



# DETECTION OF THE HIPPOCAMPAL FORMATION ASYMMETRY IN PATIENTS WITH POSTTRAUMATIC STRESS DISORDER

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## ABSTRACT

The goal of this work was to analyze asymmetry of hippocampal formation in PTSD patients. The objects of the analysis were 10 MRI scans of patients with PTSD with established cognitive function damage. MRI scans were obtained using MAGNET IMPACT SIEMENS 1,0 TESLA in T1 and T2 relaxation. The measurement of hippocampal formation dimensions, and comparisons between the right and the left side were done using evaluate - distance program on the MRI instrument of the Institute of Radiology at Sarajevo Clinics Center. We tested 20 patients with PTSD 49,9 years of average age with standard deviation of 4,62 years. Based on the analysis of our results regarding the size of hippocampal formation in all the three projections (axial, coronal and sagittal), in the group of patients with PTSD, we can make the following observations:

1. In axial slice the length of hippocampal formation measured on the left and right side is significantly asymmetric in all patients. In the sagittal slice, the hippocampal formation measured on the left side is in many cases longer than in the right – 50 %.

In coronal slice no significant differences were found in the proportion of patients according to symmetry/asymmetry of hippocampal formation width on the left and right.

2. The difference in average size of hippocampal formation between the left and right side measured in axial and coronal slices is not statistically significant, but it is significant in sagittal slice.

So, the results of this new research, showed smaller hippocampal dimensions in PTSD as measured using MRI. We have to be careful about what projection we are refusing to as being watched hippocampal formation because the results will depend on that. We suggest that future studies be done in more projections because of the importance of statistically significant conclusions. MRI – volumetric measurements have their value.

KEY WORDS: limbic system, hippocampal formation, asymmetry, PTSD

## INTRODUCTION

Hypersensitivity, avoiding / emotional weakening and repeatedly occurring situations with hard remembrance of trauma are defined signs of PTSD. Many PTSD symptoms are results of limbic structure hyperactivity, which can contribute to dysfunction of this system through their many projections into prefrontal cortex, and thus cause the loss of performance in frontal functions. This hyperactivity might be a physiological correlate of fear recognition structure, which is readily activated and may be an initiator of emotional abnormality, such as sudden incidents of hypersensitivity and sense of horror. The goal of this work was to analyze asymmetry of hippocampal formation in PTSD patients.

## MATERIAL AND METHODS

The analyzed material included 10 MRI scans of patients with PTSD with ascertained cognitive function damage. MRI scans were obtained using MAGNET IMPACT SIEMENS 1,0 TESLA in T1 and T2 relaxation. The measurement of hippocampal formation, and comparison between the right and the left side were done using software for distance evaluation on the MRI from the Institute of Radiology of Clinics Center in Sarajevo. We tested 10 patients with PTSD, 49,9 years of average age with standard deviation of 4,62 years. We performed the following calculations:

1. The number of patients with PTSD according to symmetry/asymmetry of hippocampal formation between the right and the left side

2. Analysis of patients with PTSD by the average size of hippocampal formation on left and right side  
Significance of differences is tested using t - test

## RESULTS

The lengths of hippocampal formation on the left and right side in axial slice are significantly asymmetric in all patients. Value of Chi - square test is:  $\text{ChiSq} = 10$ , level of confidence is  $p < 0,01$ . The difference in length of hippocampal formation on the left and right side in sagittal slice is not statistically significant at the level of confidence  $p < 0,05$ . Value of  $\text{ChiSq} = 3,6$ . ( Sign. for level  $p < 0,10$  ). In coronal slice there are no significant differences in patient proportion regarding sym/asymm of hippocampal formation width on the right and left side.



FIGURE 1. Sagittal MRI scans – the slice at parahippocampal gyrus and hippocampal formation level

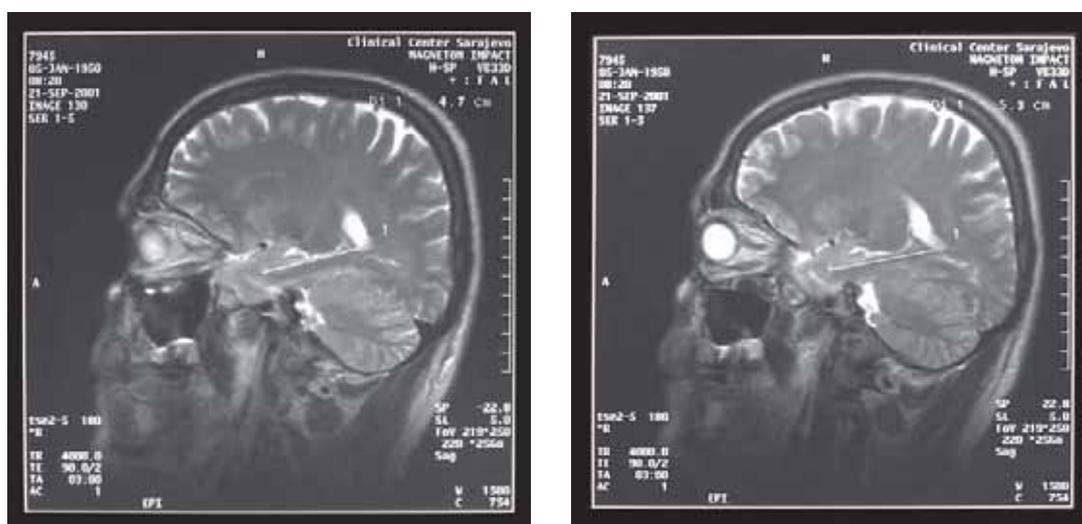


FIGURE 2. Sagittal MRI scans – the measurement of the hippocampal formation on the right and left side.

	Axial slice		Coronal slice		Sagittal slice	
	Number	in %	Number	in %	Number	in %
<b>SYMMETRY:</b> hippocampal formation on the right and left side of the slice is the same size	-	-	5	50,00	2	20,00
<b>ASYMMETRY</b> hippocampal formation on the right and the left side of the slice is of the different size	<b>Total:</b> 10	100,00	5	50,00	8	80,00
<b>Out of that:</b>						
• <i>The right side bigger than the left side</i>	6	6,00	2	20,00	3	30,00
• <i>The left side bigger than the right side</i>	4	40,00	3	30,00	5	50,00
<b>TOTAL:</b>	<b>10</b>	<b>100,00</b>	<b>10</b>	<b>100,00</b>	<b>10</b>	<b>100,00</b>

TABLE 1. Patients with PTSD according to symmetry/asymmetry of hippocampal formation between the right and the left side in the axial, coronal and sagittal slice

The differences in average size of hippocampal formation between the right and the left side are not statistically significant for axial and coronal slices, but it is significant for sagittal slice. The values of *t*- test are:

- a) axial slice:  $t = 0,0615$  not significant
- b) coronal slice:  $t = 0,223$  not significant
- c) sagittal slice:  $t = 2,727$  significant  $p < 0,05$

## DISCUSSION

Peterson et al. (1) clearly proved that MRI - hippocampal formation exactly displays structural and functional relations between memory deficit and hippocampal damage in broad spectrum of normal aging all the way to dementia. Koenen et al. (2) evaluated cognitive deficiency in PTSD. Authors suggest that many of PTSD symptoms result from hyperactive limbic structures which can, through their huge projections in prefrontal cortex, cause dysfunction of this system and consequently shortages in neuropsychological tests execution are to be expected. Pitman (3,4) proved smaller hippocampal volume bilaterally in Vietnam War veterans with PTSD. Bremner et al. (5) proved smaller hippocampal volume on the right side in Vietnam War veterans with PTSD. Bonne et al. (6) said that smaller hippocampal volume can be a risk factor for the development of especially chronic and permanent form of PTSD. They pointed out that reliable closeness of neuroanatomical subjects before traumatic experience can be achieved with MRI brain scans within few days from traumatic experience. Gilbertson et al. (7) said that researches on animals gave evidence that exposure to chronic stress may damage hippocampal formation, region well known for its role in declarative memory. This study pointed out neurotoxic

HIPPOCAMPAL FORMATION	Right side		Left side	
	$\bar{x}$ in cm	S.D. in cm	$\bar{x}$ in cm	S.D. in cm
Axial slice	3,89	0,495	3,89	0,579
Coronal slice	2,08	0,116	2,11	0,34
Sagittal slice	4,08	0,477	4,21	0,476

TABLE 2. Average size of the hippocampal formation on the right and left side in axial, coronal and sagittal slices in patients with PTSD

role of corticosteroids, where their high levels may cause atrophy and / or disappearance of hippocampal cells. Based on the analysis of our results related to the size of hippocampal formation in all the three projection (axial, coronal and sagittal), in a group of patients with PTSD (Table 1 and 2), we can make the following observations:

1. In axial slice the length of hippocampal formation measured on left and right side is significantly asymmetric in all patients. In the sagittal slice the hippocampal formation measured on the left side is in many cases longer, than in the right – 50 %.
2. On coronal slice no significant differences were found in the proportion of patients according to symmetry/asymmetry of hippocampal formation width on the left and right.

The difference in average size of hippocampal formation between the left and right side measured in axial and coronal slices is not statistically significant, but it is significant in sagittal slice. So, the results of this new research, showed smaller hippocampal dimensions in PTSD as measured using MRI. We have to be careful about what projection we are refusing to as being watched hippocampal formation because the results will depend on that. We suggest that future studies be done in more projections because of the importance of statistically significant conclusions. MRI – volumetric measurements have their value.

## CONCLUSION

1. Asymmetry of hippocampal formation in PTSD is evident
2. The results of new research, showed smaller hippocampal dimensions in PTSD as measured using MRI.
3. The projection of hippocampal formation analysis needs to be carefully decided on as it will influence the results and conclusions.
4. We suggest that future studies be done in more projections because of the importance of statistically significant conclusions

## REFERENCES

- (1) Petersen R.C. et al. Memory and MRI – based hippocampal volumes in aging and AD. *Neurology* 2000; 54: 581 – 587
- (2) Koenen K.C., Driver K.L., Oscar-Berman M., Wolfe J., Folsom S., Huang M.T., Schlesinger L. Measure of prefrontal system dysfunction in posttraumatic stress disorder, *Brain and Cognition*, 2001;45 (1): 64 – 78
- (3) Pitman R.K., Shin L.M., Rauch S.L. Investigating the pathogenesis of posttraumatic stress disorder with neuroimaging-Review. *J. Clin. Psychiatry*. 2001; 62 (Suppl 17):47–54
- (4) Pitman R.K. Hippocampal diminution in PTSD: More (or Less?) Than meets the eye. *Hippocampus* 2001 ;11:73 – 74
- (5) Bremner J.D., Randall P., Scott T.M., Bronen R.A., Seibyl J.P., Southwick S.M., Delaney R.C., McCarthy G., Charney D.S., Innis R.B. MRI – based measurement of hippocampal volume in patients with combat – related posttraumatic stress disorder. *Am. J. Psychiatry*.1995 152 ( 7): 973 – 981
- (6) Bonne O.Brandes D., Gilboa A., J. Moshe Gomori: Longitudinal MRI study of hippocampal volume in trauma survivors with PTSP, *Am. J. Psychiatry* 2001; 158: 1248 – 1251
- (7) Gilbertson M.W., Shenton M.E., Ciszewski A., Kasai K., Lasko N.B., Orr S.P., and Pitman R.K. Smaller hippocampal volume Predicts pathological vulnerability to psychological trauma *Nat. Neurosci.* 2002; 5 (11): 1242 – 1247