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Radio-Diagnosis

APPLICATION OF 3D FIESTA IN THE EVALUATION OF CRANIAL NERVES

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INTRODUCTION

The brain parenchyma and neck structures are decussated by the cranial nerves, which are extracellular extensions of the brain's functional structures. (1) Abnormalities of cranial nerves can be detected and described more accurately by examiners who comprehend their complex anatomy and typical imaging presentation. Contrast enhances MR imaging, especially three-dimensional steady-state free precession sequences, is crucial for cranial nerve investigations despite their fragility.(2)Denervation changes in end-organ muscles can be assessed using MRI. CT is less effective than MRI at visualising cranial nerves due to its poor contrast quality.(2)

Magnetic Resonance Imaging (MRI) with 3-D (heavily T2-weighted) steady-state free precession (SSFP) sequence data simplifies anomaly characterization due to superior spatial resolution and T1-weighted contrast enhancement.(3) 3D-FIESTA imaging offers superior contrast between cerebrospinal fluid and cranial nerves, resulting in increased spatial resolution. Additionally, this scan produces images faster and without contrast material compared to typical MRI scans. Recent 7.0-T MR CNS imaging data revealed optimal spatial resolution and contrast with legitimate scanning from SSPS sequence, another FIESTA similar sequence.(4,5)

FIESTA sequences helps to assess cranial nerve structural changes, the lesions associated with the cranial nerves, and congenital abnormalities involving cranial nerves through previous publications. Most of the existing research is engrossed in the expansion and authentication of FIESTA sequence techniques to evaluate cranial lesions, particularly tumors. In addition, publication regarding the usefulness of the FIESTA sequence involved with MRI in phenotypic characterization in the cranial nerves is also restricted.

Most of the existing research is engrossed in the expansion and authentication of FIESTA sequence techniques to evaluate cranial lesions, particularly tumors. In addition, publication regarding the usefulness of the FIESTA sequence involved with MRI in phenotypic characterization in the cranial nerves is also restricted. This study evaluates the effectiveness of 3D FIESTA in delineating normal cranial nerve structure and identifying disorders in individuals sent to radiology for MRI. This study evaluates the efficacy of FIESTA as an adjuvant and its superiority over conventional MR sequences in identifying cranial nerve pathologies.

AIMS AND OBJECTIVES

The purpose of the existing investigation is to delineate the normal cranial nerve anatomy, recognize the frequent cranial nerve pathologies detected through 3D-FIESTA, and thereby accounting the effectiveness of 3D-FIESTA as an adjuvant as well as its preeminence over conventional MR sequences in diagnosing various pathologies concerning cranial nerves.

MATERIALS AND METHODS

The current study was a descriptive cross-sectional observational and a hospital-subjected investigation conducted over a period of 1 year in the department of Radiology, Chettinad hospital and research institute, Chennai, India. 30 patients were enrolled in the investigation after obtaining their written informed consent. The diagnostic efficiency of MRI sequence especially 3D-FIESTA for patients who had been referred to the radiology department either by the neurologists or neurosurgeon for suspicion of specific etiology involving cranial nerve pathologies were evaluated with MRI sequence of 3D-FIESTA. Patients with history of claustrophobia, metal implant placement, pacemakers, pregnant women and unwilling patients were excluded from the study.

A 1.5- T general electric MRI equipment was used for a scanning procedure. . For the goal of determining cranial lesions, the standard MRI was improved with a three-dimensional (3-D) FIESTA sequencing for the detection of cranial nerves in the cranial base. The required sequences were chosen as follows: Diffusion-weighted imaging (-DWI) Susceptibility weighted imaging (-SWI) axial FLAIR axial picture with T1 weighting. The transverse relaxation time, or -T2 weighted axial picture, is the temporal constant that controls how quickly excited protons come to equilibrium or dephase. The sequences that were used were as follows. Gadolinium-weighted T1 imaging using 3-D FIESTA. The expense of the MRI remains the same despite the removal of the T2 sequence and the addition of the FIESTA sequence.

3D FIESTA Sequence Details Employed In Cranial Nerves

Image plane	Repetition time/ Time to echo	Slice thickness /intersl ice gap	Field of view	Matrix	Number of excitation
T1W	500 ms/15.7 ms	3 mm/ 0.5mm	20 X 20 cm	320 × 224	3
T2W	3000 ms/ 104.8 ms	3 mm/ 0.5mm	20 X 20 cm	320 × 224	3
3D FIESTA	4.8 ms/ 1.4 ms	0.5 mm/ 0.5mm	18 X 18 cm	352 × 192	4
3D FIESTA	5.7 ms/ 1.7 ms	1 mm/ 0.5mm	20 X 20 cm	256 × 256	1
T1W	400 ms/ 16.0 ms	1 mm/ 0.5mm	20 X 20 cm	256 × 192	1

Excel was used to enter the data after it was collected. With the aid of the SPSS version 25 statistical tools, data analysis was completed.

RESULTS

The average age of the total study included population was quantified to be 38.7±4.1 years and ranging from 2 years to 65 years comprising

both pediatric and adult population. Among the total 30 study participants, higher proportion of the patients were female in 53.3% (n=16) than male percentage (46.7%, n=14). Higher percentage of the study participants had disorder of the balance in a majority of 40% (n=12) followed by head ache in 30% (n=9), tinnitus in 16.7 % (n=5) and loss of hearing in 10.0% (n=3). Delineation of normal and abnormal 3D findings among the study evaluated patients showed that amongst 30 patients, least percentage of the population had 3D-FIESTA findings as normal in 30% whereas, it had identified cranial abnormalities or lesions in 70.0% (n=21) of the patients.

Table 1 Distribution Of Patients Based On Chief Symptoms

Symptoms	Frequency	Percentage
Headache	9	30.0
Hearing loss	3	10.0
Tinnitus	5	16.7
Disorder of balance	12	40.0

Table 2 Distribution Of Findings According To 3D FIESTA Evaluation.

3D-FIESTA outcome	Frequency	Percentage
Normal	9	30.0
Abnormal	21	70.0

Table 3 Patients Distribution Based On The Broad Etiological Groups.

S. No	3D-FIESTA findings of etiological groups	Frequency	Percentage
1.	Normal	9	30
2.	Congenital abnormalities	3	10
3.	Acquired	15	50
4.	Unknown	3	10

Table 4: Details Of 3D-FIESTA Findings Among The Study Included Population.

S. No	3D-FIESTA findings details	Frequency	Percentage
1.	Normal	9	30.0
2.	Absent vestibular/cochlear nerves	1	3.3
3.	AICA vascular loop abutting cisternal segments of 7th/8th nerve complex	1	3.3
4.	Cochlear nerve hypoplasia	2	6.7
5.	CPA acoustic schwannoma extending into ipsilateral IAC	2	6.7
6.	CPA cyst	1	3.3
7.	CPA meningioma	2	6.7
8.	Dolichoectatic vertebral artery causing trigeminal hypoplasia	1	3.3
9.	Glomus jugulare causing erosion of wall of tympanic segment of facial nerve	1	3.3
10.	Olfactory groove meningioma	2	6.7
11.	PA acoustic schwannoma extending into ipsilateral IAC	2	6.7
12.	Pituitary macroadenoma displacing/compression optic chiasm	2	6.7
13.	Traumatic	1	3.3
14.	Vertebrobasilar dolichoectasia causing compression / displacement of 7th /8th nerve complex	2	6.7
15.	Vertebrobasilar dolichoectasia causing compression / displacement of 7th /8th nerve complex	1	3.3

Table 5: Comparison Of Age Groups With The Normal And Abnormal Findings Present Among The Study Population.

Age (years)	Normal (n,%)	Abnormal (n,%)	$\chi 2$	p value
<50	6 (37.5%)	10 (62.5%)	0.92	0.34
≥50	3 (21.4%)	11 (78.6%)		

Table 6: Distribution Of Patients With Specific Etiological Group.

S. No	Specific etiological information	Frequency	Percentage
1.	Normal	9	30.0
2.	Tumor	10	33.3
3.	Vascular abnormality	4	13.3
4.	Aplasia	2	6.7
5.	CNS	1	3.3
6.	CPA cyst	1	3.3
7.	Inflammation of the nervous system	1	3.3
8.	Inner ear	1	3.3
9.	Trauma	1	3.3

When analyzed the normal findings and abnormal findings with respect to age groups of less than and more than 50 individually, the study inferred that there is nil variation present on the prevalence of cranial abnormalities present between the two compared age groups of the study population and there exists no statistical difference in frequency between them ($\chi 2$=0.92, p=0.34). Similar to the findings of the age groups, gender also did not reveal any difference between the normal findings of cranial nerve with abnormalities of cranial nerve lesions and there was no significant statistical difference present between the studies groups (p=0.52). The existing investigation had identified that the most prevalent cranial lesion detected to be tumor in 33.3% (n=10), followed by vascular abnormality in 13.3% (n=4), aplasia in 6.7%(n=2) and other abnormalities in negligible percentage among the total study patients.

DISCUSSION

The average age of the total study-included population was quantified to be 38.7±4.1 years and ranging from 2 years to 65 years comprising both pediatric and adult populations, in a total of 50 patients with female (53.3% (n=16) predominant population than male (46.7%, n=14).A higher percentage of the study participants had a disorder in balance in the majority of 40% (n=12) followed by headache in 30% (n=9), tinnitus in 16.7 % (n=5), and loss of hearing in 10.0% (n=3). Delineation of normal and abnormal 3D findings among the study evaluated patients showed that amongst 30 patients, least percentage of the population had 3D-FIESTA findings as normal in 30% whereas, it had identified cranial abnormalities or lesions in 70.0% (n=21) of the study included participants which was found to be more than two times of normal population as pronounced by the e 3D-FIESTA outcome. The chief diagnostic findings of 3D-FIESTA identified in the present investigation were cochlear nerve hypoplasia, Cerebello-Pontine Angle acoustic schwannoma extending into ipsilateral Internal auditory canal, Cerebello-Pontine Angle meningioma, Olfactory groove meningioma, Pituitary macroadenoma displacing/ compression optic chiasm, and vertebrobasilar dolichoectasia causing compression/ displacement of 7th /8th nerve complex with an equal percentage distribution of 6.7% separately followed by another negligible percentage of remaining pathologies. The distribution of study participants based on the etiological groups resulted that half of the percentage of the population had acquired the disease (n=15,50%), followed by the population whose diagnosis was identified to be normal in the study (n=9,30%), and the remaining populations had congenital abnormalities and unknown cause with the equated distribution of population in 10% (n=3) each out of the total population evaluated by 3D-FIESTA. Similar to the findings of the age groups, gender also did not reveal any difference between the normal findings of cranial nerve with abnormalities of cranial nerve lesions and there was no significant statistical difference present between the studies groups (p=0.52). The existing investigation had identified that the most prevalent cranial lesion detected to be a tumor in 33.3% (n=10), followed by a vascular abnormality in 13.3% (n=4), aplasia in 6.7%(n=2) and other abnormalities in negligible percentage among the total study patients.

Noble et al. (6)retrospectively analysed 96 posterior fossa FIESTA sequences to determine if they could define cranial nerve anatomy and aid in RT planning. Our prospective study did not determine the aid of FIESTA in RT planning, but our investigation found normal cranial anatomy in 30% of the studied population. The study found that FIESTA effectively displays dural reflections of posterior fossa Cranial Nerves, which aligns with our findings. According to a recent study, FIESTA can recreate imaging sequences with a sufficient field of view in the oblique plane since it is a 3D series without gaps, enabling better cranial structural visualisation. This supports our study. In contrast to literature reported, the present investigation had tumor as the most frequent cranial nerve lesion and much beyond it, our investigation had reported the tumor in especially in children also.

Cavusoglu et al. (7)found that 3D-FIESTA MRI of the temporal bone yields positive results in 19% of patients, while our study found positive results in 70% of the population. Similar to our study, 3D FIESTA provides valuable information for those with facial and audiovestibular dysfunction. According to Casadei GP et al.(8) and Smirniotopoulos JG et al. (9), acoustic schwannomas with a 2:1 female-to-male ratio are similar to our study, in which two cases were

females and none were males.

According to Harsha KJ et al. (10), the basilar and anterior inferior cerebellar arteries compress the trigeminal nerve in approx. 25% of cases, supporting our findings. S. Gultekin et al.(11) found that Cerebello-Pontine Angle patients exhibited similar neurovascular contact or even angulation of the eighth cranial nerve. Additionally, no significant association was found between tinnitus and the Cerebello-Pontine Angle vascular loop anatomy. To fully understand the potential of 3D-FIESTA in defining normal cranial nerve structure and detecting abnormalities, more authentic research is needed due to the sample size constraint.

CONCLUSION

In the current evaluation of 3D- FIESTA, the study had demonstrated that 3D-FIESTA has the potential to delineate the normal cranial nerves from the cranial nerve with lesions. Moreover, the study had identified congenital cranial nerve lesions, acquired cranial nerve disease in patients besides, the unknown etiologies as demonstrated in our investigation. Our study had proved established that there is no correlation present between the normal and abnormal findings of cranial nerve with respect to age and gender. The most frequent cranial nerve lesion identified to be a tumor in 33.3% (n=10), followed by a vascular abnormality in 13.3% (n=4), aplasia in 6.7%(n=2). Hence, the current study had demonstrated that 3D-FIESTA is feasible, effective and capable of delineating the normal cranial nerve from abnormal cranial nerves and it possesses the potential to any wide range of cranial nerve abnormalities. Therefore, 3D-FIESTA could be as an adjuvant as well as its preeminence over conventional MR sequences in diagnosing cranial nerve pathologies.

REFERENCES

1. Bordoni B, Reed RR, Tadi P, Varacallo M. Neuroanatomy, Cranial Nerve 11 (Accessory). In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 [cited 2024 Feb 1]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK507722/
2. Romano N, Federici M, Castaldi A. Imaging of cranial nerves: a pictorial overview. Insights Imaging. 2019 Mar 15;10(1):33.
3. Dalaqua M, do Nascimento FBP, Miura LK, Reis F, Garcia MRT, Barbosa Júnior AA. Magnetic resonance imaging of the cranial nerves in congenital, traumatic, and vascular diseases: a pictorial essay. Radiol Bras. 2021;54(3):185–92.
4. Grams AE, Kraff O, Kalkmann J, Orzada S, Maderwald S, Ladd ME, et al. Magnetic resonance imaging of cranial nerves at 7 Tesla. Clin Neuroradiol. 2013 Mar;23(1):17–23.
5. Erdogan N, Altay C, Akay E, Karakas L, Uluc E, Mete B, et al. MRI assessment of internal acoustic canal variations using 3D-FIESTA sequences. Eur Arch Otorhinolaryngol [Internet]. 2013 Feb 1 [cited 2024 Feb 3];270(2):469–75. Available from: https://doi.org/10.1007/s00405-012-1994-7
6. Noble DJ, Scoffings D, Ajithkumar T, Williams MV, Jefferies SJ. Fast imaging employing steady-state acquisition (FIESTA) MRI to investigate cerebrospinal fluid (CSF) within dural reflections of posterior fossa cranial nerves. Br J Radiol. 2016 Nov;89(1067):20160392.
7. Cavusoglu M, Cılız DS, Duran S, Ozsoy A, Elverici E, Karaoglanoglu R, et al. Temporal bone MRI with 3D-FIESTA in the evaluation of facial and audiovestibular dysfunction. Diagn Interv Imaging. 2016 Sep;97(9):863–9.
8. Casadei GP, Komori T, Scheithauer BW, Miller GM, Parisi JE, Kelly PJ. Intracranial parenchymal schwannoma. A clinicopathological and neuroimaging study of nine cases. J Neurosurg. 1993 Aug;79(2):217–22.
9. Smirniotopoulos JG, Jäger HR. Differential Diagnosis of Intracranial Masses. In: Hodler J, Kubik-Huch RA, von Schulthess GK, editors. Diseases of the Brain, Head and Neck, Spine 2020–2023: Diagnostic Imaging [Internet]. Cham (CH): Springer; 2020 [cited 2024 Feb 3]. (IDKD Springer Series). Available from: http://www.ncbi.nlm.nih.gov/books/NBK554352/
10. Harsha KJ, Kesavadas C, Chinchure S, Thomas B, Jagtap S. Imaging of vascular causes of trigeminal neuralgia. J Neuroradiol J Neuroradiol. 2012 Dec;39(5):281–9.
11. Gultekin S, Celik H, Akpek S, Oner Y, Gumus T, Tokgoz N. Vascular loops at the cerebellopontine angle: is there a correlation with tinnitus? AJNR Am J Neuroradiol. 2008 Oct;29(9):1746–9.