# Speech and Language Pathology after Stroke in Temporo Parieto Occipital Area

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**Abstract:** *Background*: The stroke of the parietotemporooccipital lobe most often results in speech language pathology (SLP), expressed in misunderstanding speech and language.

*Objective and Methods*: We investigated the occurrence of SLP in relation to speech auditory (oral) comprehension (AC) at 81 patients with temporal parietal occipital lesions after stroke. We was estimated AC by subtests of Boston Diagnostic Aphasia Examination (BDAE) within the first 60 days after stroke.

*Results*: The average age of the sample was 65.91. Ischemic stroke was mostly present in the sample. All patients had left brain lesions with consequent aphasia. Patients were unsuccessful on subtests: Word Discrimination 27.16%, Body Part Identification (BPI) 25.92%, Commands 33.33%, and Complex Ideational Material (CIM) 45.67% of the sample. Successes of 80% and more in: Word Discrimination had 22.22%, BPI had 24.69 %, Commands 19.75 % and CIM had 7.40% patients. The poorest results were found in patients with temporal lesions or in combination temporal area with lesions of the parietal, occipital or frontal area of the left brain hemisphere. Patients with lesions located only on the parietal area have the best results.

Conclusion: Patients with temporal parietal occipital lesions after stroke had poor results in speech and language comprehension in BDAE subtests.

**Keywords:** Stroke, brain lesions, aphasia, speech pathology, auditory comprehension, BDAE.

## INTRODUCTION

Wernicke's area is part of a human brain with function is to enable comprehension of written and spoken language. It is located in the left temporal lobe of the cerebral cortex, the part of the brain where information processing of all kinds takes place, posterior to the primary auditory complex. Temporal area is connected to Broca's area, which is located in the lower portion of the left frontal lobe and it is involved in language processing and it controls motor functions involved to speech production. Common function of these two brain areas enables us to speak, as well as to interpret, process, and understand spoken and written language.

Mentioned regions are blood supplied by artery cerebral media (ACM). Slater D, Curtin S, Johns J, Schmidt C. (2009) describe ACM as the largest brain artery and the blood vessel most often affected by cerebrovascular insult. It supplies most of the outer surface of the brain convexity, almost all the basal ganglia, and the back and the front of the internal capsule. Infarcts that occur within the ACM irrigation area lead to various neurological damage. Most cases of Brain strokes occur in the area of the ACM cerebral circulation [1].

Kadojić D, Rostohar Bijelić B, Radanović R, Porobić M, Rimac J, and Dikanović M. (2012) have found that patients with aphasia had a threefold higher incidence of stroke of the large brain blood vessels and approximately twice the frequency of cardio embolic stroke compared to other types. The incidence of stroke of the left brain hemisphere was almost double in the aphasic compared with non-vascular [2].

Vuković M. (2008) states that vascular lesions in the left hemisphere that cause aphasia mainly comprise perisilvy cortex and subcortical structures (basal ganglia, capsule internal and para ventricular white mass) fed by a medium large-scale artery. Infarcts in the area of the contact of the ACM with the anterior or posterior cerebral artery less frequently lead to aphasia [3].

Vladetic M. (2002) points out that, cognitive disorders are frequent after stroke, and mostly affect memory, attention and concentration, speech, visoceptive and constructive abilities, and orientation. A systematic review of the type and degree of cognitive impairment provided by neuropsychological evaluation gives information important for the organization of the rehabilitation process, assessment of remained abilities for professional functioning as well as daily living or an assessment of the necessary conditions for the treatment of patients [4].

The mass of the brain is reduced by aging (Pranjić, V. 2005). The greatest loss of 20-40% occurs in

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temporal gyrus and striate area. Changes are observed on cerebral arteries, too. The main influence to these processes has arterial hypertension and diabetes. Changes in cerebral arteries lead to ICV that is the first on the scale of the causes of the communication difficulties of the elderly. The blood vessels become rigid and abound with deposits accumulated for a years in the form of atherosclerotic changes in blood vessels of the brain [5].

Geranmayeh, Brownsett and Wise (2014) state that stroke most commonly occurs in people over 60 years, when ageing leads to cognitive deterioration or pre-symptomatic neuro-degenerative pathology and because of presence of long-term chronic conditions, as hypertension and diabetes, which effects micro vascularization brain [6].

Knoflach *et al*. (2012) find that age has a significant influence on the outcome of ICV [7]. Although the mechanisms on which this observation is based are not clear, one obvious factor is the effect of the damage from the general domain, accumulated and distributed throughout life at various brain localization in each patient individually.

Badcock A N, Bishop V M D, Hardiman J M, Barry G J, and Watkins E K. (2012) suggest that structural and functional studies of speech language pathology (SLP) can provide insight into the neural differences that cause changes in speech and language behavior. They concluded that there are clear proofs of atypical structures and functions in the left frontal inferior and temporal superior lobes with an impact on language production and comprehension. Subcortical components, including n. caudate and putamen also have impacts, likely due to their connection with planning, selection and preparation of the motor response [8].

Cai (2017) say that audiovisual (AV) integration presents a fundamental component of face-to-face communication. Visual cues generally support auditory comprehension of communicative intention through our innate ability to “fuse” auditory and visual information. However, our ability for multisensory integration can be affected by damage of the brain. Neuroimaging studies have indicated the superior temporal sulcus (STS) as the center for AV integration, while others suggest inferior frontal and motor regions. Cai’s findings coincide with previous work indicating that multisensory superior temporal cortex, not frontal motor circuits, are important for AV integration [9].

Previous researches have confirmed the presence of speech and language understanding pathology at lesions located behind the central fissure and the lateral fissure of the left brain hemisphere. In this research, we want to determine the extent to which these impairments affect the understanding of speech and language in patients with temporal, or associated with parietal and occipital lesions on the left brain hemisphere.

## OBJECTIVE

To determine the success of solving the tasks of auditory understanding of speech-language tasks in patients with brain lesions located behind the central and lateral cerebral sulcus.

## METHODOLOGY

Research was conducted in IPRM Dr. Miroslav Zotović in Banja Luka, Republic of Srpska, Bosnia and Herzegovina, where in one year 746 patients were involved in rehabilitation process after stroke. Of that number, our sample were 81 patients with brain lesions located on temporal or combined temporal parietal and occipital lobes of left brain hemisphere. For these patients we get data on age, sex, type of stroke, localization of brain damage and functional deficits of body parts after stroke, from medical record. The average age of the sample was 65.91 years (STD = 8.12). Male was represented with a 56.79 % to 43.21% female. The average age of males was 65.15 years (STD = 8.20), and female 66.91 years (STD = 8.12).

Patients were examined by BDAE [10] subtests for an auditory understanding of speech and language at the beginning of rehabilitation, in the first 60 days after stroke. The obtained results were put in relationship with location of the stroke.

In the examination of the following BDAE subtests were used:

The subtest Word Discrimination - the patient should identify one of the six images shown by the examiner. The images were from categories: letters, geometric figures, objects, actions, numbers and colors. There were 36 pictures presented on the subject in total. Patients could reach the maximum of 72 points, if he could recognize all the images, depending on the reaction time - recognition.

The subtest Body Part Identification (BPI) - the patient should recognize and show the designated part of the body. He needed to identify 18 parts of the body

(18 points) in total, and the designated parts of the body in relation to the left or right side of the body (2 points). The maximum of points in this subtest is 20.

The subtest Commands - patient should recognize the five commands that the examiner pronounced. Commands are pronounced going from simple to more complex ones. The most complex commands required the understanding of three consecutive actions that the patient should recognize, understand and execute. Patient can achieve a maximum of 15 points in this subtest.

The subtest comprehension Complex Ideational Material is the most complex subtest of understanding - the patient needs to understand the five statements that the examiner read. The statements are read in the order from simple (only questions asked) to more complex ones. The more complex stories of several sentences were more complex. After reading, questions were asked patient about the content of the text. This subtest could achieve a maximum of 12 points. For a data analysis, statistical package SPSS v. 20 was used.

## RESULTS

**Table 1: The Results in the Subtest BDAE Auditory Recognition of the Word (Auditory Word Discrimination)**

| Points | N | % of the sample | Cumulative % |
|---|---|---|---|
| .00 | 22 | 27,16 | 27,16 |
| 1 - 18 | 22 | 27,16 | 54,32 |
| 19 - 36 | 8 | 9,87 | 64,19 |
| 37 - 55 | 8 | 9,87 | 74,06 |
| 56 - 72 | 21 | 25,92 | 100,00 |
| Average | 81 | 27,02 points - 37,53 % | |
| Total | 81 | 100.00 % | |

**Table 2: Results in the Subtest BDAE: Body Part Identification**

| Points | N | % of the sample | Cumulative % |
|---|---|---|---|
| .00 | 21 | 25,92 | 25,92 |
| 1 - 5 | 14 | 17,28 | 43,20 |
| 6 - 10 | 11 | 13,58 | 56,79 |
| 11 - 15 | 15 | 18,51 | 75,30 |
| 16 - 20 | 20 | 24,69 | 100,00 |
| Average | 81 | 8,50 points - 42,50 % | |
| Total | 81 | 100.00 | |

**Table 3: Results on the BDAE Subtest Auditory Understanding of the Command**

| Points | N | % of the sample | Cumulative % |
|---|---|---|---|
| .00 | 27 | 33,33 | 33,33 |
| 1 – 8 | 24 | 29,62 | 62,96 |
| 9 – 14 | 19 | 23,45 | 86,41 |
| 15 | 11 | 13,58 | 100,00 |
| Average | 81 | 5,48 points - 36,53 % | |
| Total | 81 | 100,00 | |

**Table 4: Results on the BDAE Subtest in Auditory Understanding of the Complex Ideational Material (CIM)**

| Success in points | N | % of the sample | Cumulative % |
|---|---|---|---|
| 0 .00 points | 37 | 45,67 | 45,67 |
| 1 – 3,5 points | 11 | 13,58 | 59,25 |
| 3,6 – 6 points | 11 | 13,58 | 72,83 |
| 7 – 9,5 points | 16 | 19,75 | 92,59 |
| 9,6 -12 points | 6 | 7,40 | 100,00 |
| Average points | 81 | 3,38 points - 28,16 % | |
| Total | 81 | 100,00 | |

**Table 5: Results on Subtests of Understanding (BDAE) in Relation to the Location of the Brain Lesion**

| Localization of the left side of brain lesions | An average score (points) on subtests of BDAE | | | | |
|---|---|---|---|---|---|
| | N | Word Discrimination | Body Part | Command | CIM |
| | | Maximum 72 points | Maximum 20 points | Maximum 15 points | Maximum 12 points |
| Frontoparietal | 13 | 22.77 | 9.76 | 5.07 | 2.96 |
| Frontoparietotemporal | 11 | 9.00 | 3.27 | 1.90 | 1.22 |
| Frontotemporal | 3 | 1.33 | 0.66 | 1.00 | 0.00 |
| Irrigation MCA | 12 | 23.08 | 7.58 | 4.75 | 2.41 |
| Parietal | 14 | 52.50 | 14.35 | 10.28 | 6.71 |
| Parietooccipital | 2 | 49.50 | 13.00 | 7.50 | 5.75 |
| Parietooccipitotemporal | 1 | 60.00 | 14.00 | 6.00 | 5.50 |
| Parietotemporal | 13 | 23.38 | 7.84 | 5.30 | 3.19 |
| Temporal | 10 | 26.30 | 7.60 | 5.40 | 3.60 |
| Temporooccipital | 2 | 26.25 | 7.00 | 4.50 | 2.50 |
| Average points | | 27.02 | 8.50 | 5.48 | 3.38 |
| % of maximum points | | 37.53% | 42.50% | 36.53% | 28.16% |
| Maximum points | Total 81 | 72 (100%) | 20(100%) | 15(100%) | 12(100%) |

## DISCUSSION

This study was designed to determine the success of patients with brain lesions, located behind the central and lateral cerebral cortex, in relation to speech and language comprehension.

For this purpose, we used subtests of the Boston Diagnostic Aphasia Examination (BDAE) [10].

The average age of the study group was 65.91 years in range of 36 years (48-84 years).

In our sample female gender was on average older almost 2 years - 1.76 years, compared to male, what is in concordance with the results of some studies in the surrounding areas [11-14].

Ischemic stroke was most commonly present in the sample (82.71%). Next was HIC with 9.87% sample, one was with SAH and the others with a combination of these types of stroke (ischemic and HIC). Some other authors have found similar distributions of stroke types [15, 16].

All patients had left brain lesions with consequent aphasia.

In our sample there were 10 patients with brain damages in temporal lobe, 14 patients at parietal while others had lesions in various combinations localized frontally, temporally, parietal and occipital. In these combinations, damage could be related to two or three of these localizations. Depending on the location and size of the damage, we also had different performance

in the auditory understanding of speech as we will show in the following text.

Results on the subtest Word Discrimination of BDAE are shown in Table **1**. The patients averaged had 27.02 points or 37.53% of the maximum possible result of 72 points. Over a quarter of the sample (27.16%) was unsuccessful, 22 patients could not identify any of the pictures presented. The result of 50% success and less had 52 patients or 64.19% of the sample. The success of 80% and more had 18 patients or 24.69% of the sample. Only 6 patients (7.40% of the sample) successfully recognized all the images. These results show how significant the damage to the investigated localizations and how much it affected the result of this subtest.

On the subtest BDAE - Body Part Identification, the maximum possible score is 20. The results of this subtest are shown in Table **2**. More than a quarter of the patients were unsuccessful although on this subtest they achieved the best average score of 8.50 points or 42.50% of the subtest. 21 patients could not even recognize any part of the body. The result of 50% success and less had 46 patients or 56.79% of the sample. The success of 80% or more was achieved 20 patients or 24.69% of the sample. Only 7 patients (8.64% of the sample) successfully recognized all the designated parts of the body. In this subtest, patients achieved the best results in relation to other subtests. It was simpler than others subtests that were more complex, especially the subtest of Complex Ideational Material.

The patient was asked to recognize five orders the examiner had pronounced at the subtest BDAE Commands. This subtest could achieve a maximum of 15 points. The results are shown in Table **3**. Patients on subtest Commands have average 5.48 points or 36.53% of the maximum possible result. 33.33% of the sample was unsuccessful, 27 patients (33.33 % of the sample) could not recognize any of the commands. The result of 50% success and less had 51 patients or 62.96% of the sample. The success of 80% and more was achieved by 16 patients or 19.75% of the sample. 11 patients (13.58%) were able to successfully recognize all spoken tasks. This subtest was more complex than the previous and the results were worse than the previous test. On this subtest, the weakest results were achieved in the part where two or three consecutive commands were to be identified. The best results were achieved in the part where only one task was to be identified.

Subtest of auditive comprehension of Complex Ideational Material (CIM) is the most complex subtest of understanding. In addition to understanding the linguistic content, it was necessary to have preserved the ability to speech expression, in order to answer the questions asked, whose centers are located in the frontal area of the left hemisphere (Broca's area). The maximum possible score is 12 points, in this subtest. Patients have averaged 3.38 points on this subtest or 28.16% of the maximum possible result. The results of this subtest are shown in Table **4**. 45.67% patients of the sample was unsuccessful, 37 patients could not comprehension the question or content of the question or respond adequately. On the subtest of comprehension the CIM, the result of 50% success and less had 59 patients or 72.83% patients of the sample. Only 6 patients or 7.40% of the sample had the success of 80% or more. Only 2 patients (2.46% of the sample) successfully recognized all complex speech material in this subtest.

The mentioned results confirm the importance of the observed brain regions in auditory speech and language recognition. Obtained results show the average success of the entire sample for all patients on individual BDAE subtests. However, there are large differences between patients regarding the localization of lesions, or different combinations of localization of damage and the size of damage. These differences are shown in Table **5** in chapter Results. Patients with lesions located on the frontotemporal lobe left brain hemisphere were the weakest results, as can be seen from the mentioned table. Both localizations are directly related to the understanding of speech (temporal zone) and speech expression (frontal zone). These patients have achieved poor success on the 3 subtests of comprehension (words, body parts and orders) and are unsuccessful in comprehension complex ideational material. These patients were also the problem of speech expression that was caused by damage to the frontal region, in addition to the difficulty in comprehension speech induced by temporal lesion lesions.

The results obtained confirm the findings of other authors on the responsibility of these brain sites in comprehension speech and language [3, 6, 9 and 17]. Patients with temporal region lesions in combination with adjacent regions (parietal and occipital, or with lesions of all three surrounding zones) have achieved poor results on these subtests of BDAE. The obtained results show that 14 patients with lesions located only on the parietal region achieved on average the best

results. They achieved the success rate of 72.91% of the test on the Word Discrimination subtest; on Body Part subtest 71.75%; on the subtest Commands 68.53%; on the CIM subtest 55.91%. This is significantly higher than the average achievement of the entire sample. If these patients (with lesions parietal lobe) were excluded from the sample, then the average result of the remainder of the sample on all subtests would be far below the results we had by including these patients in the sample.

The results presented are significantly lower than those found by Savic, Iriskic, Djuric and Buzadzija (2013) on a sample of 135 patients with SLP with localizations to 35 brain lesions after stroke [17]. Patients in their sample had brain lesions in other brain localizations other than the temporoparietooccipital region and they achieved significantly better results.

## CONCLUSION

All patients with lesions located behind the central and lateral cerebral sulcus of left brain hemisphere had poor results on the BDAE subtests for auditory (oral) comprehension of speech and language.

Patients of this sample had poor results, especially in subtests comprehension of complex ideational material of the BDAE.

Patients with lesions in temporal lobe, especially patients with combined lesions of the frontal and temporal part of the left brain hemisphere, had significantly lesser results than the rest of the sample.

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