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Mini Review

Supremacy of Frontal Lobe and Prefrontal Cortex: A Message for Neurosurgeons; Show Respect Please!

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Abstract

Frontal lobe and prefrontal cortex is the part of brain that distinguish human being from other creature and this is because of its complex anatomy and the amazing many roles in the higher functions. Till recently, frontal lobe considered as the most lobe containing non eloquent areas and so called (silent area) and this is because of the poor knowledge about the anatomy and neuroscience of this spectacular lobe. We; the neurosurgeon, deal a lot with this lobe during our surgeries but because of poor information about the deep microanatomy and neuroscience we usually considered as a save area to do big surgery with aggression sometimes without big evident side effects or complications. This is in comparison to surgery conducted in eloquent areas which is usually done with more caution and consumption of all imaging and technical modalities to minimize the risk of injury. Such concept about the surgery in frontal lobe can be considered as dis respect from micro anatomical point of view and neuroscience aspect. this is a brief narrative review about the deep anatomy of frontal lobe with literature review aiming to raise the awareness about the big importance of frontal lobe and especially the prefrontal cortex for the human being in the higher functions, cognition and personality and to change the old concept that used to rank the frontal lobe as silent area and to show that frontal lobe has got the supremacy.

Keywords: Supremacy; Frontal Lobe; Neurosurgeon

Introduction

I think all of us as neurosurgeons know the frontal lobe, but we do not know it as it should. we considered it as the most comfortable area of brain to do surgery, actually we do not respect it as it should, if we know well the deep complex anatomy and functions of the frontal lobe areas and its importance to human; I think we will change our way of dealing with it during surgery and be more cautious like we treat the parietal lobe and other eloquent areas in the brain.

I think such careless or ignorance comes from that; we usually do not see any immediate postoperative functional changes and most patients look to be normal and they do not show any side effects in their immediate or early postoperative period ; but I think most of us faced later with those patients complaining of problems related to the memory, cognition, personality, executive and multitasking when they came for follow up and mostly these changes are noticed by the copatients, coworkers, parents or any family members or any close caregiver to the patient and such side effect is considered as a cause of anxiety and problem in communication for both.

I came to notice this neglected issue in my career in neurosurgery after I had a patient victim of RTA (road traffic accident) admitted in our department and had severe frontal injury, fortunately he passed his treatment period successfully and discharged finally quit well, mobile and conscious without any focal apparent deficit. But when he came to follow up later, his brother complained that; this not his brother any more as used to be, he lost his previous personality, his cognition and executive function and he became a handicap human waiting directing and helping in simple task from his brother. Another similar examples I saw a lot, were in our patients who underwent surgery for frontal lesions and most of the time surgery was aggressive to some extent with the anatomy of the frontal lobe.

This is a comprehensive review for the anatomy and some neuroscience of the frontal lobe by summarizing the key relevant information mentioned in other articles.

Comprehensive Review

Frontal lobe represents part of the cerebral cortex lies anterior to the central sulcus and limited laterally and inferiorly by the lateral sulcus. it is the largest lobe in the brain representing third of the hemisphere.it is full maturation is manifested late in adult life to be responsible for the behaviors and complex cognitive functions [1].

On the dorsolateral convexity of the frontal lobe, there are the superior, middle and inferior frontal gyri arranged horizontally; and the precentral gyrus arranged vertically. Also on the lateral view there is the frontal operculum which cover the insula deep at the area of lateral sulcus [1]. On The medial view of the frontal lobe there is the paracentral lobule, medial part of the superior frontal gyrus both superiorly and gyrus rectus inferiorly. cingulate sulcus and the rostral sulcus separate between the cingulate gyrus and the medial frontal gyri. The inferior surface of the frontal lobe is mainly formed by the gyrus rectus with its inferior part and the orbitofrontal gyri (anterior, posterior, medial, and lateral). The three longitudinal frontal gyri with the gyrus rectus and the anterior orbitofrontal gyrus collectively form the frontal pole whose cortex is around the marginal sulcus. Lateral sulcus on the lateral view of frontal lobe divides the inferior frontal gyrus posterior part by its ascending and horizontal limbs into three pars: pars opercula, pars triangularis and pars opercularis. There is more variability among general population for other sulci such as the diagonal sulcus which lies anterior to the precentral sulcus [1].

Frontal lobe tracts are divided into intrinsic and extrinsic connections based on their terminal projections either within or outside the frontal lobe [1]. The intrinsic connections are cortico-cortical association fibers and Most of them are short U-shaped fibers between adjacent gyri. in the posterior regions of the superior and inferior frontal gyri, the medial cortex of the gyrus rectus and superior frontal gyrus (paracingulate frontal bundle), or the orbitofrontal cortex to the frontal pole; the longer tracts are located in the deep white matter [1]. The extrinsic connections are the association fibers between the frontal lobe and other lobes within the same hemisphere, the commissural pathways that mediate communication between the two frontal lobes, and projection pathways between frontal lobe and subcortical regions [1]. the intrinsic and extrinsic fibers arrangement is considered unique to each frontal area and considered to result in its functional uniqueness. Both intrinsic and extrinsic connections are found at birth, but are poorly myelinated during this early period [1].

At the anterior half of the corpus callosum The major commissural fibers found and they follow a precise topography. Rostrum of the corpus callosum is the most inferior part of the anterior part and contains fibers connecting the orbitofrontal cortices while The prefrontal cortices are connected by the fibers of the genu. within the anterior two-thirds of the body of the corpus callosum, The fibers projecting to premotor and motor cortices [1].

Frontal lobe cortex establishes extensive direct connections with the major subcortical structures such as diencephalon, basal ganglia, hypothalamus, brainstem, and spinal cord. The three major frontal descending systems include frontostriatal fibers to the caudate and putamen, direct cortico-pontine connections, and corticofugal projections to the nuclei of the motor cranial nerves (corticonuclear tract) and spinal cord (corticospinal tract) are the frontal lobe descending fibers [1], while thalamofrontal, nonthalamic component from the amygdala and nucleus accumbens, mammillary bodies, and nucleus basalis of Meynert are the ascending fibers [1]. Arcuate fasciculus, the SLF, the cingulum, the inferior fronto-occipital fasciculus, and the uncinate fasciculus are the major inter lobar association tracts of the frontal lobe [1]. These interlobar tracts mediate direct communication between frontal areas and the cortex of other lobes. There are

short interlobar U-shaped fibers connect between the frontal lobe and the parietal lobe (perirolandic fibers), insula (fronto-insular tracts), and cingulate gyrus [1].

The term prefrontal cortex (PFC) describe anatomically the association cortex anterior to brodmann area (6) and (4). it generally can be divided into dorsolateral (brodmann area 46 and 9) above the inferior frontal sulcus, dorsomedial, ventrolateral (brodmann area 45 and 47) below this sulcus, ventromedial and the basal part orbitofrontal region (brodmann area 11,12,13,14). It has extensive connections, cortico-cortical and thalamo-frontal through which it receives various sensory inputs such as vision, gustation and olfaction [2]. Also these connections provide emotional and motivational information from the limbic system as well as from hypothalamus. Function and role of the prefrontal cortex are studied and announced as (not so silent area), mentioning its considerable effect in memory, thought, emotions, moral judgment, social behavior, evaluating rewards, and assessing its fairness or otherwise and above all.

Self-awareness [3]. Studies also revealed this area as the latest in evolution in the mammalian brain, especially the human, and considered it as the main difference for us from other animals.it was considered as silent area because a little was known about the human prefrontal cortex till recently, but with the modern imaging technique of the brain and its function and a lot is revealed about this area [3], and so it is not (silent) any more.

Human prefrontal cortex is found to be different from the primate species in the less relative size rather than in organization [4] and if Working memory is defined as a neural system for short- term active maintenance of information and processing of the maintained information; one of the studies denoted that The dorsolateral prefrontal cortex is a part of this defined working memory [5].

In study done about Degree of automaticity and the prefrontal cortex; The more anterior areas [Brodmann area (BA) 45, 47, and 10] of dorsolateral prefrontal cortex (PFC) is activated with increase in cognitive hierarchy (which is considered as the view that processes in the superordinate level control, modify, and modulate processes in the subordinate level over a longer timescale [6]. However, this does not applied for the highly automatic processes [6].

In a study about architecture and functional organization of lateral prefrontal cortex; they found that it is organized in two axis; a rostral–caudal and a dorsal–ventral. the motor region of the precentral gyrus that lies in front; is involved in fine motor control and direct sensorimotor mappings, while the caudal lateral prefrontal region is involved in higher order control processes. The mid-lateral prefrontal region more caudally; plays more role in cognitive control. The mid lateral prefrontal region is organized in a dorsal–ventral axis, with the mid dorsolateral prefrontal cortex being involved in the monitoring of information in working memory and the mid-ventrolateral prefrontal region being involved in active judgments on information [7].

Prefrontal region responsible for the Cognitive and behavioral frontal lobe functions more than the frontal lobes in general, and this what has been revealed by a study done about the prefrontal lobe functions conducted through clinical assessment [8]. This study concluded that cognitive and behavioral processes of the frontal lobe mediated by different parts of the frontal lobe, and lesions in this area produce a clinically significant deficits, the conclusion was that the Key messages in the frontal lobe are done by the prefrontal regions in specific, but the prefrontal functions are not matching to the executive functions [8].

Another study discussed the functional anatomy of the frontal lobe and how complex it is, and what the effect of lesions in this area can produce, and showed the current theories about the three primary frontal lobe circuits (function and location), which can help in detecting subtle frontal lesions, and applying these theories of neuropsychiatry to assess prognosis and plan for rehabilitation [9]. These three circuits are :dorsolateral circuit, orbitofrontal circuit and anterior cingulate circuit [9]. Prefrontal cortex anterior to the frontal eye field (brodmann area 8) is not involved in any concrete task.it does not smell, feel, see, or move part of the body, but this area allow the superiority of the humans over the other primates.it assimilates data from other area of the brain and formulate understanding of past and current experiences that is used to design a plan for future action [9].

Conclusion

Human being differ from other creature by their brains and in their brains; frontal lobe is the most important in many functions that makes this superiority and he had the supremacy over the

other lobes of the brain by the previously mentioned anatomical and functional information, but this not the reality in which other areas in the brain like the motor strip is given an over attention especially from the surgical point of view while the lesions in the frontal region taken with less attention during surgery with neglecance of the later possible complications produced by frontal regions damage. This is just a brief review from anatomical and some neuroscience point of view for the neurosurgeons about the frontal lobe and prefrontal cortex hoping that to take frontal lobe into serious consideration during brain surgery and to show anatomical respect.

Bibliography

1. Catani M. "The anatomy of the human frontal lobe". 1st ed. Handbook of Clinical Neurology. Elsevier B.V.; 163 (2019): 95-122.

2. Paik E. "Functions of the prefrontal cortex in the human brain". *Journal of Korean Medical Science* 13 (1998): 569-581.

3. Tandon P. "Not so «silent»: The human prefrontal cortex". *Neurology India* 61.6 (2013): 578-580.

4. Teffer K and Semendeferi K. "Human prefrontal cortex. Evolution, development, and pathology". 1st ed. Progress in Brain Research. Elsevier B.V.; 195 (2012): 191-218.

5. Funahashi S. "Prefrontal cortex and working memory processes". *Neuroscience* 139.1 (2006): 251-261.

6. Jeon HA and Friederici AD. "Degree of automaticity and the prefrontal cortex". *Trends in Cognitive Sciences* 19.5 (2015): 244-250.

7. Petrides M. "Lateral prefrontal cortex: Architectonic and functional organization". *Philosophical Transactions of the Royal Society B* 360.1456 (2005): 781-795.

8. Henri-Bhargava A., *et al*. "Clinical Assessment of Prefrontal Lobe Functions". *CONTINUUM: Lifelong Learning in Neurology* 24.3 (2018): 704-726.

9. Burruss JW., *et al*. "Functional neuroanatomy of the frontal lobe circuits". *Radiology* 214.1 (2000): 227-230.