Research Article

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Journal of Anatomical Sciences and Research

2021
Vol.4 No.3:3

Quantitative Evaluation of Gray Matter Volume of Amygdala in Patients with Depression on Magnetic Resonance Image: Brain Suite Segmentation Study

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Received date: June 07, 2021**; Accepted date:** June 21, 2021**; Published date:** June 28, 2021

Citation: Taha MK, Elfaki A, Ali OT (2021) Quantitative Evaluation of Gray Matter Volume of Amygdala in Patients with Depression on Magnetic Resonance Image: Brain Suite Segmentation Study. J Anat Sci Res Vol. 4 No.3:3.

Abstract

Background: Depression is one of the common mood disorders; the amygdala is almond shape structure lies within the temporal lobe. Many mental disorders, including depression, may increase or decrease it. The aim of this study is to detect structural alterations of the amygdala in patients with depression and control on MRI.

Materials and methods: amygdala volumes were measured in 50 (25 male, 25 female) patients with depression (age 20-40 years) mean age 24 years (± SD 5.02) and 50 sex age matched control (25 male, 25 female) mean age 24 years (± SD 5.28), using brain Suite on magnetic resonance image (MRI).

Results: the mean volume of gray matter of right, left and total amygdala of patients with depression and controls were 1.77 cm^3 , 1.78 cm^3 and 3.35 cm^3 (± SD 2.13, 2.10 and 4.22) and 0.41 cm^3 , 0.40 cm^3 and 0.81cm^3 (± SD 1.30, 1.52 and 2.82), respectively. With P. value<0.05. The gray matter proportion in female patients with depression was higher than males. The volume reduction on the right side of amygdala was clearly noted.

Conclusion: our data indicate that the gray matter of amygdala is increased in patients with depression; female patients have increased amygdala volume. It seems that the depression caused right side volume reduction.

Keywords: Depression; Amygdala; Brain suite segmentations; MRI Quantivications

Introduction

Depression is one of the most common forms of mental disorder in the general population, and associated with high risk of death by suicide [1]. The amygdala is almond shape structure lies within the temporal lobe that has long been known to play a key role in emotional responses and emotional memory in both humans and animals [2]. Advance in neuroimaging techniques and methods used to extract the cortex and amygdala have allowed measurement of different structures continuously across the whole parts of the brain [3]. Magnetic resonance imaging (MRI) is the most appropriate technique used for anatomical evaluation of human brain structures; due to detailed resolution and its non-invasive properties. In many studies the Brain Suite tools allow excellent approach for measurement of amygdala from T1 weighted MRI images [4,5]. Different neuroimaging studies on patients with depression showed abnormalities in both hipocampus and amygdala [6,7]. Other studies proved that no structural change can occur [8-11]. The recurrences and the course of the disease have direct effect on the size of the amygdala as well as whole brain specifically gray matter [12]. Patients with recurrent depression episodes and young age onset had significant impact on the size left and right hipocampus and amygdala [13-16]. In contrast different studies show that the change had been just of the left side on hipocampus only [17]. The aim of this study is to detect structural alterations of the amygdala [18].

In this article we quantitated and evaluated the gray matter volume of amygdala changes using automatic segmentation tool (brain Suite).

Materials and Methods

The study comprised 50 patients with depression (25 male 25 female) Sudanese and 50 subjects control (25 male and 25 female) and, the total number of volunteers was 100 and their ages were ranging between 20- 40 years mean age 24 years. Sudanese adults clinically diagnosed as patients with depression by psychiatrists. All patients with depression should meet ICD/10 criteria. All patients with depression were or were not receive regular antidepressants medication.

The patients were selected from: Tigani Almahi and Taha Bashar Psychiatric Hospital. The control group has no history of: Psychiatric disorders drug abuse medication, head trauma, neurological diseases and congenital malformation related to the brain. Control subjects were matched with patients on the

basis of gender and age. The Beck Depression Rating Scale and is also administered to the depressed patients.

MRI acquisitions

Structural MRI was done to both patients and healthy controls in the MRI section of the department of radiology in the AlAmal National Hospital. The scanner was Philips 1.5 Tesla Magnetom Avanto Vision System. T1- weighted images were obtained using three-dimensional acquisition by Magnetization Prepared Rapid Acquisition (MPRA); which produced good gray/white matter contrast in a very short acquisition time. Slice distance is 1.0 mm, the field of view was 250 read, 192 mm phase, TR=1657 ms, TE=2.95 ms, bandwidth 180 Hz/pixel, flip angle 30°, ECHO spacing=7.5ms, phase resolution=100%, slice resolution=50%, and acquisition time=5 minutes and 18 seconds. The images were in coronal sections. This T1-weighted sequence is part of the standard clinical protocol for qualitative and quantitative analysis of the whole brain in patients with epilepsy. All subjects were scanned in the supine position. The MR images scanner locked like a tunnel about 1.6 meters long surrounded by a large circular magnet. The subject lay on a couch without any metals and then entered into the scanner. When each picture was being taken the subject needed to keep still for a few minutes otherwise the scan picture may be blurred. The scan itself is painless. The whole procedure tacks six minutes, without contrast media.

Approval for the study was obtained from the ethics committee of the National Ribat University, AlAmal Hospital, Taha Bashar, Tigani Almahi Psychiatric Hospital.

3.7. MR images analysis tools

Analyses of images were performed on researcher's computer after downloaded and setup of three programs: RadiAnt Dicom Viewer which was downloaded from www.radiantviewer.com;ImageJ which was downloaded from http://rsb.info.nih.gov/ij; and Brainsuite which was downloaded from http://brainsuite.org. Before analyzing MR images, the images must be manipulated by two programs RadiAnt Dicom Viewer and Image J.

Results

Student T. test revealed the mean volume of gray matter of right, left and total amygdala of patients with depression and controls were 1.77 cm^3 , 1.78 cm3and 3.35 cm^3 (± SD 2.13, 2.10 and 4.22) and 0.41 cm^3 ,0.40 cm3 and 0.81cm^3 (± SD 1.30, 1.52 and 2.82), respectively. There was significant difference between patients with depression and control group. P. Value<0.05 in **Table 1**.

The mean volume of gray matter of right, left and total amygdala of male patients with depression and controls were 1.37 cm^3,1.40 cm^3 and 2.72 cm^3 (± SD 2.69, 2.64 and 5.32) and 0.16 cm^3, 0.10 cm^3 and 0.27 cm^3 (± SD 0.20, 0.11 and 0.29), respectively. There was significant difference between patients with depression and control group. P. Value<0.05 in **Table 2**.

The mean volume of gray matter of right, left and total amygdala of female patients with depression and controls were 2.17 cm3, 2.17 $cm^3$and 4.34 cm^3 (± SD 1.30, 1.30 and 2.59) and 0.65 cm3, 0.69 cm^3 and 1.34 cm^3 (± SD 1.82, 2.12 and 3.93), respectively. There was a significant difference between patients with depression and control group. P. Value<0.05 in **Table 3.**

Gray matter volumes	Case	N	Mean (cm^3)	Std. deviation(±)	Sig. P value
Gray matter volume of right Amygdala (cm^3)	Patients with depression	50	1.77	2.13	0.0005*
	control	50	0.41	1.30	
Gray matter volume of left Amygdala (cm^3)	Patients with depression	50	1.78	2.10	0.0003*
	control	50	0.40	1.52	
Gray matter volumes of right and left Amygdala (cm^3)	Patients with depression	50	3.55	4.22	0.0004*
	control	50	0.80	2.81	
P. value is significant at the level of 0.05 or less *=Significant					

Table 1: Comparison of the mean of the gray matter volumes of amygdala between patients with depression and control.

Gray matter volumes	Case	N	Mean (cm^3)	Std. deviation(±)	Sig. P value
Gray matter volume of right Amygdala (cm^3)	Patients with depression	25	2.17	1.30	0.001*
	Control	25	0.65	1.82	
Gray matter volume of left Amygdala (cm^3)	Patients with Depression	25	2.17	1.30	0.004*
	Control	25	0.69	2.12	
Gray matter volumes of right and left Amygdala (cm^3)	Patients with depression	25	4.34	2.59	0.003*
	Control	25	1.34	3.93	
P. value is significant at the level of 0.05 or less *=Significant					

Table 2: Comparison of the mean of the gray matter volume of amygdala between male patients with depression and control.

Gray matter volumes	Case	N	Mean (cm^3)	Std. deviation(±)	Sig. P value

Gray matter volume of right Amygdala (cm^3)	Patients with depression	25	2.17	1.30	0.001*
	Control	25	0.65	1.82	
Gray matter volume of left Amygdala (cm^3)	Patients with depression	25	2.17	1.30	0.004*
	Control	25	0.69	2.12	
Gray matter volumes of right and Left Amygdala (cm^3)	Patients with depression	25	4.34	2.59	0.003*
	Control	25	1.34	3.93	
P. value is significant at the level of 0.05 or less *=Significant					

Table 3: Comparison of the mean of the gray matter volume of amygdala between female patients with depression and control.

Discussion

The results of the current study revealed that there were significant differences between genders in mean volumes of the gray matter of amygdala. This result is in line with the previous studies [19-21] including meta-analysis [22]. Other reports were in contrast to the present results [23,24]. However, the amygdala is a difficult structure to measure, because in many areas the ''cortical amygdala'' merges with surrounding structures. Particular boundaries selected can vary widely [25], especially, when it was done manually. However, automated voxel based morphometric studies regarding this issue reveled that there were reduction of gray matter volume of amygdala [26-28], with varying number of samples. The reduction in volume of amygdala due to "glucocorticoid neurotoxic effect" that could lead to neuronal damage [29]. This could be accepted since amygdala has glucocorticoid receptors as hipocampus did, a molecular study confirmed that [30]. However, increased gray matter volume of amygdala could be explained in different ways, firstly; functional magnetic resonance image (fMRI) study on depression has shown a dendritic hypertrophy in the amygdala in first episode of depression[31,32], this expansion could explained by increased reactivity of this brain region in patients with stress-related disorders. Support for this theory comes from animal studies, which showed that acute stress leads to increased dendritic arborization in the amygdala and overall neuronal growth [33].Secondly; genetic influence may play an important role in enlargement of amygdala in depression, especially for those subjects carrying the S-allele of the serotonin transporter promoter polymorphism [34]. Thirdly; Increased amygdala volume in first-episode patients with depression may be consistent with increased glucose metabolism in the amygdala of patients with depression [35]. Finally: enlarged amygdala volumes in first-episode in patients with depression may be due to numerous factors influencing brain volumes (e.g., vascular perfusion, synaptic plasticity, or aging processes) [19-21]. Our data showed that there is increased left side amygdala. Left hypertrophy of amygdala has been associated with depression [36]. It is suggested that this is due to the low glucocorticoid density receptors in left side [37]. The differences between brain structures across gender was the interest of neuroscientist for decades [38]. The results of the current study revealed that there were statistical significance differences between genders in mean volume of the gray matter of amygdala. The male volume is smaller than females in control comparing with depression and that was in line with published literature [39]. This enlargement in female could be explained due to presence of elevated estrogen hormone level in depression, but the mechanism of volume increase remains unclear [40]. Gene evaluations were not including in this study. Gene analysis among patients with depression would help understanding what possible gene might trigger this disease in future studies.

Conclusion

This paper evaluated the volume changes and comparisons between patients with depression and control using the automated segmentation techniques (Brain Suite). Quantitative data obtained allowed the researcher to make statistical comparison between groups. The data obtained in this paper is independent from the observer's evaluation, therefore it was unbiased.

Our findings introduced a new evidence of abnormalities in amygdala volumes; the gray matter volumes of right, left and total amygdala were statistically different between patients with depression and control. The gray matter volumes of right, left, and total amygdala of males with depression were higher than control males. The gray matter volumes of right, left and total amygdala in females with depression were higher than control females. The gray volumes of right, left and total amygdala in females with depression were higher than males with depression. We can conclude that the disease resulted in a volume decrease in males more than in females.

Acknowledgements

The authors are greatly thanks to the technicians of the department of radiology in the Alamal hospital\ Sudan, for their humble and great contribution to this study and to the subjects who participated in collection of data.

References

1. Balon R (2006) Review of Stress, the Brain and Depression. Ann Clin Psychiatry 18(1):69–70.
2. Drevets WC (2000) Neuroimaging studies of mood disorders. Biol Psychiatry 48(8): 813–29.
3. Teipel SJ, Ewers M, Wolf S, Jessen F, Klsch H et al. (2010) Multicentre variability of MRI-based medial temporal lobe volumetry in Alzheimer's disease. Psychiatry Res. Neuroimaging 182(3): 244–50.
4. Nielsen JD, Madsen KH, Puonti O, Siebner HR, Bauer C et al. (2018) Automatic skull segmentation from MR images for realistic

volume conductor models of the head: Assessment of the state-of-the-art. Neuroimage 174(1): 587–98 .

5. Mikhael S, Hoogendoorn C, Valdes-Hernandez M, Pernet C (2018) A critical analysis of neuroanatomical software protocols reveals clinically relevant differences in parcellation schemes. Neuroimage 170(15): 348–64.
6. Leinsinger G, Teipel S, Wismüller a, Born C, Meindl T et al. (2003) Volumetric MRI for evaluation of regional pattern and progressin of neocortical degeneration in Alzheimer's disease. Radiologe 43(7): 537–42.
7. Smith GS, Kramer E, Ma Y, Kingsley P, Dhawan V et al. (2009) The functional neuroanatomy of geriatric depression. Int J Geriatr Psychiatry 24(8): 798–808.
8. Wang L, Price JL, Gado MH, Province MA et al. (2003) in Depression. Am J Psychiatry 160(1): 83–9.
9. Bremner JD, Narayan M, Anderson ER, Staib LH, Miller HL et al. (2000) Hippocampal Volume Reduction in Major Depression. Am J psychiatry 157(1): 115–7.
10. Mervaala E, Föhr J, Könönen M, Valkonen-Korhonen M, Vainio P et al. (2000) Quantitative MRI of the hippocampus and amygdala in severe depression. Psychol Med 30(1): 117–25.
11. Vakili K, Pillay SS, Lafer B, Fava M, Renshaw PF et al. (2000) Hippocampal volume in primary unipolar major depression: a magnetic resonance imaging study. Biol Psychiatry 47(12): 1087–90.
12. Bremner JD (2002) Structural changes in the brain in depression and relationship to symptom recurrence. CNS Spectr 7(2):129–30, 135–9.
13. Romanczuk-Seiferth N, P??hland L, Mohnke S, Garbusow M, Erk S et al. (2014) Larger amygdala volume in first-degree relatives of patients with major depression. NeuroImage Clin 5: 62–8.
14. Sheline YI, Wang PW, Gado MH, Csernansky JG, Vannier MW (1996) Hippocampal atrophy in recurrent major depression. Proc Natl Acad Sci USA 93(9): 3908–13.
15. Neumeister A, Wood S, Bonne O, Nugent AC, Luckenbaugh DA et al. (2005) Reduced hippocampal volume in unmedicated, remitted patients with major depression versus control subjects. Biol Psychiatry 57(8): 935–7.
16. Sheline YI (2011) Depression and the Hippocampus : Cause or Effect ?. Boil psychiatry 70(4): 308–9.
17. Bremner JD, Narayan M, Anderson ER, Staib LH, Miller HL et al. (2000) Hippocampal volume reduction in major depression. Am J Psychiatry 157(1): 115–8.
18. Giedd JN, Vaituzis AC, Hamburger SD, Lange N, Rajapakse JC et al. (1996) Quantitative MRI of the temporal lobe, amygdala, and hippocampus in normal human development: Ages 4-18 years. J Comp Neurol 366(2): 223–30.
19. Frodl T, Meisenzahl EM, Zetzsche T, Born C, Jäger M et al. (2003) Larger amygdala volumes in first depressive episode as compared to recurrent major depression and healthy control subjects. Biol Psychiatry 53(4): 338–44.
20. Machado-de-Sousa JP, De Lima Osório F, Jackowski AP, Bressan RA, Chagas MHN et al. (2014) Increased amygdalar and hippocampal volumes in young adults with social anxiety. PLoS One 9(2): 1–5.
21. Romanczuk-Seiferth N, P??hland L, Mohnke S, Garbusow M, Erk S et al. (2014) Larger amygdala volume in first-degree relatives of patients with major depression. NeuroImage Clin 5: 62–8.
22. Hamilton JP, Siemer M, Gotlib IH (2008) Amygdala volume in major depressive disorder: a meta-analysis of magnetic resonance imaging studies. Mol Psychiatry 13(11): 993–1000.
23. Weniger G, Lange C, Sachsse U, Irle E (2009) Reduced amygdala and hippocampus size in trauma-exposed women with borderline personality disorder and without posttraumatic stress disorder. J Psychiatry Neurosci 34(5):383–8.
24. Sheline YI, Gado MH, Kraemer HC (2003) Untreated depression and hippocampal volume loss. Am J Psychiatry 160(8): 1516–8.
25. Andreescu C, Butters MA, Begley A, Rajji T, Wu M et al. (2008) Analysis. Neuropsychopharmacology 33(11): 2566–72.
26. Van Tol M-J, van der Wee NJ a, van den Heuvel O a, Nielen MM a, Demenescu LR et al. (2010) Regional brain volume in depression and anxiety disorders. Arch Gen Psychiatry 67(10): 1002–11.
27. Chen MC, Hamilton JP, Gotlib IH (2010) Decreased hippocampal volume in healthy girls at risk of depression. Arch Gen Psychiatry 67(3): 270–6.
28. Kroes MCW, Rugg MD, Whalley MG, Brewin CR (2011) Structural brain abnormalities common to posttraumatic stress disorder and depression. J Psychiatry Neurosci 36(4): 256–65.
29. Rusch BD, Abercrombie HC, Oakes TR, Schaefer SM, Davidson RJ (2001) Hippocampal morphometry in depressed patients and control subjects: Relations to anxiety symptoms. Biol Psychiatry 50(12): 960–4.
30. Johnson LR, Farb C, Morrison JH, McEwen BS, LeDoux JE (2005) Localization of glucocorticoid receptors at postsynaptic membranes in the lateral amygdala. Neuroscience 136(1): 289–99.
31. Van Eijndhoven P, van Wingen G, van Oijen K, Rijpkema M, Goraj B et al. (2009) Amygdala Volume Marks the Acute State in the Early Course of Depression. Biol Psychiatry 65(9): 812–8.
32. Stockmeier CA, Rajkowska G (2004) Cellular abnormalities in depression: Evidence from postmortem brain tissue. Dialogues Clin Neurosci 6(2): 185–97.
33. Klaming R, Spadoni AD, Veltman DJ, Simmons AN (2019) Expansion of hippocampal and amygdala shape in posttraumatic stress and early life stress. NeuroImage Clin 24: 101982.
34. Kempton MJ, Salvador Z, Munafò MR, Geddes JR, Simmons A et al. (2011) Structural neuroimaging studies in major depressive disorder. Meta-analysis and comparison with bipolar disorder. Arch Gen Psychiatry 68(7): 675–90.
35. Lai C-H (2013) Gray matter volume in major depressive disorder: a meta-analysis of voxel-based morphometry studies. Psychiatry Res 211(1): 37–46.
36. Bruder GE, Stewart JW, McGrath PJ (2017) Right brain, left brain in depressive disorders: Clinical and theoretical implications of behavioral, electrophysiological and neuroimaging findings. Neurosci Biobehav Rev 78: 178–91.
37. Sheline YI, Gado MH, Price JL (1998) Amygdala core nuclei volumes are decreased in recurrent major depression. Neuroreport 9(9): 2023–8.
38. Forbes EE, Cohn JF, Allen NB, Lewinsohn PM (2006) History of Depression. Forbes 5(1): 1–19.
39. Tebartz Van Elst L, Woermann F, Lemieux L, Trimble MR (2000) Increased amygdala volumes in female and depressed humans. A quantitative magnetic resonance imaging study. Neurosci Lett 281(2–3): 103–6.

40. Walf AA, Frye CA (2006) A review and update of mechanisms of estrogen in the hippocampus and amygdala for anxiety and depression behavior. Neuropsychopharmacology 31(6):1097–111.