Original Article

CT perfusion study of brain: Normal and in its various diseases

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Abstract

Introduction: Perfusion is the process of delivering blood to a capillary bed of biological tissues. The word is derived from the French verb "perfuser" meaning "pour over or through". **Aims and Objectives:** To Study CT perfusion Study of Brain: Normal and In its Various Diseases. **Methodology:** This was Prospective study of 2 months (March 2014 - April 2014) duration at sriramachandra hospital, A tertiary care teaching hospital, Department of Radiology and Imaging Sciences. 10 patients of either sex presented themselves in Radiology department. Their reports and image data's were collected prospectively during the study period between March 2014 to April 2014.Parameters for CT perfusion brain were in cine mode, Parameters for CT perfusion Brain and neck regions shuttle mode. **Result:** The CT perfusion parameters of the first three patients with normal CT findings showed normal values. The CT perfusion in the patient with acute stroke showed significant decrease in Cerebral blood flow (CBF) in the affected hemisphere. Significant decrease in cerebral blood volume (CBV) was also seen. The CBV maps were less sensitive and TTP maps were less specific and also showed areas of collateral blood flow. **Conclusion:** In summary, perfusion CT is clearly a viable alternative to other modalities used to measure perfusion. This technique is fast and available in most standard helical CT scanners equipped with the appropriate software. Perfusion CT can be used to assess not only patients with acute stroke but also helpful in the diagnosis and subsequent treatment response in patients with a variety of tumors. Further investigations are necessary to determine the accuracy, reliability, and reproducibility of the quantitative results.
Keywords: CT perfusion parameters, Cerebral blood flow (CBF), Cerebral blood volume (CBV).

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INTRODUCTION

Perfusion is the process of delivering blood to a capillary bed of biological tissues. The word is derived from the French verb "perfuser" meaning "pour over or through". Tests verifying that adequate perfusion exists are a part of a patient's assessment process that is performed by medical or emergency personnel. The most common methods include evaluating body's skin color, temperature, condition and capillary refill. In 1920, August Krogh was awarded the Nobel Prize in Physiology or Medicine for his discovering the mechanism of regulation of capillaries in skeletal muscle. Krogh was the first to describe the adaptation of blood perfusion in muscle and other organs according to demands through the opening and closing of arterioles and capillaries. Computed tomography (CT) is a technology that uses computer-processed x-rays to produce topographic images (virtual slices) of specific areas of the scanned object, allowing the user to see what is inside it without cutting it open. Digital geometry processing is used to generate a three-dimensional image of the inside of an object from a large series of two-dimensional radiographic images taken around a single axis of rotation. Medical imaging is the most common application of x-ray CT. Its cross-sectional images are used for diagnostic and therapeutic purposes in various medical disciplines. CT produces a volume of data that

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can be manipulated in order to demonstrate various bodily structures based on their ability to block the x-ray beam. Although, historically, the images generated were in the axial or transverse plane, perpendicular to the long axis of the body, modern scanners allow this volume of data to be reformatted in various planes or even as volumetric (3D) representations of structures. In the assessment of acute stroke syndrome, neuroimaging plays a critical role in determining patient care. NCCT remains the first-line imaging technique for differentiating hemorrhagic and ischemic stroke and identifying other etiologies for altered neurologic status, such as an intracranial mass.[1] In stroke, NCCT is used to exclude acute hemorrhage and large areas of clearly infarcted tissue and to select patients for thrombolysis[2-4] The addition of cross-sectional CT angiography and perfusion imaging can further improve detection of infarct, can identify candidates who will have the best functional outcome after thrombolysis, and may further widen the time window for intravascular therapy.[5–8]. The role of CTP in the acute stroke setting continues to grow despite widespread use of DWI.9 CT has distinct advantages, including relative cost, availability, and ease of patient monitoring.[10] he advent of multi-detector CT has also increased imaging speed, making dynamic and angiographic imaging possible. CTP and CTA can be performed rapidly and conveniently following NCCT.[11] On 16-section multi-detector scanners, the total additional scanning time for CTP/CTA is <2 minutes. The total additional acquisition time is approximately [15] minutes, and additional post-processing time is approximately 10 minutes.[12] CTP imaging can be performed while keeping the radiation dose as low as possible and producing useful perfusion maps. Care must be taken to optimize scanning parameters for CTP as per recent statements from the US Food and Drug Administration,[13] the American College of Radiology, and American Society of Neuroradiology.[14] With CTP, it is not only possible to accurately identify potentially salvageable ischemic tissue (penumbra) and separate this from irreversibly infarcted tissue (core), but recent work shows that CTP can be used to predict the benefit after thrombolysis.[15] Studies have shown good agreement of CTP findings with DWI and MR perfusion.[7] In addition, CBF can be quantified by using CTP. CTP packages are now available on virtually all commercial ct scanners. As the role of CTP grows in the diagnosis and treatment of acute stroke, it becomes ever more important for the radiologist to understand patterns and potential pitfalls in interpretation. We review a series of perfusion patterns with illustrative cases of cerebral ischemia and mimickers. normal perfusion: CTP parameters that are commonly calculated by commercially available post processing software platforms include CBF, CBV, MTT, and TTP. CBF, CBV, and MTT are related by the central volume principle: CBF = CBV/MTT.[17] these are commonly derived from CTP source data by using deconvolution analysis.[18] CTP measures brain tissue blood perfusion. CBV is measured in units of milliliters of blood per 100 g of brain and is defined as the volume of flowing blood for a given volume of brain. mtt is measured in seconds and defined as the average amount of time it takes blood to transit through the given volume of brain. CBF is measured in units of milliliters of blood per 100 g of brain tissue per minute and is defined as the volume of flowing blood moving through a given volume of brain in a specific amount of time.[18] in the setting of acute infarction, areas of irreversibly infarcted tissue show matched areas of decreased CBF and CBV with increased MTT (Fig 2). This pattern suggests neuronal death with irreversible loss of function or core infarct.[20] in several studies correlating CTP with DWI, severe decreases in CBV are particularly sensitive and specific for defining the extent of unsalvageable core.[8,21]

MATERIAL AND METHODS

This was Prospective study of 2 months (March 2014 - April 2014) duration at sriramachandra hospital, A tertiary care teaching hospital, Department of Radiology and Imaging Sciences. 10 patients of either sex presented themselves in Radiology department. Their reports and image data's were collected prospectively during the study period between March 2014 to April 2014. A detailed history of various patients data includes patient demographic details, hospital ID, radiology accession number, and the study reports were collected and entered in a specially designed Proforma. The acquired study data of " CT Perfusion data" of each patients were then post processed by using a GE ADVANTAGE WORKSTATION (software version 4.4) and CTP values of Brain were collected by using a specially designed software called "FUNCTOOL. Full detailed reports with the history of all patients were collected and used for the study.All the patients' data within the study period were collected. Patients were selected irrespective of their age group, gender excluded from the study. Parameters for CT perfusion brain were in cine mode, Parameters for CT perfusion Brain and neck regions shuttle mode.

RESULT

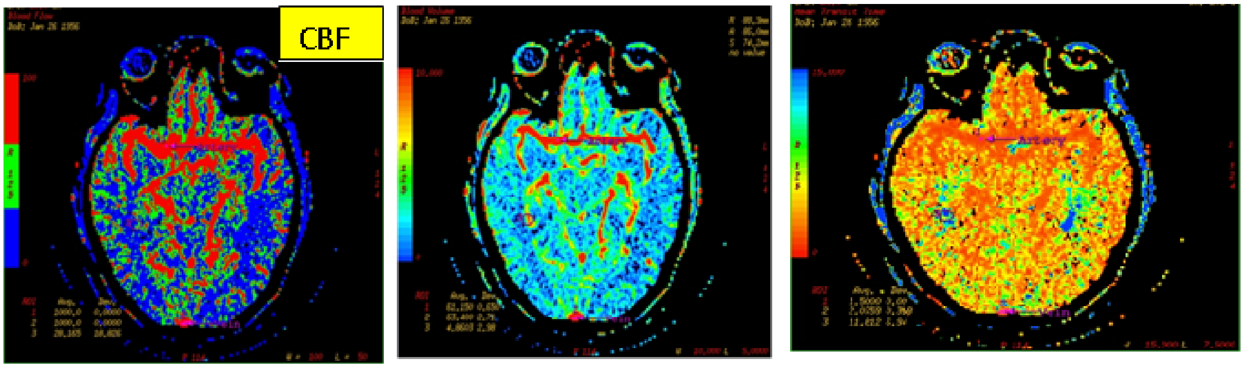

Figure 1: CT perfusion of normal brain

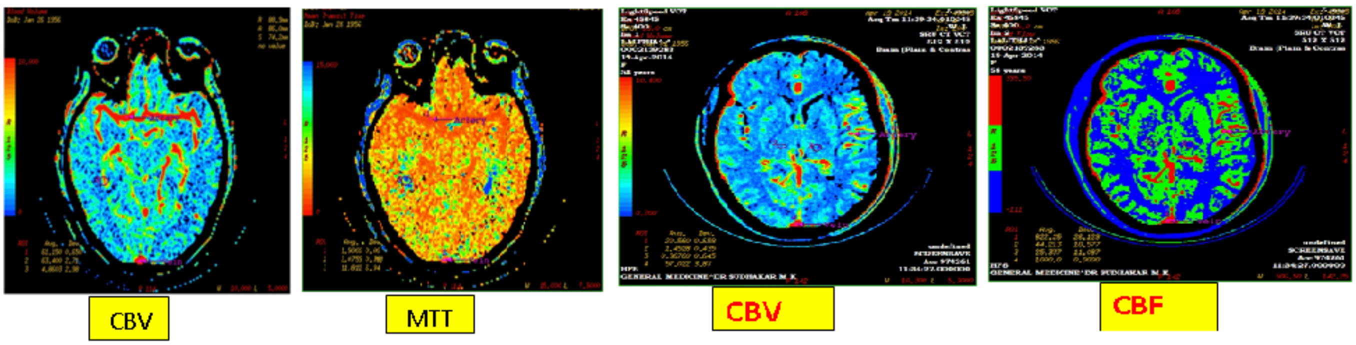

Figure 2: **CT Perfusion of brain in acute stroke**

Table 1: Distribution of the Normal and acute infarct with respect to CT perfusion of brain

Region	Blood Volume (BV)	Blood Flow (BF)	Mean Transit Time (MTT)	Surface Permeability (SP)
Normal Brain parenchyma	1.45	44.21	2.21	0.29
Brain (acute infarct)	0.987	25.3	2.39	1.89

From above figures CT perfusion of brain was performed in four patients. Three were performed on patients who presented with complaints of generalized headache. The fourth study was performed on a patient who presented with complaints of right sided weakness. The perfusion studies were performed after routine brain study was completed. The CT brain of the first three patients was normal. The CT brain of the fourth patient showed subacute infarct in the left thalamus. The CT perfusion was performed in the fourth patient with acute stroke to indicate tissues at risk and to measure a perfusion limit to predict infarction. The CT perfusion parameters of the first three patients with normal CT findings showed normal values. The CT perfusion in the patient with acute stroke showed significant decrease in Cerebral blood flow (CBF) in the affected hemisphere. Significant decrease in cerebral blood volume (CBV) was also seen. The CBV maps were less sensitive and TTP maps were less specific and also showed areas of collateral blood flow.

DISCUSSION

The perfusion studies on the patient with acute stroke showed relative values of CBV and CBF which very well discriminated the areas of reversible and irreversible ischemia. The study provided substantial and important additional information to facilitate optimal treatment strategy on patient with acute stroke. In our study we found The CT perfusion in the patient with acute stroke showed significant decrease in Cerebral blood flow (CBF) in the affected hemisphere. Significant decrease in cerebral blood volume (CBV) was also seen. The CBV maps were less sensitive and TTP maps were less specific and also showed areas of collateral blood flow.

CONCLUSION

In summary, perfusion CT is clearly a viable alternative to other modalities used to measure perfusion. This technique is fast and available in most standard helical CT scanners equipped with the appropriate software. Perfusion CT can be used to assess not only patients with acute stroke but also helpful in the diagnosis and subsequent treatment response in patients with a variety of tumors. Further investigations are necessary to determine the accuracy, reliability, and reproducibility of the quantitative results.

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