibitionistic, and subject to outbursts of irritability or violence. In other cases the person may become depressed, apathetic, lacking in initiative, negligent about personal appearance, and inclined to persevere.

The case of Phineas Gage: Tamping iron blown through skull resulted in frontal brain injury. Physical recovery was excellent but there was dramatic personality change - 'no longer Gage' - stubborn, lacked in consideration for others, had profane speech, failed to execute his plans.

FLS are grouped as motor abnormalities, emotional make-up and personality, cognitive and intellectual changes, speech and language disorder, akinesia and lack of initiative, incontinence of bladder and bowel, a distinct abnormality of gait.

Motor abnormalities are spastic paralysis of contralateral face, arm and leg; release phenomena - 'instinctive grasping' (Denny Brown); paralysis of contralateral eye and head turning; mutism, contralateral motor neglect, impairment of bibrachial coordination, bilateral lesions causing quadriplegia or quadriparesis; imitation and utilization behaviour (Lhermitte); perseveration and impersistence; gegenhalten; astasia-abasia; cerebral paraplegia in flexion, organic drivenness.

Emotional make-up and personality may be the only manifestation like apathy / euphoria / emotional lability, emotional incontinence; decreased drive / poor impulse control; abulia, akinetic mutism; pseudobulbar palsy, opercular syndrome; Witzelsucht, moria.

Cognitive and intellectual changes are concrete thinking, diminished insight, defect in planning / executive control. Luria's four steps of problem solving are disturbed - specification of problem, formulation of plan of action, execution, and checking or comparison. There are inattentiveness, defect in working memory, defect in sequencing and perseverance.

Speech and language disorder includes Broca's / non-fluent aphasia, language-motor dissociation, lack of spontaneity of speech, akinetic mutism, lack of fluency, perseveration of speech, dysarthria.

Incontinence of bladder and bowel results from lesions involving posterior part of superior frontal gyrus and anterior cingulate gyrus. There is no warning of fullness of bladder. Frequency and urgency occurs with less complete forms of syndromes. An element of indifference is seen in lesions of more anterior parts.

Disorders of gait accompanies frontal lobe ataxia or apraxia; advances slowly with small, shuffling, hesitant steps; turning by a series of tiny, uncertain steps; need to seek support; initiation of walking is difficult, 'gait ignition failure' (Atchison et al.); there may be astasia-abasia, 'magnetic feet' or 'slipping clutch syndrome' (Denny Brown).

Diseases commonly associated with frontal lobe lesions

Traumatic brain injuries like gunshot wound, closed head injury (there is widespread stretching and shearing of fibers throughout and frontal lobe is more vulnerable), contusions and intracerebral hematomas.

Frontal Lobe seizures, usually secondary to trauma, and they are difficult to diagnose - can be odd (laughter, crying, verbal automatism, complex gestures).

Vascular disease is a common cause, especially in elderly. Anterior communicating arterial territory infarction causes damage to medial frontal area and middle cerebral arterial territory involves dorsolateral

frontal lobe. Anterior communicating aneurysm rupture leads to personality change, emotional disturbance.

Tumors such as gliomas and meningiomas; subfrontal and olfactory groove meningiomas cause profound personality changes and dementia.

In multiple sclerosis, frontal lobes represent second highest number of plaques. Manifestations are euphoric / depressed mood, memory problems, cognitive and behavioural effects.

Degenerative diseases like Pick's disease and Huntington's disease; infectious diseases like neurosyphilis, herpes simplex encephalitis, human immunodeficiency virus (HIV).

Psychiatric illnesses such as depression, schizophrenia, obsessive-compulsive disease (OCD), posttraumatic stress disorder (PTSD), attention-deficit/hyperactivity disorder (ADHD), antisocial personality disorder, substance abuse, suicide.

### **Frontal lobe and depression**

Depression results from and can result in changes in the functional neuroanatomy of the brain. The medial frontal, left frontal, and left temporal lobe, the adrenal medulla, amygdala, and the norepinephrine (NE) and serotonin (5HT) neurotransmitter systems have been implicated. Right frontal lobe demonstrated increased activity in response to negative mood. Cortisol reaction to emotional stimuli is under the primary control of right hemisphere. Repetitive transcranial magnetic stimulation (rTMS) of the right frontal lobe reduces depressive symptoms. Left frontal activity increases with the alleviation of depression. Cognitive therapy responders exhibit higher left hemisphere activity.

### **Frontal lobe and schizophrenia**

Schizophrenia is associated with abnormalities of the frontal and temporal lobes, as well as the basal ganglia (caudate), amygdala, hippocampus, hypothalamus, and lateral ventricles. Reductions in left frontal gray matter and brain volume reductions and decreased activity have been repeatedly noted, including decreased blood flow, hypoactivity, and reduced metabolism (hypofrontality). Abnormalities predominantly involving the left hemisphere and the left frontal and temporal lobe are indicated in a sizable minority of patients diagnosed with schizophrenia. Catatonic schizophrenia is predominantly (if not exclusively) associated with medial frontal lobe damage. Individuals classified as suffering from schizophrenia demonstrate electroencephalographic (EEG) and other abnormalities suggestive of bilateral or left frontal dysfunction or hypoarousal. Patients with schizophrenia who are most likely to be suffering from frontal lobe dysfunction tend to display unusual

mannerisms, catatonia, 'emotional blunting', apathy, and/or 'hebephrenia' (puerile, silly, childish, disinhibited and jocular behaviour), though negative symptoms predominate.

### **Frontal lobe and OCD**

Three most important structures involved in the expression of OCD symptoms are orbitofrontal cortex (OFC), anterior cingulate gyrus (ACG), and caudate nucleus (CN). Both the OFC and the ACG may operate as error detection mechanisms. The CN uses the information from the OFC and ACG to prepare for and initiate behavioural responses. Selective serotonin reuptake inhibitors (SSRIs) work to improve mood and reduce anxiety by boosting levels of serotonin in the brain. Cognitive behavioural therapy (CBT) is the proven form of psychotherapy for OCD.

### **Frontal lobe and PTSD**

The frontal neocortex is 'interlocked' with the limbic system, striatum, and the primary and secondary receiving areas. Differential slow wave activity in right frontal areas indicate a dysfunctional PFC leading to diminished extinction of conditioned fear and reduced inhibition of the amygdala. SSRI and CBT are used for therapy. CBT is the most effective type of counselling for PTSD in two forms - cognitive processing therapy (CPT) and prolonged exposure (PE) therapy.

### **Frontal lobe and ADHD**

Many aspects of everyday life are mainly controlled by the frontal lobe system, like resisting temptations and habitual responses, impulse control and dealing with frustrations. Reduced dopamine in PFC is the reason for attention deficit disorder (D1, D4).

### **Frontal lobe and personality disorder**

The orbitofrontal syndrome is the most well known and consists of major antisocial behaviours such as disinhibition, emotional lability, and impulsivity. In some cases, changes are severe enough to lead to new onset of criminality. Apathy and amotivational state lie at the other end of the personality change spectrum.

### **Frontal lobe and substance abuse**

Decreased local cerebral metabolic rates for glucose is observed bilaterally in the medial frontal area of the cerebral cortex in alcohol dependent patients. In frontal lobe impairment, a patient may become impulsive, act rashly, and adopt risky behaviours such as substance abuse. Drugs such as cocaine, nicotine, amphetamine and others increase dopamine in the mesolimbic reward pathway.

## Frontal lobe and suicide

The frontal lobes are responsible for the integration of sensations, perceptions, consciousness and memory into organised and planned behaviours. Suicidal behaviour is associated with a decreased binding potential of prefrontal 5-HT<sub>2A</sub> receptors along with increased levels of hopelessness. Serotonin acts in an antagonistic way to dopamine, so that a depletion of serotonin might indeed disinhibit aggressive behaviour.

### Case 1

Gage was a 25 year-old railroad worker. While he was working with explosives, an accident drove an iron rod through Gage's head. He survived, but both frontal lobes were severely damaged. After the accident, his behaviour changed dramatically. JM Harlow, MD in 1868 wrote the case as follows – (Gage) is fitfull, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires... His mind was radically changed, so decidedly that his friends and acquaintances said he was “no longer Gage”.

### Case 2 (Lhermitte 1986)

Thus when taken into a room containing a buffet, his patient laid out the glasses and offered him food, spontaneously behaving like a hostess. Confronted with make up she used it immediately, and seeing wool and knitting needles began to knit.

### Case 3 (Lhermitte 1986)

Another patient, when taken into a bedroom with the sheet turned back, got undressed, went to bed and prepared to go to sleep. On hearing the word 'museum' while in an apartment he began methodically to examine the paintings on the wall, and walked from room to room inspecting various objects.

### FLS summary

Effects of unilateral frontal disease (either left or right) are contralateral spastic hemiplegia; slight elevation of mood, increased talkativeness, tendency to joke (Witzelsucht), lack of tact, difficulty in adaptation, loss of initiative; if entirely prefrontal, no hemiplegia, grasp or suck reflex or instinctive grasping may be

released; anosmia with involvement of orbital parts. Effects of right frontal disease are additional left hemiplegia. Effects of left frontal disease are right hemiplegia; motor speech disorder with agraphia, with or without apraxia of the lips and the tongue; sympathetic apraxia of the left hand; loss of verbal association fluency, perseveration. Effects of bifrontal disease are bilateral hemiplegia; spastic bulbar (pseudobulbar) palsy; if prefrontal, abulia or akinetic mutism, lack of ability to sustain attention and solve complex problems, rigidity of thinking, bland affect, social ineptitude, behavioural disinhibition, inability to anticipate, labile mood, varying combination of grasping, sucking, decomposition of gait, and sphincteric incontinence.

### Take away messages

It is not uncommon for patients to suffer from, for example, an expanding medial frontal tumor, and to be diagnosed as depressed, but for the tumor to be overlooked. Large tumours in the prefrontal areas may present with euphoria and / or irritability or both alternating. One should not assume that a patient who manifest a disorder of gait but no other neurological abnormality is necessarily suffering from hysteria.

### References

1. Adams and Victor's principles of neurology, 7th edition.
2. Organic psychiatry: the psychological consequences of cerebral disorder - William Alwyn Lishman, 3rd edition.
3. Harrison's principles of internal medicine, 16th and 17th editions.
4. Kaplan & Sadock's synopsis of psychiatry, 10th edition.
5. New oxford textbook of psychiatry, 2nd edition.
6. Stahl's essential psychopharmacology: neuroscientific basis and practical applications - Stephen M. Stahl, 3rd edition.
7. Introduction to psychology - Clifford T. Morgan, Richard A. King, John R. Weisz, John Schopler, 7th edition.
8. World wide web.