Can We Always Rely on Computed Tomography Perfusion Imaging When Selecting Stroke Patients for Thrombectomy ?

Trombektomi İçin İnme Hastalarını Seçerken Her Zaman Bilgisayarlı Tomografi Perfüzyon Görüntülemesine Güvenebilir miyiz?

İngilizce Kısa Başlık: Reliability of CRP in stroke patients?

Türkçe Kısa Başlık: İnme Hastalarında BT Perfüzyonun Güvenli mi?

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09.06.2021
17.01.2022

ABSTRACT

Multimodal görüntüleme yöntemlerinden, perfüzyon bilgisayarlı tomografilerin kullanımı (BTP), son dönemlerde inme merkezlerinde endovasküler tedavi adaylarını belirlemede önemli araç haline gelmiştir. Bununla birlikte, BTP'nin enfarktüs çekirdeğini tanımlamadaki güvenilirliği, semptom başlangıç zamanına, kollateral durumuna ve diğer klinik faktörlere bağlı olarak değişebilmektedir. Yapılan bazı çalışmalarda, endovasküler tedavi için hasta seçiminde, BTP görüntüleme ile penumbrayı göstermenin tedavide başarı şansını arttırdığı gösterilmiştir. Beyin parankiminde farklı alanların (beyaz cevher, gri cevher gibi) hipoksiye duyarlılığının farklı olması, iskemik doku cevabını belirlemeyi güçleştirmektedir ve bu da perfüzyon çalışmalarının önemini arttırmaktadır. Bu nedenle özellikle son zamanlarda BTP görüntüleme ile çok sayıda otomatik yazılım programları kullanılmaya başlanmıştır. Bunlardan RAPID (IschemaView, Menlo Park, California, USA) ve Olea Sphere (Olea Medical Solutions, La Ciotat, France) en sık kullanılanlar arasında sıralanmaktadır. Bu programların her birinin enfarkt korunu gösterme oranları, yanılma olasılıkları farklı çalışmalarda ele alınmıştır.

Bu makalede sağ orta serebral arter kliniği ile gelen, uyanma inmesi, 55 yaşında kadın hastanın endovasküler tedavi kararı öncesi yapılan BTP görüntülemelerinin tedavi sürecinde ne kadar yol gösterici olduğunu değerlendirmeyi amaçladık.

Anahtar Kelimeler: Iskemik inme, RAPID, Olea

ÖZ

The use of perfusion computed tomography (CTP), one of the multimodal imaging

modalities, has recently become an important tool in determining endovascular treatment candidates in stroke centers. However, the reliability of CTP in identifying the infarct core may vary depending on the time of symptom onset, collateral status, and other clinical factors. In some studies, it has been determined that showing the penumbra with CTP imaging increases the chance of success in the selection of patients for endovascular treatment. The difference in sensitivity to hypoxia in the brain parenchyma (such as white matter, gray matter) makes it difficult to determine the ischemic tissue response, thus increasing the importance of perfusion studies. Therefore, many automatic software programs have been used with CTP imaging. Of these, RAPID (IschemaView, Menlo Park, California, USA) and Olea Sphere (Olea Medical Solutions, La Ciotat, France) are among the most frequently used. The rates of each of these programs showing the infarct core and the probability of error discussed by different studies.

In this article, we aim to evaluate the role of CTP imaging in the treatment process before the decision for endovascular treatment of a 55-year-old female patient who presented with right middle cerebral artery clinic and had a wake-up stroke.

Keywords: Stroke, RAPID, Olea

INTRODUCTION

The use of Computed Tomography Perfusion imaging in the early diagnosis and treatment algorithm of acute ischemic stroke patients has become widespread with the introduction of the third generation computed tomography (CT) (1). CTPs have a large number of automatic software programs. Although their cost, it has been reported that the software programs frequently used in stroke centers are RAPID (IschemaView, Menlo Park, California, USA) and Olea Sphere (Olea Medical Solutions, La Ciotat, France) (2). CTP is a method based on the examination of brain perfusion using contrast material. By repeatedly imaging a certain part or all of the cerebral parenchyma, the passage of contrast material from arteries to venous structures via capillaries is visualized. From the dynamic images taken after the contrast material; Evaluation is made by forming peak time (TTP), cerebral blood volume (CBV), cerebral blood flow (CBF) maps. TTP indicates the time when the contrast agent reaches the tissue. It is the most sensitive indicator of cerebral ischemia. TTP value increases in these areas because the contrast material is delayed in reaching the ischemic tissue compared to normal tissues. Alternatively, the mean transit time (MTT) or maximum transit time (Tmax) is calculated. Since MTT shows the time between the transfer of the contrast agent into the tissue and its removal from the tissue, it is expected to be prolonged in ischemic areas. This value can be calculated with the formula $MTT = CBV / CBF$. Tmax time increases in ischemic tissue. Although this parameter is widely used, its physiological meaning is not fully understood. Cerebral blood volume (CBV) refers to the volume of blood present in a given brain area at a given moment and is calculated from the area under the time curve. Cerebral blood flow (CBF) shows the blood supply to the brain at a certain time (1,3).

The main purpose of CTP imaging is to determine the ratio of irreversible infarct core area to the penumbra. The penumbra area is the tissue outside the ischemic core that maintains the vitality when reperfusion is achieved. Peripheral of the penumbra area are the less hypoperfused area; the area of benign oligemia. This area maintains its vitality even if reperfusion does not occur. Many different approaches have been present to estimate CTP and penumbra. Areas where CBV is significantly reduced indicate ischemic core, while areas where only CBF and TTP are reduced indicate penumbra. In summary, the areas where CBV and CBF incompatibility is observed can be named as the penumbra (1,2,3). In this article, we

evaluated the role of CT perfusion in the diagnosis and treatment of acute ischemic stroke by comparing the results of RAPID and Olea software.

CASE

A 55-year-old female patient presented to the emergency department with left-sided weakness and it was evaluated as stroke. CTP was taken because of waking stroke. In his medical history, she had myocardial infarction and cardiac thrombus when she was 40 years old. Transthoracic echocardiography (ECHO) revealed an ejection fraction (EF) of 25%. Although, the patient was followed up with acetylsalicylic acid and beta-blockers in long-term treatment. In her neurological examination at the emergency room, she was conscious, partially cooperative, partially oriented, and speech was mildly dysarthric. The eyes were deviated to the right, PIR: ++/++, left gaze was limited. She had 2/5 hemiparesis, including the left side face and left-sided neglect. The National Institutes of Health Stroke Scale (NIHSS) were evaluated as 18. There were frequent ventricular extrasystoles on electrocardiography, but the basal rhythm was sinus. Although there was no history of stroke in her history, computed tomography (CT) showed chronic infarct areas in the left opercular area and the right frontal cortex, and hyperdense appearance in the right middle cerebral artery (MCA) (Figure 1A). On CT angiography (CTA), the right MCA was observed to be occluded after the level where the anterior temporal artery was spared. (Figure 1B,C). In RAPID, CBF was less than 30% 0 mL, mismatch volume 86ml, Tmax > 6.0-volume 86ml, total Tmax > 6.0 volume 164ml, total mismatch was 164 mL (Figure 2), in OLEA the infarct volume was 19.32cc, and the hypoperfused area was 79.22 cc mismatch volume was 59.9 cc (Figure 3). The patient was taken to angiography. With the isolated stent technique, modified Thrombolysis in Cerebral Infarction score was 3 (Figure 4,5). After the procedure, the patient's motor deficit increased to 4/5 hemiparesis. In DWI MR (Diffusion-Weighted Imaging Magnetic Resonance) taken at the 12th hour, infarct areas were observed at the level of the interna capsule and corona radiata on the right. According to ABC/2 calculation, the infarct volume measured in DWI MR was 2.8 mL (Figure 6). In the 24th hour transthoracic Echo, EF of 25.5%, apical akinesia, aneurysmal dilatation, a smear-like organized thrombus and non-ischemic cardiomyopathy were observed. After the patient was transferred to the stroke unit, heparin infusion was started. Warfarin treatment was continued after 48 h. The patient, who was stable during the hospital follow-up period, had a Modified Rankin Scale (mRS) 1 at discharge. In the outpatient follow-up, the third-month mRS was 0.

DISCUSSION

Nowadays, with the development of electronic engineering, the chance of success in the diagnosis and treatment of diseases increases in the field of medicine as in many other fields. Among these diagnostic methods, radiological imaging is important. With the introduction of the third generation CT devices, neurologists' chances of success in the diagnosis and treatment of acute ischemic stroke patients are increasing day by day. Especially in patients with acute ischemic stroke with large vessel occlusion, in making decisions for thrombolytic therapy and mechanical thrombectomy, except the symptom time of the stroke, it is important to evaluate the infarct core area, penumbra and collateral level. Today, many stroke centers use CTP imaging to bring clarity to these issues (1,4,5). Different automatic software programs were created because of the frequent use of CTP imaging in acute ischemic stroke patients with large vessel occlusion. The most commonly used of these programs is the RAPID software. In the last 1-2 years, the use of the Olea automatic software has become widespread (4,5). In our stroke center, we perform the diagnosis and treatment

process of stroke patients by using these two software programs within multimodal imaging examinations.

There are studies evaluating how collateral circulation status are related to certain predefined cerebral perfusion parameters using CTP software programs and evaluating their capacity to predict the growth of infarct volume in patients with acute ischemic stroke who are suitable for endovascular therapy (4). Simultaneously, the success rate in the selection of patients who will undergo thrombectomy with these software programs has been investigated (5,6,7,8,9). Even if full recanalization has been achieved in patients, it is important to determine the clear boundaries of ischemic core tissue that has no healing potential (5). Recently, the error rates of CTP imaging have been discussed with increasing software programs. Studies have shown that the estimated volume of infarct in the control DWI MR images taken in the early 24–48 h of conservatively treated patients is not more than predicted. Additionally, head movement during imaging, errors in the way the contrast agent is administered and its timing can affect the result (2,3). In a prospective study, while the software error rate was 4.7% with RAPID, this rate was 0.78% with Olea. Compared to Olea, the ischemic core volume in RAPID is closer to the DWI-MRI infarct volume (2).

Automated computed tomography perfusion is recommended suitability for selection of stroke patients for thrombectomy > 6 hours from the ictus. However, artifacts on automated perfusion output may overestimate the tissue at risk leading to misclassification of thrombectomy suitability in some patients. In a retrospective study of RAPID data from 410 stroke patients with acute anterior circulation large vessel occlusion, the mean artifact volume was shown to be 12 cc. Although CTP images were reliably described by trained evaluators, of these, 43% had Tmax > 6 seconds abnormalities discordant with clinical symptoms and vessel imaging (12).

In this study, the infarct volume (CBF) in RAPID was 0 mL, the infarct volume in Olea was 19.32 cc, and the volume in the hypoperfused area was 79.22 cc. The total infarct volume was 2.8 mL on diffusion-weighted imaging taken at the early 12th hour after TICI3 recanalization was achieved.

In the study by Kurz et al., the sensitivity of RAPID in acute ischemic stroke patients was 40.5%, its specificity was 97.6%, these rates for Olea; sensitivity was shown as 73.7% and specificity as 68.3% (3). It has also been shown that RAPID has a numerically higher failure rate than Olea in detecting ischemic brain regions. In another study, it was stated that Olea enlarged the infarct volume by 69.7% and underestimated the infarct volume by 7.3%. In the use of RAPID, on the other hand, the reduction of infarct volume of 1.7%, enlargement, and incompatibility in infarct volume in 61% was reported (13).

In conclusion; we wanted to highlight the advantages and limitations of two CTP software programs commonly used in the clinical setting. Discussions about the necessity of CTP in making treatment decisions are still ongoing. Therefore, it is beneficial to use combined multimodal imaging techniques in the diagnosis and treatment of acute ischemic stroke patients with large vessel occlusion by expert neurologists.

Ethics

Informed Consent: Written and verbal consent was obtained from the patients and their relatives, after informing them.

Authorship Contributions: Interventional Angio and Medical Practices: A.O.O, O.A, F.M, F.A.K. Concept: A.O.O, O.A, F.M. Design: A.O.O, O.A, F.M. Data Collection or Processing: F.M, O.A. Analysis or Interpretation: A.O.O, O.A. Literature Search F.M, O.A. Posted by F.M. Translation: S.A.S.

Conflict of Interest: The authors declared no conflict of interest regarding this article.

Financial Support: No financial support was received from any institution or person for our study.

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Figure 1 A) Non-contrast CT imaging of the patient: Hyperdense artery sign in the right middle cerebral artery. Figure 1B) (axial image) and 1C) (Coronal image) CT Angiography; The right MCA was observed to be occluded after the level where the anterior

Figure 2: RAPID; CBF was 30 : 0mL, mismatch volume: 86ml,Tmax6.0 volume: 86ml, total Tmax6.0 volume: 164ml, total mismatch: 164mL.

Figure 3: Olea; Volume of the infarct 19.32 cc, hypoperfused area 79.22 cc,mismatch volume 59.9 cc

Figure 4: Intracranial selective cerebral angiographic A:) The right MCA was observed to be occluded after the level where the anterior temporal artery was spared. B) A-P projection and C) Lateral projection; Modified Thrombolysis in Cerebral Infarc

Figure 5: Thrombus specimen retrieved with isolated stent technique as a result of mechanical thrombectomy

Figure 6: A capsula interna and a corona radiata infarction was observed in Diffusion-Weighted Imaging Magnetic Resonance and Apparent diffusion coefficient of the patient