Observing the Asymmetry of Amygdaloid Complex in Patients with Complex Partial Attacks

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Abstract

Lobus limbicus is an anatomical basis for understanding the temporal epilepsy because it includes not only the focus of temporal lobe infection but of the frontal lobe as well. With it we can explain many of the phenomena accompanying epilepsy (hallucinations, the change of the effects, and so on). The goal of this assignment was to explore the asymmetry of amygdaloidal complex in the patients with complex partial attacks. The results show that the smallest number of patients with epilepsy have a symmetric (same size) amygdaloidal complex on the left side and the right. According to the asymmetry direction the difference in the number of patients with epilepsy is not statistically significant. Coefficient of asymmetry shows that the asymmetry on the left side is more frequent in men, while women have the same distribution on both sides. The greatest differences were found when considering the age factor. So, in all the three groups of evaluated data the differences in average age of patients with epilepsy according to total symm. / asymm. were not statistically significant. But, the differences in average age depending on the direction of asymmetry were significant. Patients with longer amygdaloidal complex on the left side are significantly younger, both male and female (related to the axial slice, ant. – post. diameter). Thus, we propose the application of MRI technique in examining the asymmetry of the amygdaloidal complex that we used in this assignment as a template for future examinations in a sense of shedding light on the anatomical functions that underlie neuro-psychiatric dysfunctions.

KEY WORDS: limbic system, amygdaloidal complex, asymmetry, temporal epilepsy

Introduction

In the limbic system visceral functions are integrated with emotional behavior. That is best illustrated by clinical picture of complex partial attack with vegetative, psychiatric (dysfunction of a sensible behavior) and motor symptoms (oral automatism). Bilateral injury of the temporal lobe that has a great effect on amygdaloidal complex that causes a series of behavioral changes named Kluver – Bucy syndrome. This is evident in patients with temporal lobe trauma or after surgical operation on the temporal lobe due to epilepsy. Lobus limbicus is anatomical basis for understanding the temporal epilepsy because it includes not only the focus of temporal lobe infection but of the frontal lobe as well. With it we can explain many of the phenomena accompanying epilepsy (hallucinations, the change of the effects, and so on). Many bodily functions maintain regular rhythms with cycles of different length. The role of «biological clock« that regulates these rhythms is a part of the limbic system function. Therefore, psychomotor epilepsy is frequently associated with epilepsy focused in temporal region.

Material and Methods

35 MRI scans of patient with complex partial attacks were used as a background material for this study. The size of amygdaloidal complex was measured in two projections: horizontal (axial) and sagittal. In axial projections we measured anterior – posterior and lateral – medial diameters of amygdaloidal complex. We did not measure the amygdaloidal complex in coronal projections, because other cerebral structures make clear diffraction impossible. MRI scans were obtained using MAGNET IMPACT SIEMENS 1,0 TESLA in T1 relaxation (TR 500 – 600 / TE 15 / field of view 180 x 260, the layer thickness SL 5 mm) and T2 relaxation (TR 4000 / TE 90 field of view 188 x 250 for axial and 173 x 230 for coronal, 210 x 240 for sagittal scans in 5 mm layer). Dual sequences are used - PD and T2. In PD TR is 4000, and TE 22. We used head – neck spiral, as well as head spiral. For the measurement of amygdaloidal complex sizes, and their comparison from the right to the left we used a program that evaluates the distance in MRI from Sarajevo Clinics Center Institute of Radiology. This study conforms to all the standards of research ethics as proposed by the Ethics Comity of Sarajevo School of Medicine.

For amygdaloidal complex in two projections (axial and sagittal) we gave:

1. The number of patients with epilepsy according to symmetry/asymmetry on the right and left side.
2. Analysis of patients with epilepsy according to the approximate size of left and right side. Significance of differences was tested with t-test.
3. Distribution of patients with epilepsy according to the difference between the right and left side. The results are given in tables and diagrams.
4. The approximate age of patients with epilepsy according to symmetry / asymmetry on the right and left side. Significance of differences was tested with t-test.

Methods of statistical analysis used in this assignment are:

1. Arithmetic mean
2. Standard deviation
3. Standard error
4. Median
5. Mod
6. Chi-square test
7. t-test differences of arithmetic mean
8. t-test of frequencies
9. Coefficient of asymmetry

FIGURE 1. Axial MRI scans – the slice at the hippocampal formation level

FIGURE 2. Axial MRI scans – lengths of the ant.-post. diameter of the amygdaloidal complex from the left and the right side

RESULTS

		Male		Female		TOTAL	
		Number	%	Number	%	Number	%
SYMMETRY: amygdaloidal complex (ant. – post. diameter) on the right and the left side in the axial slice of the same length		5	26,32	2	12,50	7	20,00
ASYMMETRY: amygdaloidal complex (ant. – post. diameter) on the right and the left side in the axial slice of different lengths	Total:	14	73,68	14	87,50	28	80,00
	Out of that:						
	The right side longer than the left side	8	42,11	7	43,75	15	42,86
	The left side longer than the right side	6	31,57	7	43,75	13	37,14
TOTAL:		19	100,00	16	100,00	35	100,00

1. The number of epilepsy patients with symmetric (same lengths) ant.-post. diameters of the amygdaloidal complex on the left and right side in the axial slice is significantly smaller than the number of epilepsy patients with asymmetrical (different lengths) ant.-post. diameters of the amygdaloidal complex on the left and right side.
   The value of Chi-square test is: $H_i^2 = 12,6$; the level of confidence is $p< 0,01$.
2. There are no significant differences in number of epilepsy patients according to asymmetry direction.

TABLE 1. Patients with epilepsy according to symmetry/asymmetry of the ant.-post. diameter of the amygdaloidal complex on the right and left side in the axial slice

		Male		Female	
		Right side	Left side	Right side	Left side
Arithmetic mean	X	1,47 cm	1,43 cm	1,23 cm	1,31 cm
Standard deviation	S.D.	0,29 cm	0,22 cm	0,20 cm	0,24 cm
Standard error	SX	0,065	0,051	0,050	0,061
Median	Me	1,56 cm	1,53 cm	1,21 cm	1,36 cm
Coefficient of asymmetry	a	-0,967	-1,287	+1,652	-0,212

Coefficient of asymmetry shows asymmetry on the left side. Exception is asymmetry in females, which is on right side.

TABLE 2. The patients with epilepsy according to the approximate length of the ant.-post. diameter of amygdaloidal complex from the right and the left in the axial slice

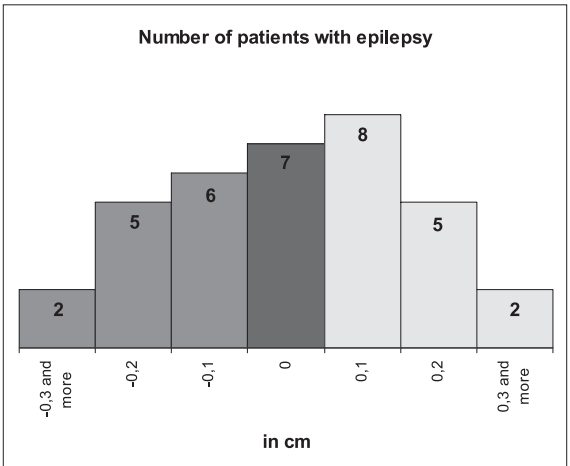

FIGURE 3. Distribution of patients with epilepsy according to the difference in ant.-post. diameters of the amygdaloidal complex on the right and the left in the axial slice

		Male		Female		TOTAL	
		X Year	S.D.	X Year	S.D.	X Year	S.D.
TOTAL		40,8	18,37	27,1	11,68	34,6	17,09
SYMMETRY: amygdaloidal complex (ant. – post. diameter) on the right and the left side in the axial slice of the same length		32,0	15,65	32,5	7,50	32,14	14,94
ASYMMETRY: amygdaloidal complex (ant. – post. diameter) on the right and the left side in the axial slice of the different length	Total:	44,0	18,23	26,57	11,91	35,29	17,69
	Out of that:						
	The right side longer than the left side	50,37	16,57	30,0	13,72	40,87	19,02
	The left side longer than the right side	35,5	16,82	23,14	8,48	28,85	14,98

Significance of the differences in average age considering symmetry / asymmetry was tested by t-tests. Results of the tests are:

1. Difference in average age of epilepsy patients considering total symmetry / asymmetry is not statistically significant. t-test value = 0,432.
2. Difference in average age of epilepsy patients considering the direction of asymmetry is significant at the level of confidence $p< 0,10$, and t–test value = 1,836. The patients with the left side longer than the right side are significantly younger than the patients with the right side longer than left.

The same conclusion pertains to both male and female.

TABLE 3. Average age of patients with epilepsy according to symmetry / asymmetry of ant.-post. diameters of the amygdaloidal complex on the right and the left in the axial slice

		Male		Female		TOTAL	
		Number	%	Number	%	Number	%
SYMMETRY: amygdaloidal complex (lat. – med. diameter) on the right and the left side in the axial slice of the same length		3	15,79	2	12,50	5	14,9
ASYMMETRY: amygdaloidal complex (lat. – med. diameter) on the right and the left side in the axial slice of different lengths	Total:	16	84,21	14	87,50	30	85,71
	Out of that:						
	The right side longer than the left side	7	36,84	5	31,25	12	34,29
	The left side longer than the right side	9	47,37	9	56,25	18	51,42
TOTAL:		19	100,00	16	100,00	35	100,00

1. The number of epilepsy patients with symmetric (same lengths) lat.- med. diameters of the amygdaloidal complex on the left and the right side in the axial slice is significantly smaller than the number of epilepsy patients with asymmetrical (different lengths) lat.-med. diameters of the amygdaloidal complex at the left and the right side.

The Chi-square test value is: $H_i^2 = 17,857$; the level of confidence is $p< 0,01$.
There are no significant differences in the number of epilepsy patients according to asymmetry direction. Hi_i^2 value = 1,20.

TABLE 4. Patients with epilepsy according to symmetry/asymmetry of the lat.-med. diameter of the amygdaloidal complex from the right and the left in the axial slice

		Male		Female	
		Right side	Left side	Right side	Left side
Arithmetic mean	X	2,03 cm	2,09 cm	1,86 cm	1,96 cm
Standard deviation	S.D.	0,27 cm	0,26 cm	0,23 cm	0,27 cm
Standard error	SX	0,061	0,061	0,059	0,067
Median	Me	1,99 cm	2,12 cm	1,71 cm	2,01 cm
Coefficient of asymmetry	a	+0,407	-0,246	+1,867	-0,461

Coefficient of asymmetry indicates asymmetry on the right side, for right side and for both sex, and left asymmetry, for left side and for both sex. Asymmetry is particularly pronounced on the right side in female.

TABLE 5. The patients with epilepsy according to the approximate length of the lat.- med. diameters of the amygdaloidal complex from the right and the left side in the axial slice

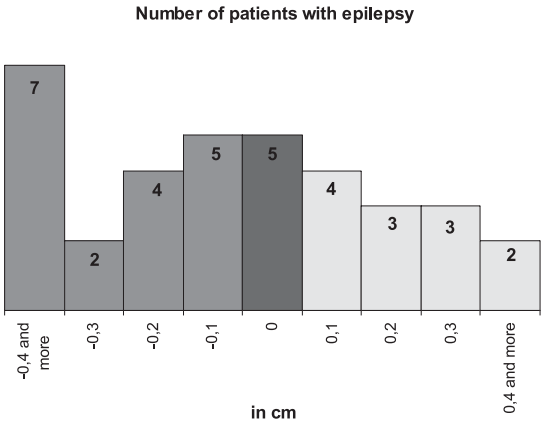

FIGURE 4. Distribution of patients with epilepsy according to the differences in lat.-med. diameters of the amygdaloidal complex from the right and the left side in the axial slice

Coefficient of asymmetry indicates asymmetry on the right side, for right side and for both sex, and left asymmetry, for left side and for both sex. Asymmetry is particularly pronounced on the right side in female.

		Male		Female		TOTAL	
		X Year	S.D.	X Year	S.D.	X Year	S.D.
SYMMETRY: amygdaloidal complex (lat. – med. diameter) on the right and the left side in the axial slice of the same length		25,7	6,65	22,5	2,5	24,4	6,26
ASYMMETRY: amygdaloidal complex (lat. – med. diameter) on the right and the left side in the axial slice of different length	Total:	43,68	18,46	27,78	12,31	36,27	17,76
	Out of that:						
	The right side longer than the left side	41,86	12,91	23,0	6,34	34,0	14,46
	The left side longer than the right side	45,11	21,72	30,44	14,34	37,78	20,38

Significance of differences in average age according to symmetry / asymmetry was tested with t – tests. The results of the testing are:

1. Difference in average age of epilepsy patients according to symmetry and total asymmetry is not statistically significant. T-test value t = 1,463
2. Difference in average age of epilepsy patients according to asymmetry direction is not statistically significant. T-test value t = 0,554
3. Difference in average age between male and female groups of epilepsy patients with asymmetric values of the length of lateral – medial diameter is statistically very significant. Value of the t-tests is: t = 2,732 and confidence level p< 0,01

TABLE 6. Average age of patients with epilepsy according to symmetry / asymmetry of lat.-med. diameters of the amygdaloidal complex on the right and the left in the axial slice

		Male		Female		TOTAL	
		Number	%	Number	%	Number	%
SYMMETRY: amygdaloidal complex on the right and the left side in the sagittal slice of the same length		5	26,32	7	43,75	12	34,29
ASYMMETRY: amygdaloidal complex on the right and the left side in the sagittal slice of different lengths	Total:	14	73,68	9	56,25	23	65,71
	Out of that:						
	The right side longer than the left side	6	31,58	5	31,25	11	31,43
	The left side longer than the right side	8	42,10	4	25,00	12	34,28
TOTAL:		19	100,00	16	100,00	35	100,00

1. Difference in the number of epilepsy patients with symmetric length of amygdaloidal complex in the sagittal slice in relation to number of epilepsy patients with asymmetric values is not statistically significant at the confidence level $p < 0,05$, but is significant at the lower level of confidence $p < 0,07$; $H_i^2 = 3,457$.
2. Difference in the number of epilepsy patients in relation to symmetry / asymmetry between male and female is not statistically significant. $H_i^2 = 1,303$.

TABLE 7. Patients with epilepsy according to symmetry/asymmetry of the amygdaloidal complex in the sagittal slice

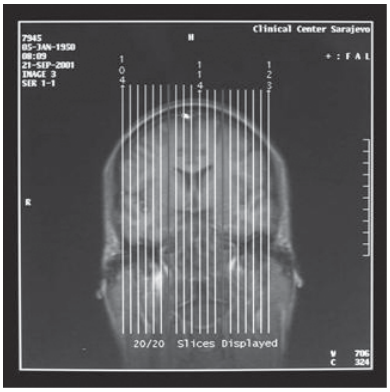

FIGURE 5. Sagittal MRI scans –slice at the level of parahippocampal girus and hippocampal formation

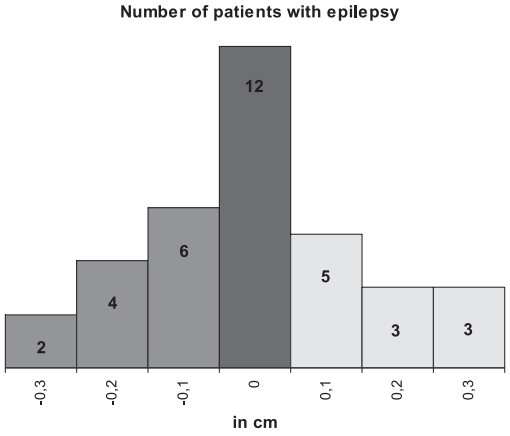

FIGURE 6. Distribution of patients with epilepsy according to the differences of amygdaloidal complex on the right and the left in the sagittal slice

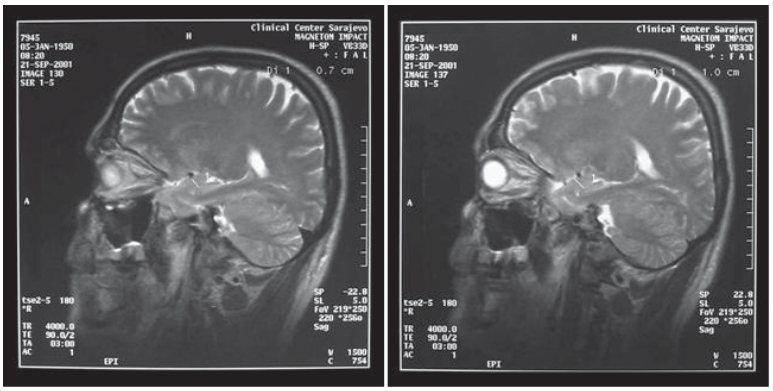

FIGURE 7. Sagittal MRI scans – the measurements for amygdaloidal complex on the right and left side

		Male		Female	
		Right side	Left side	Right side	Left side
Arithmetic mean	X	1,24 cm	1,24 cm	1,21 cm	1,19 cm
Standard deviation	S.D.	0,21 cm	0,19 cm	0,17 cm	0,20 cm
Standard error	SX	0,048	0,044	0,043	0,049
Median	Me	1,29 cm	1,26 cm	1,21 cm	1,23 cm
oefficient of asymmetry	a	-0,722	-0,406	+0,043	-0,594

Coefficient of asymmetry shows left asymmetry except for female right side.

TABLE 8. The patients with epilepsy according to the approximate length of amygdaloidal complex on the right and the left in the sagittal slice

		Male		Female		TOTAL	
		X Year	S.D.	Year	S.D.	X Year	S.D.
TOTAL		40,8	18,37	27,1	11,68	34,6	17,09
SYMMETRY: amygdaloidal complex on the right and the left side in the sagittal slice of the same length		53,8	10,11	30,57	13,45	40,25	16,71
ASYMMETRY: amygdaloidal complex on the right and the left side of the sagittal slice of different length	Total:	36,21	18,44	24,44	9,25	31,61	16,53
	Out of that:						
	The right side longer than the left side	33,83	15,47	22,2	8,70	28,55	14,77
	The left side longer than the right side	38,00	20,19	27,25	9,12	34,42	18,84

Significance of differences in average age according to symmetry / asymmetry of amygdaloidal complex in sagittal slice were tested with t – tests. The results of the testing are:

1. Difference in average age in relation to symmetry and total asymmetry is not statistically significant. T – test value is: t = 1,440.
2. Difference in average age of epilepsy patients in relation to the direction of asymmetry is also not statistically significant. Value of the t – tests is: t = 0,404.

TABLE 9. Average age of patients with epilepsy according to symmetry / asymmetry of the amygdaloidal complex from the right and the left in the sagittal slice

Discussion

The precise location of the incorrect anatomical function that underlies neurological and psychiatric dysfunctions just recently became the subject of intensive research in this filed. In that sense it is important to apply structural and functional techniques of MRI, for future pinpointing of the problems in working with epilepsy. Therefore, MRI offers the most sensitive volumetric measurements of hippocampal formation. Chronister R. C. et al. (1) use limbic system as a reference that pertains to emotions and interconnecting pathways. Authors differentiate centers of aversions and centers of pleasures (gratifications). If we stimulate centers of aversions person will face fear or sadness. On the other hand, stimulation of centers of pleasures will have pleasure as a result. Functional interconnections among aversion and gratification centers, according to the authors, contribute to emotional stability. As a consequence, amygdale stimulation can cause fear, while nucleus accumbens stimulation leads to a feeling of happiness and pleasure. Hadziselimovic et al. (2,3,4,5) confirmed that hippocampus and amygdaloidal complex with their positions depend on the position of temporal lobe; that their positions are followed by brain asymmetry and, when analysis of their positions are made it has to be taken into account. Vogeley K. et al. (6) in Brain image study show loss of upper temporal gyri (smaller size) and abnormal asymmetry example in SCH, but concerning this, there are no sustainable diagnoses. Belin P. et al. (7) in paper Lateralization of speech and hearing temporal processing prove that auditoria processing of fast acoustic passes is lateralized in human brain as well as that functional asymmetry in temporal processing is most likely contributed to lingual lateralization to the lower level of cortical empting. In their works Tzourio N. et al. (8) came to the conclusions that size of left temporal plane is relative anatomic indicator for lingual domination and demonstrate that anatomic asymmetry is a part of functional lingual variation. In morphological studies of temporal lobe and the related central temporal structures in children and adolescents from

14 to 18 years of age, which were conducted by Jay N. Giedd et al. (9), the total volume of temporal lobe was stable, while amygdale increased its volume only in males and hippocampus increased its volume only in females. This example coexists with the distribution of sex hormonal receptors for this structure; amygdale predominantly hosts androgen receptors while hippocampus predominantly hosts estrogens receptors.

Conclusion

On the basis of our analysis we can conclude:

1. In all the three slices the least number of patients with epilepsy have symmetric (same size) amygdaloidal complex on the left and the right side. That number is statistically significantly lower then the number of patients with epilepsy with asymmetric (different size) amygdaloidal complex from both sides. In this group we found no statistically significant difference according to the direction of the asymmetry.
2. In all the three groups, differences in average length of right and left amygdaloidal complex are statistically not significant concerning neither sex nor the direction of asymmetry.
3. The coefficient of asymmetry shows that the asymmetry on the left side is more frequent in men, while women have the same distribution on both sides.
4. Besides the previous parameters which are mainly harmonized, age as a factor shows the highest differences. So, in all the three groups of evaluated data differences in average age of patients with epilepsy according to total symmetry / asymmetry are not statistically significant. But, differences in average age depending on the direction of asymmetry are significant. Patients with longer amygdaloidal complex on the left side are significantly younger, both male and female (related to axial slice, ant. – post. diameter).
5. Every one of the analyzed asymmetries shows the same characteristics in the group, in which we emphasize variations.
6. We also emphasize the importance of presence of consensus in individual characteristics of every one of the parameters in the shading light on asymmetry of amygdaloidal complex
7. We have to be careful in what projection we observe amygdaloidal complex because the results will depend on that. We can suggest the prospective studies in more projections because of the value of the statistically significant conclusions.
8. MRI – volumetric measurement have their values.
9. We suggest the usage of MRI techniques in examining the asymmetry of amygdaloidal complex that we used, as a tool in the future studies in the sense of shading light on the anatomical functions that underlie neuropsychiatry dysfunctions.

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