CASE REPORT

Case Report: Arterial Spin Labeling Perfusion MRI Contribution for Clinical Implementation of Brain Disease

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ABSTRACT

Currently, ASL is widely used as an additional breakthrough sequence in MRI due to acquiring reliable results. The case report aims to prove the efficacy and effectiveness of a quantitative method of ASL sequence through the calculation of the cerebral blood flow (CBF) on CBF maps in different cases. ASL sequence has been done on four patients with different cases. Then, the authors put 2 regions of interest (ROI) for measurement in normal and different regions on CBF maps and then calculated the average value result from CBF maps. ASL has been proven as a reliable and breakthrough sequence in MRI for detecting brain disease with a non-invasive method through the calculation of CBF value. ASL should be used as an additional protocol in brain examinations because it allows radiologists to assess the significance of CBF values using a quantitative method that is more reliable and non-invasive.
Malaysian Journal of Medicine and Health Sciences (2023) 19(5):441-443. doi:10.47836/mjmhs19.5.53

Keywords: MRI Brain, Arterial spin labeling (ASL), Cerebral blood flow (CBF), CBF maps

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INTRODUCTION

The benefit of the ASL method in MRI Brain examinations has been increased, due to non-invasiveness. Currently, ASL method is frequently used in numerous human's organs, but this case report is only primarily focused on the brain region because this technique has been widely applied in the brain due to their advantages. An early study of ASL was seen in acute stroke cases (1) and nowadays 3D ASL MRI method has been increased because it remains a prominent method for detecting acute stroke cases particularly the ability of detecting hyper perfusion suggesting stroke mimics. This case report aims to present the function and contribution of ASL in MRI brain examination.

CASE REPORT

The first case (Fig. 1) was male, 25 years old with no history examinations. There was brain tuberculoma of the left parietal lobe which shows hypointense on T1W, restricted area on DWI and hyperintense signal on T2W and after contrast injection shows multiple-rim enhancement and then CBF value were calculated by positioning two ROIs (region of interest), both using

11.5 mm^2. The average for about 48.04 (normal region) and 95.06 (abnormal region) respectively. From that data, the lesions showing highest perfusion signal as visually determined from the CBF maps, thus we can conclude that there is an increase in the CBF value in abnormal region for about 95.06, whereas in the normal region the average was only 48.04. For the percentage, the increase of CBF value reached 98%, from 100% to 198%.

For the second case (Fig. 2) was male with 48 years old and no history examinations. There was brain glioma of the right parietal which shows hypo-hyperintense on T1W, hyper-hypointense on T2W/Flair, and hyperintense on DWI. After contrast injection there is an enhancement in the tubular region. The average value was from 21.96 (normal region) and 58.31 (abnormal region) respectively. From that data, the lesions showing highest perfusion signal as visually determined from the CBF maps. The increasing value reached about 166%, from 100% to 266%.

For the third case (Fig. 3) was male with 68 years old and has CT Abdomen non contrast as previous examination. There was hypodense nodule on liver segment as a result of a metastatic process, while in MRI Brain examination there was heterogeneous solid extra axial mass on anterior falx cerebri, showing hyperintense on T2W Flair and no restricted area on DWI. Based on CBF maps data, the authors put two ROIs in different regions,
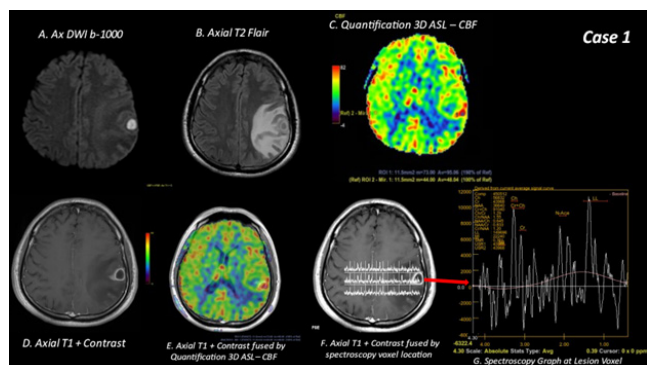
Figure 1: Male, 25 years old has diagnosed with tuberculoma parietal sinistra; (A) Axial DWI b-value 1000; (B) Axial T2 Flair; (C) Quantification 3D ASL – CBF; (D) Axial T1 + Contrast; (E) Quantification 3D ASL CBF fused by Axial T1 + Contrast; (F) Axial T1 + Contrast fused by spectroscopy voxel location; (G) Spectroscopy Graph at Lesion Voxel
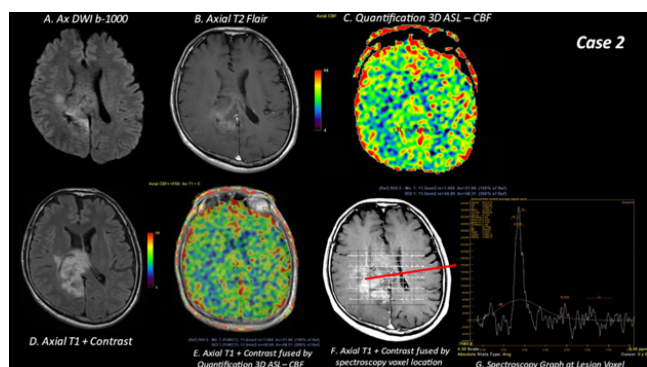

Figure 2: Male, 48 years old has diagnosed with glioma parietal dextra; (A) Axial DWI b-value 1000; (B) Axial T2 Flair; (C) Quantification 3D ASL – CBF; (D) Axial T1 + Contrast; (E) Quantification 3D ASL CBF fused by Axial T1 + Contrast; (F) Axial T1 + Contrast fused by spectroscopy voxel location; (G) Spectroscopy Graph at Lesion Voxel
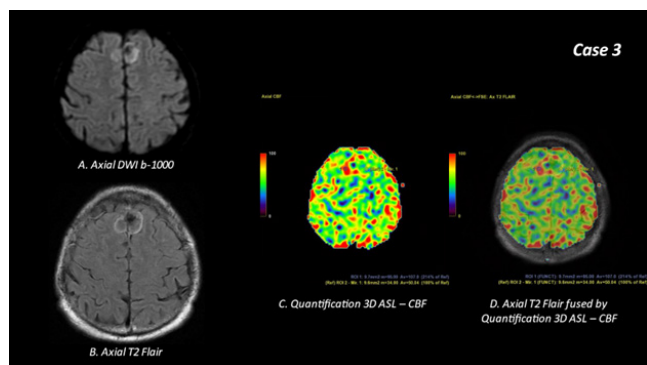
Figure 3: Male, 68 years old has diagnosed with tumor (evaluation after treatment); (A) Axial DWI b-value 1000; (B) Axial T2 Flair; (C) Quantification 3D ASL – CBF; (D) Axial T2 Flair fused by Quantification 3D ASL – CBF

normal and abnormal regions for about 50.04 and 107.0 respectively. Then, there is a significant increase in CBF accounting for 114%, from 100% to 214% which means the increasing value was significantly higher.

For the fourth case (Fig. 4) was male with 60 years old and no history examinations. The patient with suspected
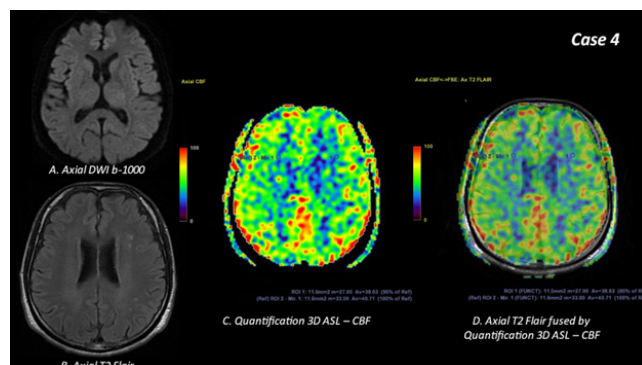
Figure 4: Male, 59 years old, suspect stroke; (A) Axial DWI b-value 1000; (B) Axial T2 Flair; (C) Quantification 3D ASL – CBF; (D) Axial T2 Flair fused by Quantification 3D ASL – CBF

stroke diagnosis. There was no abnormality on (Fig. 4B) T2 Flair and no restricted area on DWI. Then CBF values were calculated by positioning two ROIs. They have an average for about 40.71 (normal region) and 38.63 (abnormal region), and from that data does not show stroke abnormality. Nicholas A et al (5) stated that there are abnormalities that can either increase or decrease the CBF value, but for the stroke case, the CBF value can be decreased.

DISCUSSION

The function of ASL not only measures the CBF value but also distinguishes it from neoplastic and non-neoplastic brain lesions (3). Furthermore, in the first case, the examination was followed by magnetic resonance spectroscopy (MRS). Based on the spectroscopy graph; the NAA, NAA/Choline, NAA/Creatine value was decreased, whereas the Lipid and Lactate value was significantly increased. According to the previous research, Gupta et al stated that the presence of Lipid and Lactate on MRS as a marker for tuberculoma cases. They concluded that for the brain tumor cases, for the higher sensitivity and specificity results should use MRS to measure the concentration of biochemical components.

For the second case, the substantial increase in value based on CBF maps, exceeding 100%, accompanied by the positioning of the ROI within the tubular region, underscores the potential significance of this anatomical choice. The observed decrease in NAA value and concurrent elevation of Choline and Creatine levels in the spectroscopy table align with the authors' assertion of a malignant transformation tumor occurrence. Nevertheless, a comprehensive discussion encompassing the rationale behind ROI selection, possible limitations such as sample size and comparability with existing literature, alternative explanations for the observed results, and the implications for clinical practice and future research would enhance the robustness and contextual understanding of these findings.

As for the third case, based on radiologist's report, the CBF value's increased on the edge of the mass on anterior falx cerebri and suggested as a meningioma. Xin et al (4) stated that perfusion patterns on CBF maps can help to differentiate benign from malignant intracranial meningiomas.

DWI sequence will be mandatory in the fourth case. Generally, in the suspect stroke cases, DWI sequence was top priority to early detection in acute ischemic stroke infraction which represent hyperintensity on lesion because of a drop of diffusivity, and followed by 3D ASL. Based on Fig. 4A; there is no restricted area in the DWI sequence. This is matched with the ASL result (Fig. 4C) which shows no decrease of CBF value. In conclusion, for the fourth case this can be categorized as a normal result.

CONCLUSION

In terms of time efficiency, and accuracy diagnostic values, 3D ASL is usually an additional protocol for brain MRI examinations, while mandatory sequences are DWI and T2 Flair (conventional MRI). However, through this 3D ASL the radiologists can see the significance of the CBF value based on the CBF map with more reliable quantitative method and non-invasive technique. In addition, this case report used a 1.5T MRI system, despite there being numerous research or case reports before which used 3T MRI for measuring the function of ASL. According to basic physics, the SNR is limited in the 1.5T MRI system, but 3D ASL in 1.5T MRI still has the capability to show the significant result to predict some disease in MRI Brain examinations.

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