

ACE-R TESTS RESULTS AFTER CAS

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Abstract: The objective of this paper was to compare the results in ACE-R tests in the group of 32 patients of the Department of Neurology in Vítkovice Hospital, Ostrava, Czech Republic, who underwent carotid artery stenting (CAS) there from 2012 to 2015. Carotid artery stenting is a surgical treatment of the carotid artery (the artery that supplies the brain). A plaque can built up in the artery wall (this process is called atherosclerosis) and cause a narrowing (stenosis) of the artery. Pieces of plaque can break off, move to the brain and cause a stroke - one of the most serious diseases of present time (the third leading cause of death in industrialized countries and the major cause of functional impairment). Carotid artery stenting is an endovascular surgery where a stent (a tube-like metallic mesh) is deployed within the lumen of the affected carotid artery to dilate it and prevent a stroke. The effect of CAS on patients' cognitive functions was examined in various studies with different results. ACE-R test was used to assess the quality of cognitive functions of the patients in our study and significantly better results were found after CAS. Statistical analysis was carried out with the programs SPSS (Chicago, IL, USA) and Microsoft Excel (Redmont, WA, USA). A paired sample *t*-test was used and the value of $p = 0.05$ was taken as a level of significance. Bland and Altman plot was constructed to confirm our result and provide a graphical display of the data agreement.

Keywords: carotid artery stenting, ACE-R test, paired sample *t*-test, Bland and Altman plot

1 Introduction

1.1 Carotid artery stenting

Cerebrovascular accident (also ictus, brain attack or stroke) belongs to the most serious diseases of present time. It is the third leading cause of death in industrialized countries and the

major cause of functional impairment [1]. It is a suddenly growing brain damage caused by a poor blood flow to the brain cells. This fault can occur either on the basis of cerebral artery occlusion (ie. ischemic stroke), or on the basis of cerebral vessels bleeding (ie. hemorrhagic stroke). It is an important diagnostic task to distinguish between ischemic and hemorrhagic stroke as the therapeutic approach is different in both cases and its inappropriate choice could worsen the patient's health state. Signs and symptoms of a stroke may include an inability to move or feel on one side of the body, problems with understanding and speaking, dizziness or impaired vision and hearing. Hemorrhagic strokes may also be associated with a severe headache. The main risk factor for stroke is high blood pressure, other risk factors include tobacco smoking, obesity, high blood cholesterol, diabetes mellitus and atrial fibrillation [2].

In the Czech Republic, stroke is the second leading cause of death and the leading cause of functional impairment and ischemic strokes (80%) predominate over hemorrhagic (20%) [3]. Annual incidence of ischemic stroke ranges from 250 to 300 per 100,000 persons [3] and annual mortality from 70 to 80 per 100,000 persons and the incidence increases with the age [4]. Ischemic stroke is very frequently caused by carotid artery stenosis. The carotid artery is an artery that supplies the brain. A plaque is often built up here (atherosclerosis) and causes a narrowing (stenosis) of the artery (see Fig. 1). Pieces of plaque can break off and block the blood flow in arteries, which leads to a stroke.



Fig.1 Arteries affected by atherosclerosis

There are three methods used in the treatment of carotid artery stenosis - conservative therapy, carotid endarterectomy (CEA) and carotid artery stenting (CAS). The classical conservative therapy is the primary step that is based on identifying and eliminating risk factors of atherosclerosis and prescribing special drugs - antiaggregants. Carotid endarterectomy is a classic surgical method consisting in surgical removal of the atherosclerotic plaque that narrows the artery. Carotid artery stenting is an endovascular surgery where a stent (a tube-like metallic mesh, see Fig. 2) is deployed within the lumen of the affected carotid artery to dilate (see Fig. 3) it and prevent a stroke. This minimally invasive method is often used to treat high-risk patients, when carotid endarterectomy is considered too risky.

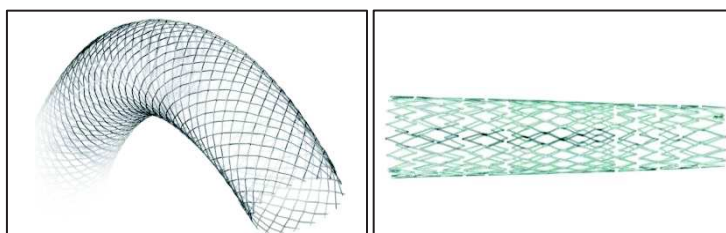


Fig.2 Two types of stents

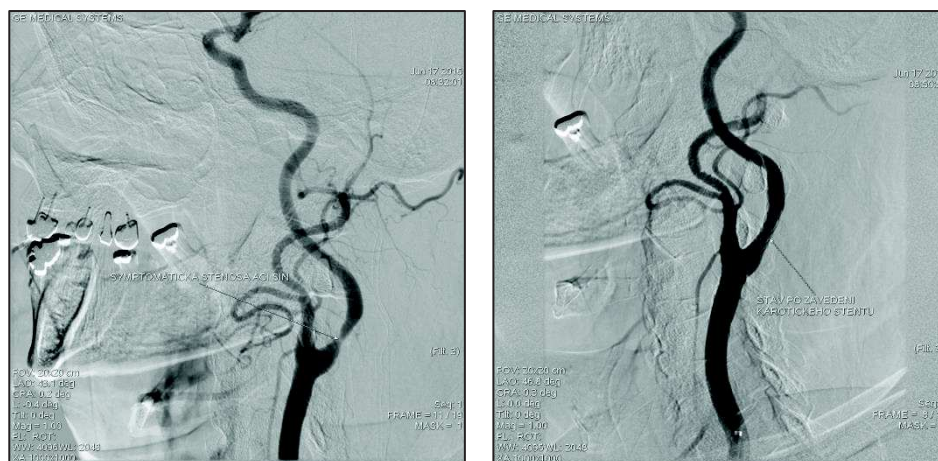


Fig.3 Perioperative DSA angiography showing tight stenosis and Control DSA angiography after stent implantation

1.2 ACE-R test

ACE-R test belongs to the group of cognitive tests, which provide assessments of the cognitive capabilities of humans. The Addenbrooke's Cognitive Examination (ACE) [5] and its subsequent iteration, ACE-R [6], are easy to use, acceptable to patients, and have shown excellent diagnostic utility in identifying dementia and cognitive impairment in a variety of clinical situations (Alzheimer's disease, frontotemporal lobar degenerations, Parkinsonian syndromes, stroke and vascular dementia, and brain injury). The ACE-R test is used worldwide and is available in a number of languages. The ACE-R takes about 15 min to administer and score in a clinical setting. It contains 5 sub-scores, each one representing one cognitive domain: attention/orientation (18 points), memory (26 points), fluency (14 points), language (26 points) and visuospatial (16 points). ACE-R maximum score is 100, composed by the addition of the all domains, a higher score denotes better cognitive function [6].

2 Methodology

2.1 Aim of the study

The aim of our study was to determine the impact of carotid artery stenting on patients' cognitive functions.

2.2 Study design

The examined group of 32 patients were indicated to CAS by a committee consisting of an interventional radiologist, a vascular surgeon and a neurologist in Vítkovice Hospital, Ostrava from 2012 to 2015. The indication criteria for CAS followed the current recommendations of the American Stroke Association. Addenbrooke's Cognitive Examination Revised (ACE-R) was used to test the level of the patients' cognitive functions. The patients underwent the ACE-R testing immediately before CAS and one month after the surgery. The test was performed by a clinical speech therapist with long-term experience in cognitive functions testing. The original tables of the ACE-R test by Mioshi et al [6] were used as a template for the testing.

2.3 Statistical analysis

Statistical analysis was carried out with the programs SPSS (Chicago, IL, USA) and Microsoft Excel (Redmont, WA, USA). A paired sample t -test was used and the value of $p = 0.05$ was taken as a level of significance. Bland and Altman plot was constructed to confirm our result and provide a graphical display of the data agreement.

3 Results

The paired sample t -test is a statistical procedure used to determine whether the mean difference between two sets of observations is zero. In a paired sample t -test, each subject or entity is measured twice, resulting in pairs of observations. The main assumption of this test is, that the differences between the paired values should be (approximately) normally distributed.

In our case the ACE-R score was measured immediately before CAS (ACE-R₁ variable) and one month after CAS (ACE-R₂ variable) at each of 32 patients and the differences in these two scores were computed for each patient. As the differences meet the assumption of normality (Kolmogorov-Smirnov test, $p = 0.816$), a paired sample t -test was performed and the following results were obtained:

Tab.1 Paired Samples Test

	ACE-R ₁ (Average $\pm$ SD)	ACE-R ₂ (Average $\pm$ SD)	ACE-R ₂ - ACE-R ₁ (Average $\pm$ SD)	p - value
ACE-R score	87.8 $\pm$ 7.1	91.6 $\pm$ 5.4	3.8 $\pm$ 3.9	< 0.001

Table 1 summarizes the conclusion of one-sided paired samples test. As the calculated p -value (< 0.001) is much smaller than the stated level of significance (0.05), we can consider the patients' ACE-R score results after CAS significantly higher than the score results before the surgery.

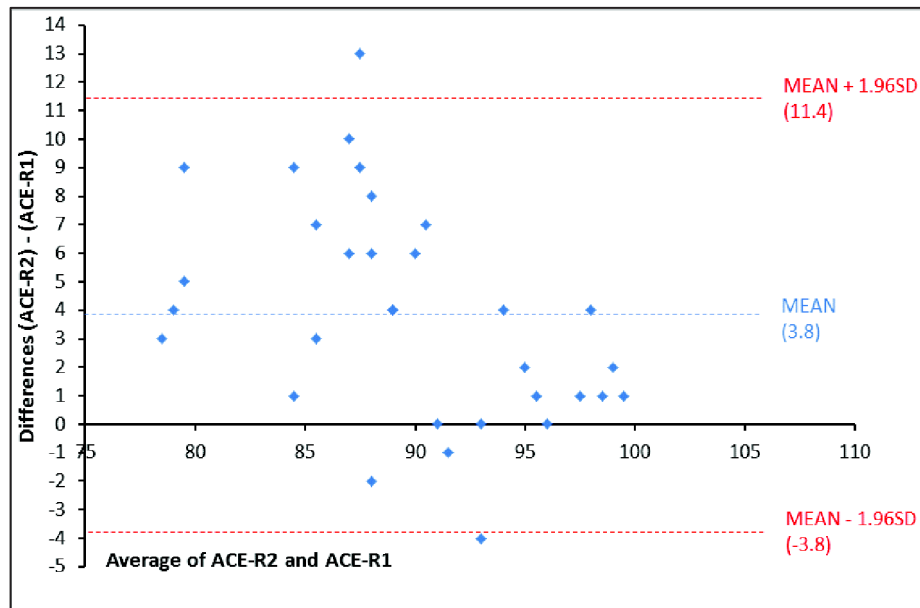


Fig.4 Bland and Altman plot

Our analysis was supplemented by Bland and Altman plot (Fig. 4), which was constructed to provide a graphical display of the difference between the two data sets and confirm our result.

Bland and Altman plot is the plot of the differences between the paired values against their mean. It is often accompanied by the 95% limits of agreement (average difference $\pm$ 1.96 standard deviation of the difference), represented by two red horizontal lines in Fig. 4, which tells us how far apart the observations were more likely to be for most individuals.

Fig. 4 displays considerable lack of agreement between the values of the ACE-R scores before and after CAS. Almost all the points tend to be above zero, so the difference $ACE-R_2 - ACE-R_1$ is positive in most cases. It corresponds with the conclusion of *t*-test that the patients' ACE-R score results are higher after CAS than before it.

Conclusion

Thirty-two patients of the Department of Neurology in Vítkovice Hospital, Ostrava, Czech Republic, who underwent carotid artery stenting from 2012 to 2015, underwent the ACE-R testing of their cognitive functions. Recent studies focused on the effect of CAS on patients' cognitive functions differ in their results. Our study found significantly better ACE-R score results at the patients after CAS. The improvements in cognitive performance in most patients can be attributed to the improvements in cerebral perfusion after CAS.

References

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VÝSLEDKY ACE-R TESTŮ PO KAS

Abstrakt: Cílem této studie bylo porovnat výsledky ACE-R testů u skupiny 32 pacientů Neurologického oddělení Vítkovické nemocnice v Ostravě, kteří zde v letech 2012 - 2015 podstoupili karotický stenting (KAS). Karotický stenting je chirurgická léčba karotické tepny (tepny zásobující mozek). Na vnitřní stěně této tepny se může usazovat plak (tento proces se nazývá ateroskleróza), což způsobuje zúžení (stenózu) tepny. Kousky plaku se mohou odlomit a krevním řečištěm doputovat k mozku, kde mohou zapříčinit mozkovou mrtvici - jedno z nejzávažnějších onemocnění dnešní doby (ve vyspělých zemích je to třetí nejčastější příčina úmrtí a nejčastější příčina invalidity). Karotický stenting je endovaskulární výkon, při kterém se do postižené cévy zavede stent (kovová síťka tvaru trubičky), jehož úkolem je cévu rozšířit a udržet její průchodnost. Vliv KAS na kognitivní funkce pacientů byl zkoumán v četných studiích s různými výsledky. V naší studii byly kognitivní funkce pacientů posuzovány pomocí ACE-R testu a statisticky významně lepší výsledky v těchto testech byly u pacientů shledány po provedeném KAS. K statistické analýze byl použit párový t -test (s hladinou významnosti $p = 0,05$), Bland Altmanův graf byl sestaven k následné vizualizaci rozdílu mezi porovnávanými hodnotami a k potvrzení našeho výsledku. Výpočty byly provedeny pomocí programů SPSS (Chicago, IL, USA) a Microsoft Excel (Redmont, WA, USA).

Klíčová slova: karotický stenting, ACE-R test, párový t -test, Bland Altmanův graf