Case report

THREE - DIMENSIONAL FLUID ATTENUATED INVERSION RECOVERY SEQUENCE ON 3 TESLA MAGNETIC RESONACE IMAGING IN CRANIAL NERVE PATHOLOGIES: TWO CASE REPORTS

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ABSTRACT

Three - dimensional fluid attenuated inversion recovery sequence (3D-FLAIR) was introduced as a practical sequence which helps to reduce the cerebrospinal fluid pulsation and flow artefacts of conventional 2D acquisition and brings contiguous slices, ability in reformatting in variable planes which are typical features of 3D acquisition. 3D - FLAIR has been applied on assessing several neurologic pathologies. In this article, we introduce the application of 3D - FLAIR sequence without contrast enhancement on detecting abnormalities of cranial nerve pathology by presenting two cases, acute vestibular neuritis and facial nerve palsy. We suggest that 3D - FLAIR is the relatively useful sequence in detecting cranial nerve pathologies.

Keywords: *3D - FLAIR, fluid attenuated inversion recovery sequence, 3T MRI, cranial neuritis, cranial nerve pathology.*

I. INTRODUCTION

Fluid - attenuated inversion recovery (FLAIR) is a magnetic resonance imaging (MRI) sequence that uses an inversion radiofrequency (RF) pulse to suppress the cerebrospinal fluid (CSF) signal, so as to enhance the distinctness and the detectability of the lesions by way of increasing lesion - to - background CSF contrast [1,2]. FLAIR sequence is commonly obtained using 2D multi - slice turbo spin - echo (TSE) [3]. Recently, along with the advances of new MRI techniques, 3D - FLAIR was introduced as a useful sequence providing higher signal - to - noise ratio (SNR) and contrast - to - noise ratio (CNR), diminishing significantly CSF pulsation and flow artefacts compared to 2D acquisition, as well as bringing contiguous slices that enable reformatting the data in other planes [4-7]. Thus, 3D - FLAIR especially on 3 Tesla (3T) MR system is valuable in detecting minor subarachinoid hemorrhage (SAH), white matter lesions in multiple sclerosis (MS), inner ear pathologies, peripheral lesions of brainstem and cranial nerve pathologies [8-11]. Certain articles have revealed the usefulness of 3D - FLAIR sequence with and without gadolinium administration in evaluating the cranial nerve's abnormalities [11-13]. In this article, we introduced two cases of cranial nerve pathologies which the patients' clinical symptoms were compatible with the abnormal findings found on non - contrast - enhanced (NCE) 3D - FLAIR MR imagesin cluding one case was diagnosed as acute vestibular neuritis and the other was diagnosed

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as acute peripheral facial palsy. Both cases were improving the symptoms after receiving proper treatment.

II. CASE PRESENTATION

Case 1: A 31 - year - old man with no significant past medical history was admitted to our hospital with complaints of severely sudden vertigo, nausea and tinnitus in left ear for two days. The clinical examination revealed spontaneous right - beating horizontal nystagmus with positive horizontal head impulse test. Audiogram test was normal for both sides. The examination also revealed the patient's gait was instable towards the left, on the other hand he still presented ambulatory ability and could stand unsupported. Neither focal neurological deficits nor abnormal central nervous symptoms were observed. Preliminary diagnosis was left - sided acute vestibular neuritis.

Three days after the onset, a head 3T MRI with the standard single dose of Gadolinium (0.1 mmol/kg of body weight) was performed to assess the cranial nerves and brain. The head MRI protocol was set up with the following sequences: T1 - weighted (T1W) in the sagittal plane; T2 - weighted (T2W) in axial and coronal planes; diffusion - weighted imaging (DWI) sequence in axial plane for whole brain; 3 - dimensional constructive interference in steady state (3D - CISS), pre - and post - contrast 3D - FLAIR for the infratentorial level assessment; post - contrast T1W in axial plane. The post - contrast sequences were taken in 10 - minute delayed phase with 01millimeter in slice thickness.

The abnormal signal of the left vestibular nerve was exposed on pre - contrast 3D - FLAIR sequence with focally high signal intensity of the cisternal segment of this nerve (Figure 1A) which did not help in assessing enhanced nature of the lesion on post - contrast 3D - FLAIR sequence afterwards. On post - contrast T1W images, no abnormal enhancement of this nerve was noted (Figure 1B). On the remaining sequences, there was neither abnormal signal of the left vestibular nerve nor abnormalities of the cerebral parenchyma and the other intracranial structures revealed.

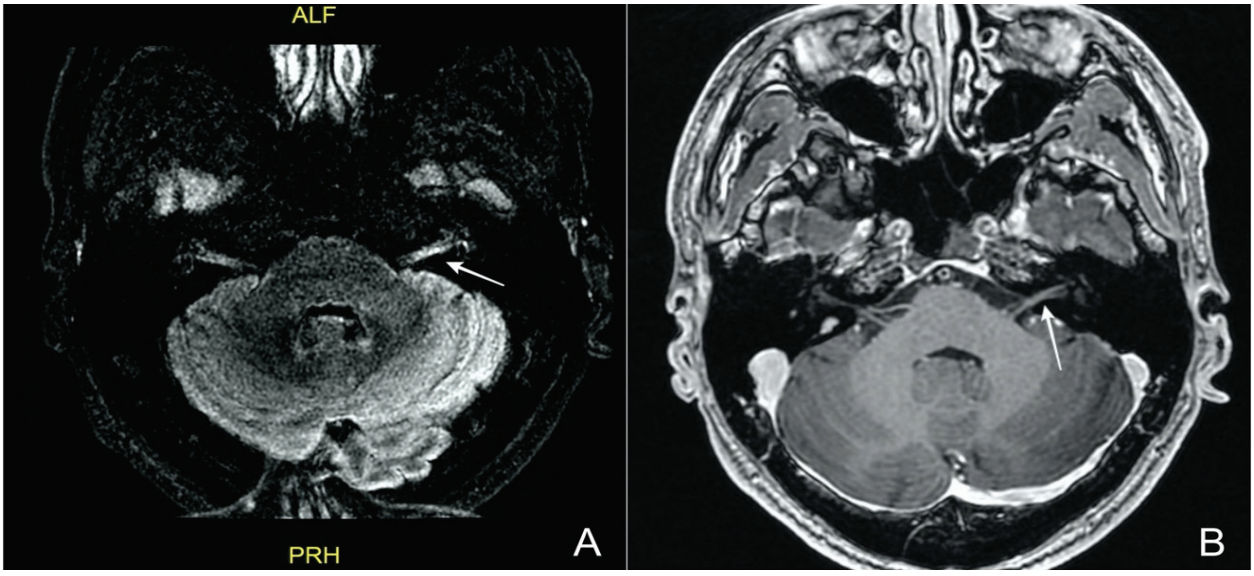

Figure 1: (A) The 3D - FLAIR MRI shows focally high signal intensity in the cisternal segment of the left vestibular nerve (white narrow). (B) The post - contrast T1W MRI shows no enhancement of the left vestibular nerve.

Based on clinical symptoms and MRI findings, he was diagnosed with left-acute vestibular neuritis and was treated with oral dexamethasone in several weeks. He recovered significantly without complication after 4 weeks.

Case 2: A 53 - year - old male patient presented to our hospital with left hemifacial weakness over a week. The patient did not report any extremity weakness, speaking trouble, fever, nausea, vomiting or other systemic symptoms. He also denied any

sick contacts previously. He had a history of chronical kidney failure. The physical examination showed facial asymmetry with the left side of face was flat and expressionless; restriction in wrinkling the forehead, limited movement of the left upper and lower lips. No tenderness was revealed around the affected region. Charles Bell's sign was positive. He was diagnosed merely peripheral facial nerve paralysis. A head 3T MRI without gadolinium injection was indicated owing to his kidney failure condition. The protocol was installed similarly as was used for the patient in case 1 but the post - contrast sequences were skipped. 3D - FLAIR images exposed the abnormally high signal intensity of the descending segment (as known as mastoid and extracranial segments) of the left facial nerve. There was not abnormal signal intensity of the left geniculate ganglion and other segments of the nerve.

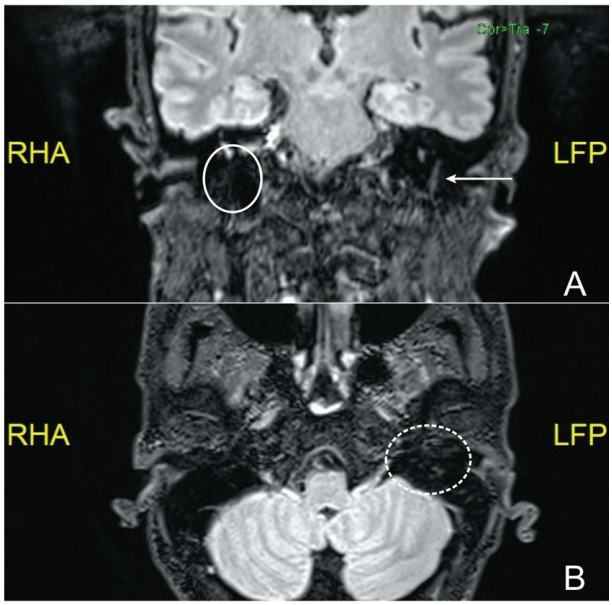

Figure 2: (A) 3D - FLAIR image on coronal plane shows high signal intensity of the descending segment of the left facial nerve (white narrow). No abnormal signal of the descending of the right facial nerve is seen (white circle). (B) No abnormal signal of the geniculate ganglion is seen (dash circle).

He was started on the course of acyclovir. He was scheduled for a follow - up after a month and significant recovery was seen.The recovery of the patient indicated that facial neuritis originates from viruses. Further follow - ups were planned for every month in the next 3 months.

III. DISCUSSION

3D - FLAIR has been proved as the sequence not only overcomes the artefacts from CSF pulsation and flow of standard 2D FLAIR but also offers the advantages associated with common 3D acquisition including superior SNR and CNR, contiguous slices, ability in reformatting in variable planes [4-7]. The dominance of 3D - FLAIR is enhanced by obtaining on higher field strength of 3 Tesla MR which helps improving SNR. Thanks to the superiority of 3D - FLAIR over 2D acquisition, this sequence has been applied on detecting subtle white matter lesions in MS [10,14], minor SAH [9], abnormalities of inner ear and certain conditions [8].

For the cranial nerve pathologies, especially for the facial and vestibulocochlear nerves, the sequences with gadolinium - enhancement have shown a relatively useful sequences to evaluate the anatomic course and abnormal enhancement of these nerves [11,15,16]. Nonetheless, T1W with contrast enhancement (CE) has revealed considerable limitations in diagnosing facial and vestibulocochlear neuritis in certain conditions. T1W with CE has shown indistinguishable enhancement of both normal and abnormal nerves [15,17,18]. On the other hand, several patients with contraindication of using contrast agents such as kidney failure in our case could not be performed MR scanning with CE sequences. Acute neuritis is the inflammated and edematous condition of the cranial nerve which is hypothesized that it could expose high signal intensity on FLAIR. With the advantages of 3D acquisition, 3D - FLAIR is supposed it has higher sensitivity than conventional 2D in detecting thebright signal intensity of the lesion. To the best of our knowledge, there was only case of Kang Min Park et al. Reported about focally high signal intensity of the vestibular nerve on 3D - FLAIR without CE in acute vestibular neuritis (AVN) [13].

In our first case with diagnosis of left - sided AVN, non - CE 3D - FLAIR sequence has revealed the high signal intensity in the cisternal segment of the left vestibular nerve meanwhile it did not show any abnormal enhancement of this nerve on post - contrast T1W images. This sign on MRI was consistent with the patient's clinical symptoms. In our second case with diagnosis of facial neuritis, high signal intensity in the mastoid segment of the left facial nerve has observed on non - CE 3D - FLAIR images. This patient was treated with acyclovir and has improved gradually after a month.

IV. CONCLUSION

From our cases and reviewed articles, we suggest that NCE 3D - FLAIR is the relatively useful sequence in detecting cranial nerve pathologies, particularly in case of contraindication of gadolinium administration. However, toproperly assess thevalue of 3D - FLAIR in evaluating cranial nerve pathologies, further research with numerous samples should be performed.

REFERENCES

1. Kates R, Atkinson D, Brant - Zawadzki M. Fluid - attenuated inversion recovery (FLAIR): clinical prospectus of current and future applications. Top Magn Reson Imaging. 1996;8(6):389-396.
2. Bydder GM, Young IR. MR imaging: clinical use of the inversion recovery sequence. J Comput Assist Tomogr. 1985;9(4):659-675.
3. Adams JG, Melhem ER. Clinical usefulness of T2 - weighted fluid - attenuated inversion recovery MR imaging of the CNS. AJR Am J Roentgenol. 1999;172(2):529-536. doi:10.2214/ajr.172.2.9930818
4. Gold GE, Busse RF, Beehler C, Han E, Brau ACS, Beatty PJ, et al. Isotropic MRI of the knee with 3D fast spin - echo extended echo - train acquisition (XETA): initial experience. AJR Am J Roentgenol. 2007;188(5):1287-1293. doi:10.2214/AJR.06.1208
5. Chagla GH, Busse RF, Sydnor R, Rowley HA, Turski PA. Three - dimensional fluid attenuated inversion recovery imaging with isotropic resolution and nonselective adiabatic inversion provides improved three - dimensional visualization and cerebrospinal fluid suppression compared to two - dimensional flair at 3 tesla. Invest Radiol. 2008;43(8):547-551. doi:10.1097/RLI.0b013e3181814d28
6. Naganawa S, Koshikawa T, Nakamura T, Kawai H, Fukatsu H, Ishigaki T, et al. Comparison of flow artifacts between 2D - FLAIR and 3D - FLAIR sequences at 3T. Eur Radiol. 2004; 14 (10):1901-1908. doi:10.1007/s00330-004-2372-7
7. Li Z, Pipe JG, Ooi MB, Kuwabara M, Karis JP. Improving the image quality of 3D FLAIR with a spiral MRI technique. Magn Reson Med. 2020;83(1):170-7.
8. MacKenzie G., Kumar Kanodia A., Yeap P., O. Riordan J., Stephen Nicholas R., Main G. Role of 3D FLAIR in Demonstration of Peripheral Lesions of Brainstem and Cranial Neuropathies. International Neuropsychiatric Disease Journal. 2014; 2(4), 167-174. doi: 10.9734/INDJ/2014/8190
9. Lummel N, Schoepf V, Burke M, Brueckmann H, Linn J. 3D fluid - attenuated inversion recovery imaging: reduced CSF artifacts and enhanced sensitivity and specificity for subarachnoid hemorrhage. AJNR Am J Neuroradiol. 2011; 32(11):2054-2060. doi:10.3174/ajnr.A2682
10. Tawfik AI, Kamr WH. Diagnostic value of 3D - FLAIR magnetic resonance sequence in detection of white matter brain lesions in multiple sclerosis. Egypt J Radiol Nucl Med. 2020;51(1):127. doi:10.1186/s43055-020-00247-6
11. Hwang J-Y, Yoon H-K, Lee JH, Yoon HM, Jung AY, Cho YA, et al. Cranial Nerve Disorders in Children: MR Imaging Findings. RadioGraphics. 2016;36(4):1178-94. doi: 10. 1148/rg.2016150163
12. Nakata S, Mizuno T, Naganawa S, Sugiura

M, Yoshida T, Teranishi M, et al. 3D - FLAIR MRI in facial nerve paralysis with and without audio - vestibular disorder. Acta Otolaryngol (Stockh). 2010;130(5):632-6. doi: 10.3109/00016480903338123

13. Park KM, Shin KJ, Ha SY, Park JS, Kim SE. A Case of Acute Vestibular Neuritis Visualized by Three - Dimensional FLAIR - VISTA Magnetic Resonance Imaging. Neuro - Ophthalmol. 2014; 38(2):60-1. doi:10.3109/01658107.2013.874454
14. Toledano - Massiah S, Sayadi A, de Boer R, Gelderblom J, Mahdjoub R, Gerber S, et al. Accuracy of the Compressed Sensing Accelerated 3D - FLAIR Sequence for the Detection of MS Plaques at 3T. Am J Neuroradiol. 2018;39(3):454-8. doi:10.3174/ajnr.A5517
15. Karlberg M, Annertz M, Magnusson M. Acute Vestibular Neuritis Visualized by 3 - T Magnetic Resonance Imaging With High - Dose Gadolinium. Arch Otolaryngol Neck Surg.2004;130(2):229. doi:10.1001/archotol. 130.2.229
16. Lim HK, Lee JH, Hyun D, Park JW, Kim JL, Lee H y., et al. MR Diagnosis of Facial Neuritis: Diagnostic Performance of Contrast - Enhanced 3D - FLAIR Technique Compared with Contrast - Enhanced 3D - T1 - Fast - Field Echo with Fat Suppression. Am J Neuroradiol. 2012;33(4):779-83. doi:10.3174/ajnr.A2851
17. Kinoshita T, Ishii K, Okitsu T, Okudera T, Ogawa T. Facial Nerve Palsy: Evaluation by Contrast - enhanced MR Imaging. Clin Radiol. 200;56(11):926-32. doi:10.1053/crad.2001.0730
18. Hong HS, Yi B - H, Cha J - G, Park S - J, Kim DH, Lee HK, et al. Enhancement pattern of the normal facial nerve at 3.0 T temporal MRI. Br J Radiol. 2010;83(986):118-21. doi:10.1259/bjr/70067143