Comparison between the Role of CT Perfusion versus MRI Perfusion in the Diagnosis of Acute Cerebral Ischemia

Essay

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مقارنه بين دورالتشبع بالأشعة المقطعية والتشبع بالرنين المغناطيسي في حالات السكتة الدماغية الحادة نتيجة القصور الدموي

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Abbreviations

ACA …………Anterior Cerebral Artery
ADC………….Apparent Diffusion Coefficient
AICA………. Anterior Inferior Cerebellar Artery
AIF…………...Arterial Input Function
ASL…………..Arterial Spin Labeling
BA…………. Basilar Artery
BBB…………… Blood-Brain Barrier
CBV…… Cerebral Blood Flow
CBV……….. Cerebral Blood Volume
CI……………..Confidence Interval
CMRO2………... Cerebral Metabolic Rate for Oxygen
CNS…………..Central Nervous System
CTA……….. CT-Angiography
CTP………... CT Perfusion
DSC…………..Dynamic Susceptibility Contrast
DWI-MR……. Diffusion Weighted Magnetic Resonance
ECA……….. External Carotid Artery
EPI……………Echo-Planar Imaging
GE…………….Gradient Echo
HT……. Hemorrhagic Transformation
ICA……… Internal Carotid Artery
IP………….. Ischemic Penumbra
MCA………….Middle Cerebral Artery
MDCT……….. Multi-Detector CT
MRA………….Magnetic Resonance Angiography
MRI……. … Magnetic Resonance Imaging
MTT…………. Mean Transit Time

Abbreviations

NCCT…….-...... Noncontrast CT
PCA……….. Posterior Cerebral Artery
PET……… Positron Emission Tomography
PICA……….. Posterior Inferior Cerebellar Artery
PS………... Surface area Product(measuring microvascular permeability)
PWI-MR….. perfusion-weighted magnetic resonance
ROI…………. Region Of Interest
s……………….Second
SCA…… Superior Cerebellar Artery
SE……………..Spin Echo
SI……………..Signal Intensity
SPECT……... Single Photon Emission CT
T……………...Tesla
TAC………... Time-Attenuation Curves
tPA……………Tissue type Plasminogen Activation
TR…………….Time to Repeat
TTP…………..... Time To Peak
XECT………….. Xenon-Enhanced CT

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Introduction and aim of work

Introduction:

Stroke is a heterogenous syndrome caused by multiple disease mechanisms, all of which result in disruption of normal cerebral blood flow. broadly, stroke can be classified into two categories: ischemic and hemorrhagic. The former accounts for an estimated 80.85% of cases; the rest are hemorrhagic. Stroke is a leading cause of death in developed countries and one of the most common causes of long-standing disability ***(Khandelwal, 2008)***.

It is agreed that emergency, non–contrast-enhanced CT scanning of the brain accurately identifies most cases of intracranial hemorrhage and helps discriminate nonvascular causes of neurological symptoms e.g. (brain tumors) ***(Adams et al., 2007).***

The National Institute of Neurological Disorders and Stroke Recombinant Tissue Plasminogen Activator (NINDS rt-PA) Stroke Study demonstrated the efficacy of treatment with intravenous rt-PA (alteplase) started within three hours after the onset of symptoms and up to six hours after the onset of stroke ***(Hacke et al., 2004).***

The major target of intervention in acute ischemic stroke treatment is the ischemic penumbra which can be evaluated both on CT images (on which it is evidenced by a discrepancy in perfusion parameters) and on MR images (on which it is indicated by a mismatch between diffusion and perfusion parameters) ***(Srinivasan et al., 2006).***

Diffusion-weighted imaging (DWI) is widely used to investigate hyper acute cerebral ischemia detecting early ischemic abnormalities related to reduction of the apparent diffusion coefficient (ADC) of brain water ***(Meng et al., 2004).***

Perfusion-weighted imaging (PWI) provides information about the hemodynamic status of brain tissue and detects regions with impaired cerebral perfusion. Perfusion MRI is useful for acute stroke because this technique evaluates the blood flow in the brain's micro-vasculature (capillaries) ***(Meng et al., 2004).***

The combination of perfusion and diffusion images obtained during the same session enabled Warach et al. to report their findings on the penumbra in the acute ischemic stroke and thus establishing the mismatch concept ***(Lövblad et al., 2004).***

CT perfusion is a functional imaging technique that provides important information about capillary-level hemodynamic of the brain parenchyma in the evaluation of acute stroke. CT perfusion can be performed by monitoring the contrast agent through the cerebral vasculature. Changes in tissue attenuation that occur in the brain after contrast injection are measured. Post processing of the perfusion data allows the generation of color-coded maps of various perfusion parameters including cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT), and the time to peak (TTP). These maps generated depend on the algorithm of the CT perfusion data obtained ***(Konstas et al., 2009).***

Aim of the work:

To compare the results and accuracy of CT perfusion versus MRI perfusion in diagnosis of hyper-acute stroke.

VASCULAR ANATOMY OF THE BRAIN

The mode of distribution of the vessels of the brain has an important bearing upon a considerable number of the pathological lesions , It is necessarily to understand the normal cerebrovascular anatomy, the significant arterial anastomoses and collateral circulatory patterns that should be considered during evaluation of acute stroke patient ***(Bell et al., 2008).***

The brain is a highly vascular organ, its profuse blood supply characterized by a densely branching arterial network. The brain is supplied by two internal carotid arteries and two vertebral arteries which form a complex anastomosis (circulus arteriosus, circle of Willis) on the base of the brain ***(Griffiths, 2008).***

Intracranial Arteries

I. Internal Carotid Artery:

The internal carotid artery (ICA) originates from the common carotid artery in the neck at the approximate level of the fourth cervical vertebra. The internal carotid arteries and their major branches essentially supply blood to the forebrain, with the exception of the occipital lobe ***(Gallucci et al., 2005).***

- ***<u>According to the latest classifications, it can be divided into seven segments:</u>*** (fig.1.1)

- Cervical portion (C1): it begins at the bifurcation of the common carotid, and runs upward to the carotid canal.
- Petrous portion (C2): it corresponds to the petrous portion of the temporal bone.
- Lacerum portion (C3): it extends from the endocranial carotid canal to the petrolingual ligament, and ascends in the carotid sulcus of the basisphenoid.
- Cavernous portion (C4): it is situated inside the cavernous sinus, forming the roof of the sinus.
- Clinoid Portion (C5): it is the shortest part of the ICA, completely intradural.
- Ophthalmic portion (C6): it ends proximal to the posterior communicating artery origin.
- Communicating portion (C7): it ends by giving its terminal branches, anterior cerebral artery (ACA) and middle cerebral artery (MCA) ***(Bouthillier et al., 2005).***

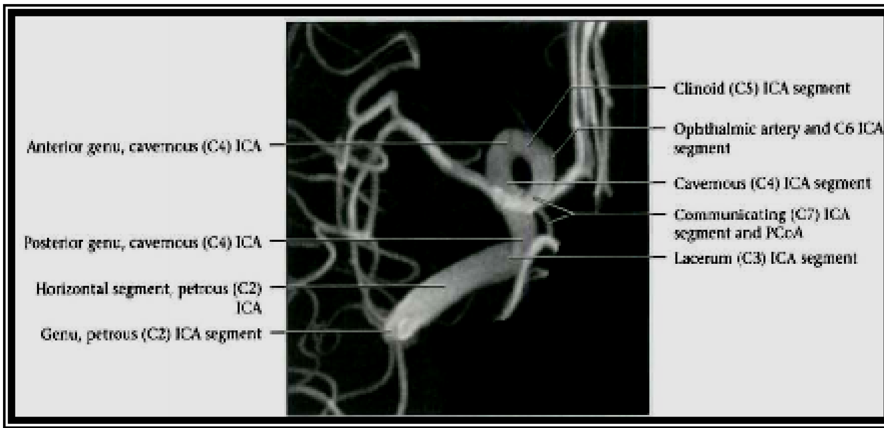

Figure (1.1): *MRA of ICA segments* ***(Quoted from Osborn, 2006).***

- ***<u>The following are the branches of the internal carotid artery, listed by segment</u>***:

C1: Branches from the cervical portion: - none.

C2: Branches from the petrous portion:

- ✧ Vidian artery (artery of pterygoid canal) anastomoses with external carotid artery(ECA)
- ✧ Caroticotympanic artery (supplies middle ear)

C3: Branches from the lacerum portion: – none.

C4: Branches from the cavernous portion:

- ✧ Meningohypophyseal trunk (arise from posterior genu, supplies pituitary, tentorium and clival dura).
- ✧ Introlateral trunk arises from horizontal segment, supplies cavernous sinus dura / cranial nerves; anastomoses with ECA branches through F.rotundum, spinosum, ovale.

C5: Branches from the clinoid portion: – none

C6: Branches from the ophthalmic portion:

- ✧ Ophthalmic artery from anterosuperior ICA , passes through optic canal to orbit; gives off ocular, lacrimal, muscular branches.
- ✧ Superior hypophysial artery courses posteromedially; supplies anterior pituitary, infundibulum, optic nerve/ chiasm).