Visualization of Cranial Nerves, V-VIIIth with MRI; Value of b-FFE, T2W Drive,T2W TSE and Post Contrast T1W Sequences

V-VIII. Kranial Sinirlerin MRG ile Görüntülenmesi; b-FFE, T2W Drive, T2W TSE ve Post Contrast T1A Sekansların Değeri

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ABSTRACT Objective: The aim of this study is to assess the best effective MRI sequence for the visualization of the V-VIIIth cranial nerves (trigeminal,abducent,facial and vestibulocochlear nerves) in their cisternal\canalicular courses. Balanced fast-field echo (b-FFE), 3D-T2W DRIVE Sense, T2W 2D TSE and post contrast T1W sequences were all applied and we tried to get the best sequence for the exact assessment of the V-VIIIth cranial nerves. **Material and Methods:** A hundred patients with 800 nerves without the symptoms of trigeminal neuralgia, facial paralysis, diplopia and hearing loss were examined using the above sequences. Imaging analysis is graded as; nerves analyzed by certainty (score of 2), nerves analyzed partially (score of 1), nerves not identified (score of 0). **Results:** In all four nerves, the best sequence for the visualization of the cisternal and intracanalicular course was b-FFE among others, with %97.75 average success in showing the fascicles of V-VIIIth nerves. DRIVE T2W sequence is superior than the T2W TSE sequence in assessing the cisternal parts of V-VIIth nerves. In visualizing the vestibulocochlear nerve, both DRIVE and TSE T2W sequences were almost equal. Post-contrast T1W sequence was probably the worst sequence in showing all four nerves. **Conclusion:** B-FFE sequence should be the optimal choice for imaging of V-VIIIth cranial nerves.

Key Words: Magnetic resonance imaging; abducens nerve; facial nerve; cranial nerves

ÖZET Amaç: Bu çalışmanın amacı 5-8. kranial sinirlerin (trigeminal-abdusens-fasial ve vestibulokohlear sinirler) sisternal/kanaliküler seyirlerinde görüntülenmesinde en etkili MRG sekanslarını değerlendirmektir. Dengeli hızlı-saha ekosu (b-FFE), 3D-T2W DRIVE Sense, T2W 2D TSE ve post kontrast T1W sekanslarının hepsi uygulandı ve 5-8. kranial sinirlerin kesin değerlendirmesi için en iyi sekansı elde etmeye çalıştık. **Gereç ve Yöntemler:** Trigeminal nevralji, fasial paralizi, diplopi ve işitme kaybı semptomları olmayan 100 hastanın 800 siniri yukarıda tanımlanan sekanslar kullanılarak incelendi. Görüntüleme analizleri şu şekilde sınıflandırıldı; kesin olarak incelenen sinirler (skore 2), kısmen incelenen sinirler (skor 1), teşhis edilemeyen sinirler (skor 0). **Bulgular:** Dört sinirin de sisternal ve intrakanaliküler seyirlerinde görüntülenmesinde diğerlerine göre en iyi sekans b-FFE olup 5-8. sinirlerin dallarını göstermede ortalama başarısı %97.75 idi. 5-7. sinirlerin sisternal kısımlarını değerlendirmede DRIVE T2W sekansı T2W TSE sekansından daha üstündür. Vestibulokohlear sinirin görüntülenmesinde DRIVE ve TSE T2W sekansları hemen hemen eşitti. Post-kontrast T1W sekansı dört sinirin her birini göstermede muhtemelen en kötü sekanstı. **Sonuç:** B-FFE sekansı 5-8. kranial sinirlerin görüntülenmesinde optimal seçenek olmalıdır.

Anahtar Kelimeler: Manyetik rezonans görüntüleme; abdusens siniri; fasiyal siniri; kraniyal sinirler

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The detection of the cisternal courses of individual cranial nerves in the posterior fossa and brain stem is useful in diagnostic imaging; however visualization by using conventional magnetic resonance (MR) imaging protocols does not provide adequate details of the individual

nerves.[1,2] With the rapid development of magnetic resonance imaging (MRI) technology, newer 2D-3D high spatial resolution strong T2 weighted sequences have been used such as 3D-CISS (three-dimensional constructive interference in steady state), 3D-MP-RAGE (three-dimensional magnetization-prepared rapid gradient-echo) and 3D-FIESTA (three-dimensional fast imaging employing steady-state acquisition).[1-5] Balanced fast-field echo (bFFE) sequence and 3D-T2W Driven equilibrium RF Reset Pulse (DRIVE) sequences can also provide heavily T2 weighted good MR-cisternographic images and can also be used to evaluate cranial nerves nuclei or root entry zones.[4-6] Nowadays by using such sequences with high contrast and high spatial resolution, it can be easier to determine the anatomic differentiation of various components of the V-VIIIth cranial nerve complexes in the fluid containing compartments of the internal auditory canal (IAC), cerebellopontine angle (CPA) and mesencephalon.[5-7] In this study, we aimed to assess the most efficient sequence in evaluating and visualizing the fifth, sixth, seventh and eighth cranial nerves on both sides of all patients. We applied BFFE, 3D DRIVE T2W, 2D-T2W TSE and Post-contrast T1W sequences, and tried to choose the best sequence in exact determination of all four nerves.

MATERIAL AND METHODS

Eight-hundred cranial nerves in 100 patients without symptoms of trigeminal neuralgia, facial paralysis, diplopia or hearing loss were included in this study. All the patients had temporal MRI requests from the clinicians. Majority of them had the chief complaint of vertigo. Between July-December 2008, 47 males and 53 females were analyzed. Mean age for men was 57 (± 4.5) years, for women 45 (± 2.5) years. Informed obtained prior to the section. All MRI sections were performed with 1.5 T Philips Nova Dual HP MRI scanners (16 channels Achiva Master, Eindhoven Netherlands) with a 33 mT\m maximum gradient strength and a 180 mt\m per millisecond slew rate, using a standard head coil. We obtained MR images with using B-FFE, T2W 3D-DRIVE, T2W 2D-TSE and Post-contrast T1W sequences.For the post-contrast series, contrast agents of 0.1-0.2 mmol\kg gadolinium-DTPA, (Magnevist-Schering) and (Omniscan-GE), were administered.

The parameters for the B-FFE sequence were as follows: TR\TE\averages= 7.1\3.5 ms\3, flip angle= 50, matrix= 308*320, field of view= 18*25 cm, reconstruction field of view= %83, number of signals averaged (NSA-NEX)= 3, slice thickness= 1.0 mm, number of partitions= 40. Scan time was 2.03 min.

The parameters for the T2W 3D-DRIVE sequence were as follows: TR\TE= 1500\250, field of view= 13 cm, reconstruction field of view= %100, NSA-NEX= 2, matrix= 256*256, slice thickness= 1.4 mm, turbo spin echo factor= 74, flip angle= 90, number of partitions= 30. Scan time was 1.23 min.

The parameters for the T2W 3D-TSE sequence were as follows: TR\TE= 3000\120, field of view= 14.8*17.5 cm, reconstruction field of view= %124, NSA-NEX= 6, matrix= 168*256,slice thickness= 2.0 mm, turbo spin echo factor= 17, flip angle= 90, number of partitions= 12. Scan time was 1.24 min.

The parameters for the Post-contrast T1W FSE sequence were as follows: TR\TE= 400\10, field of view= 14.8*17.5 cm, reconstruction field of view= %123, NSA-NEX= 6, matrix= 128*256, slice thickness= 2.0 mm, turbo spin echo factor= 3, flip angle= 90, number of partitions= 12. Scan time was 1.44 min.

Statistical analysis was performed using Pearson chi-square applied upon the SPSS 11.5 written form (SPSS-Inc, Chicago-IL). $P< 0.05$ was considered statistically significant.

IMAGE ANALYSIS

Analysis of the data set obtained with all sequences was based on the original axial 3D images with an effective thickness between 1-2.0 mm. Two radiologists evaluated independently the visualization rates of cranial nerves V-VIIIth in their cisternal-intracanalicular courses with the MRI sequences of b-FFE, T2W 3D-DRIVE, T2W 2D-TSE and Post contrast T1W. In cases of disagreement, a third neuroradiologist made the final diagnosis. Then it was

graded and scored as follows: 1-Nerves identified with certainty (score of 2, nerves regularly visualized in both sides), 2-Part of the nerves probably identified (score of 1, nerves partially visualized in both sides or exactly visualized in only one side), 3-Nerves could not be identified on both sides (score of 0). Interobserver variability and the neuroradiologist discordance was 1.5-1.6% for VIIth and VIIIth cranial nerves, 7% for Vth cranial nerve and 11% for the visualization of VIth nerve (k> 0.05). As seen here, the third radiologist was mostly needed for these discordances especially for the evaluation of the VIth cranial nerve. Rationally-Comparison statistical test between dependent groups was performed between the results of both radiologists and it is observed that both group findings are quite similar (k= 0.5, Ho: No statistical difference between both ratios in all nerves and sequences).

RESULTS

In visualizing the FIFTH (trigeminal) nerve; we identified 196 nerves of 98 patients with score of 2 (98%, Figure 1a) and 2 nerves with score of 1 (%1) using the B-FFE sequence. Both nerves of one patient were not identified (score of 0). With the T2-DRIVE TSE sequence, however, 190 nerves of 95 patients were identified with score of 2 (95%, Figure 1b) and six nerves of three patients were identified with score of 1 (3%), where as in two patients; four trigeminal nerves were not identified (score of 0). With using the T2W TSE sequence, trigeminal nerves were identified certainly in 178 cases, score of 2 (89%, Figure 1c), 16 nerves were identified as score of 1(8%). There nerves were not identified in only three patients bilaterally, score of 0 (3%). With the post-contrast T1W sequences, 130 nerves of 65 patients were identified certainly with the score of 2 (65%, Figure 1d), 58 nerves were identified as score of 1 (29%) and they were not identified in six patients bilaterally (score of 0) (6%) (Table 1, Graph 1).

For the SIXTH (abducent) nerve; by using the b-FFE sequence, we identified 192 nerves of 96 patients with score of 2 (96%, Figure 2a) and four nerves with score of 1 (2%). Both nerves of two patients were not identified, score of 0. With the T2-

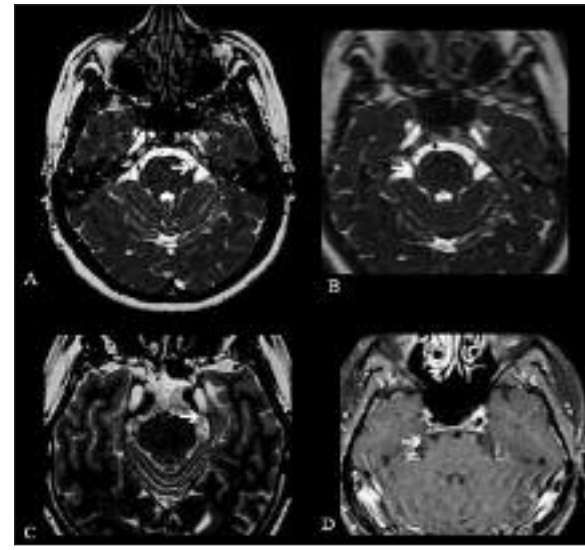
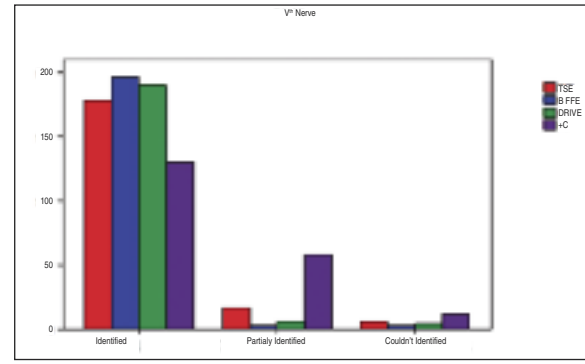


FIGURE 1: B-FFE (A), T2-DRIVE TSE (B), T2W TSE (C) and T1W post contrast sequences showing the fifth cranial nerve (arrows). Note that the nerve is entering into the Meckels cave on T2W TSE sequence (C).

TABLE 1: V-VIIIth nerve identification on different sequences.

		T2 TSE	B-FFE	DRIVE	T1 Contrast
	Identified	178	196	190	130
Vth Nerve	Partialy identified	16	2	6	58
	Could not identified	6	2	4	12
	Identified	102	192	170	54
VIth Nerve	Partialy identified	58	4	12	60
	Could not identified	40	4	18	86
	Identified	192	196	197	168
VIIth Nerve	Partialy identified	2	2	6	20
	Could not identified	6	2	0	12
	Identified	196	198	196	170
VIIIth Nerve	Partialy identified	2	2	2	20
	Could not identified	2	0	2	10



GRAPHIC 1: Identification status of Vth nerve on different squences.

DRIVE TSE sequence, however, 170 nerves of 85 patients were identified with score of 2 (85%, Figure 2b) and 12 nerves of six patients were identified with score of 1 (6%). In nine patients, 18 abducent nerves were not identified score of 0. Using the T2W TSE sequence, abducent nerve was identified certainly in 102 cases, score of 2 (51%, Figure 2c), 58 nerves were identified with, score of 1 (29%) and, it was not identified in 10 patients bilaterally, score of 0. With the post-contrast T1W sequences, 54 nerves of 27 patients were identified certainly with the score of 2 (27%, Figure 2d), 60 nerves were identified with score of 1 (30%), where as the nerves were not identified in 43 patients bilaterally, score of 0.

In depicting the SEVENTH (facial) nerve; with the b-FFE sequence, we identified 196 nerves of 98 patients with score of 2 (98%, Figure 3a) and two nerves with score of 1 (1%). Two nerves of one patient were not identified, score of 0. With the T2-DRIVE TSE sequence, however, 194 nerves of 97 patients were identified with score of 2 (97%, Figure 3b) and six nerves of three patients were identified with score of 1 (40%); None of the facial nerves were identified with score of 0. Using the T2W TSE sequence, facial nerve was identified certainly in 192 cases with score of 2 (96%, Figure 3c), two nerves were identified with score of 1 (1%), and the nerves were not identified in only three patients bilaterally, score of 0. With the post-contrast T1W sequences, 168 nerves of 84 patients were identified certainly with score of 2 (84%, Figure 3d), 20 nerves were identified with score of 1 (10%), and the nerves were not identified in six patients bilaterally, score of 0. (Table 1, Graphic 3).

For assessing the EIGHT (vestibulocochlear) nerve; we identified 198 nerves of 99 patients with score of 2 (99%, Figure 3a) and two nerves with score of 1 (1%). With the T2-DRIVE TSE sequence; however, 196 nerves of 98 patients were identified with score of 2 (98%, Figure 3b) and two nerves of a patient with score of 1 (1%). In another patient, two vestibulocochlear nerves were not identified (score of 0). With using the T2W TSE sequence, vestibulocochlear nerve was identified certainly in 196 cases with score of 2 (98%, Figure 3c), two nerves were identified with score of 1 (1%), and they were not identified in only one patient bilaterally, score of 0 (1%).With the post-contrast T1W sequences, 170 nerves of 85 patients were identified certainly with score of 2 (85%, Figure 3d), 20 nerves were identified with score of 1 (10%), and they were not identified in five patients bilaterally, score of 0 (5%) (Table 1, Graphic 4).

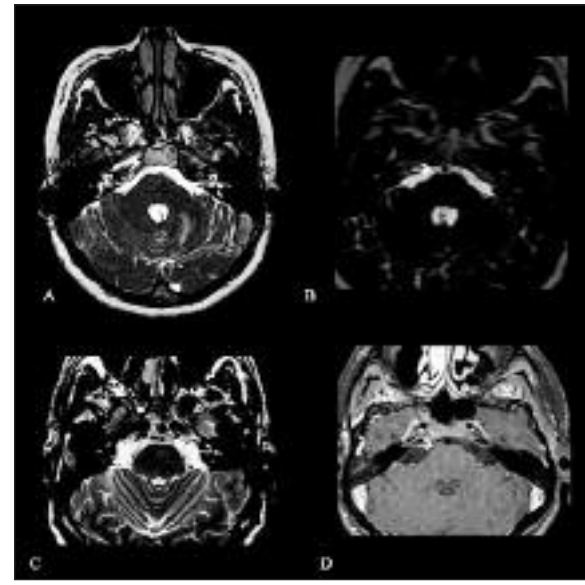


FIGURE 2: B-FFE (A), T2-DRIVE TSE (B), T2W TSE (C) and T1W post contrast sequences showing the sixth cranial nerve (arrows).

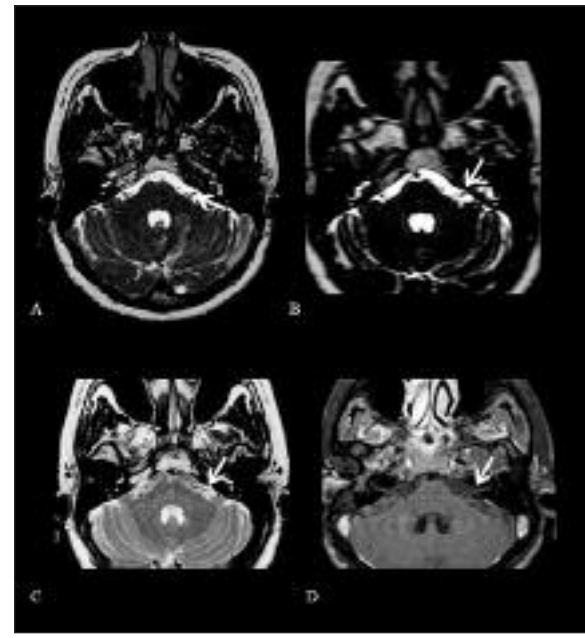
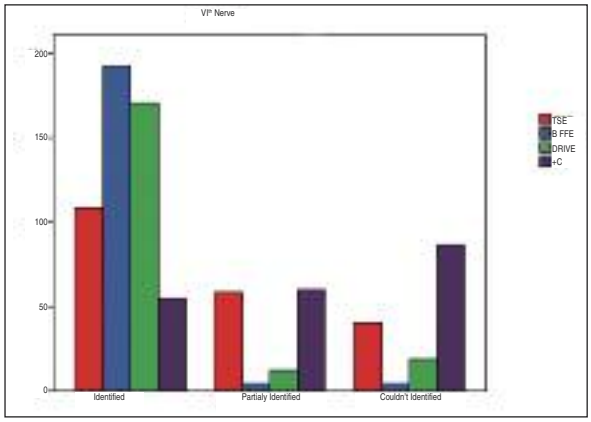
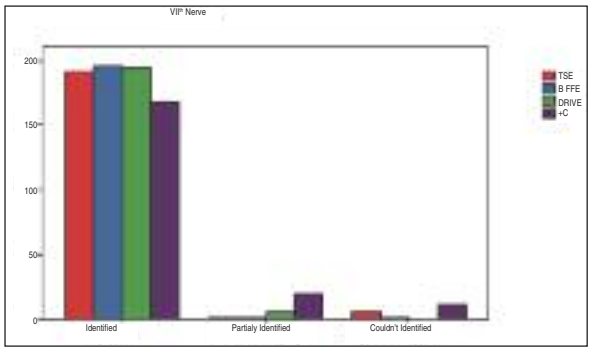


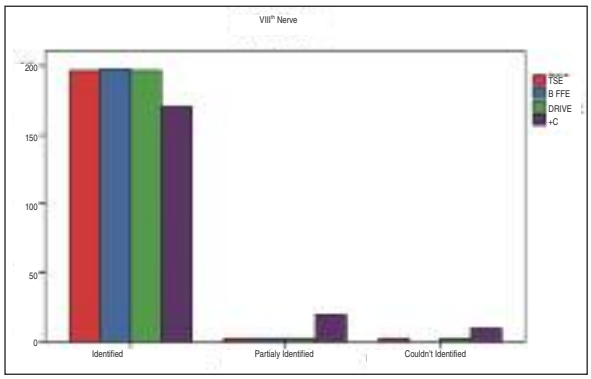
FIGURE 3: B-FFE (A), T2-DRIVE TSE (B), T2W TSE (C) and T1W post contrast sequences showing the seventh and eighth cranial nerves (arrows).



GRAPHIC 2: Identification status of VIth nerve on different sequences.



GRAPHIC 3: Identification status of VIIth nerve on different sequences.



GRAPHIC 4: Identification status of VIIIth nerve on different squences.

Pearson chi-square test is proved to be effective for observing the statistical differences between the imaging modalities to analyze the Vth, VIth and VIIth cranial nerves, as the number of cells with frequency lower than 5 was not more than 20% of all cells in all three groups. With statistically significant difference at 0.01 level, it is found that there are significant differences for visualizing the Vth, VIth and VIIth cranial nerves between imaging procedures ($p< 0.001$). At this statistical level, the best effective sequence for visualizing all three nerves was found to be b-FFE (Table 2, Graphic 1-3). For the analysis of VIIIth cranial nerve, as the number of cells with frequency lower than 5 was more than 20% of all cells, Pearson chi-square test is not proved to be effective. To make the test statistically effective, we added the "score 1-partly identified" results to the "score 0 not-identified" ones, and found that the number of cells with frequency lower than 5 was not more than %20 of all cells, the test has got effectivity ($p< 0.001$). Under these circumstances, the best sequence for visualizing the VIIIth cranial nerve was b-FFE ($p< 0.001$) (Table 3, Graphic 5). The second most efficient sequence for visualizing the Vth and VIth cranial nerves were the T2 DRIVE ($p< 0.001$) (Table 2, Graphic 1, 2). For the facial nerve analysis, as the results of T2W 2D-TSE and T2-DRIVE sequences were almost the same, we added the "score 1-partly identified" ones to the "score 2 certainly identified", and found that T2-DRIVE sequence was the second most efficient sequence for visualizing the VIIth cranial nerve, and it was superior than the T2W TSE sequence ($p< 0.01$) (Table 4, Graphic 6). T2-DRIVE and T2 TSE sequences were almost equal in visualizing the vestibulocochlear nerve under all statistical circumstances and they both were the second most efficient sequence in visualizing the VIIIth cranial nerve ($p< 0.001$ for Table 2 and 3, $p< 0.01$ for Table 5), (Table 2, 3, 5; Graphic 4, 5, 7). Postcontrast T1W sequence was probably the worst one in determining all four nerves ($p< 0.01$).

DISCUSSION

The fifth cranial (trigeminal) nerve is the largest of the cranial nerves and has both motor and sensory functions.[8,9] The pathologic processes involving the fifth nerve is mainly the trigeminal neuropathy that may be caused by brainstem-CPA neoplasms, perineural tumour spread, meningitis, multiple sclerosis, vascular lesions, skull base fractures and etc.[8]

The sixth cranial (abducent) nerve supplies motor innervation to the lateral rectus muscle within the orbit (Figure 4).[8] Sixth nerve palsy (opht-

TABLE 2: Statistical table of percentages of identification status in different sequences.

Nerves				Method							
				TSE	B FFE	DRIVE	+C	Sum	χ^2	Sd	p
Vth Nerve	Observation	Identified	n	178	196	190	130	694	121.380 (a)	6	0.000
			%n	25.6%	28.2%	27.4%	18.7%	100.0%			
		Partialy identified	n	16	2	6	58	82			
			%n	19.5%	2.4%	7.3%	70.7%	100.0%			
		Could not identified	n	6	2	4	12	24			
			%n	25.0%	8.3%	16.7%	50.0%	100.0%			
	Sum		n	200	200	200	200	800			
			%n	25.0%	25.0%	25.0%	25.0%	100.0%			
VIth Nerve	Observation	Identified	n	108	192	170	54	524	273.553(b)	6	0.000
			%n	20.6%	36.6%	32.4%	10.3%	100.0%			
		Partialy identified	n	58	4	12	60	134			
			%n	43.3%	3.0%	9.0%	44.8%	100.0%			
		Could not identified	n	40	4	18	86	148			
			%n	27.0%	2.7%	12.2%	58.1%	100.0%			
	Sum		206	200	200	200	806				
			%n	25.6%	24.8%	24.8%	24.8%	100.0%			
VIIth Nerve	Observation	Identified	n	192	196	194	168	750	48.747(c)	6	0.000
			%n	25.6%	26.1%	25.9%	22.4%	100.0%			
		Partialy identified	n	2	2	6	20	30			
			%n	6.7%	6.7%	20.0%	66.7%	100.0%			
		Could not identified	n	6	2	0	12	20			
			%n	30.0%	10.0%	0.0%	60.0%	100.0%			
	Sum		200	200	200	200	800				
			%n	25.0%	25.0%	25.0%	25.0%	100.0%			
VIIIth Nerve	Observation	Identified	n	196	198	196	170	760	57.063(d)	6	0.000
			%n	25.8%	26.1%	25.8%	22.4%	100.0%			
		Partialy identified	n	2	2	2	20	26			
			%n	7.7%	7.7%	7.7%	76.9%	100.0%			
		Could not identified	n	2	0	2	10	14			
			%n	14.3%	0.0%	14.3%	71.4%	100.0%			
	Sum		200	200	200	200	800				
			%n	25.0%	25.0%	25.0%	25.0%	100.0%			

halmoplegia) is mainly lack of conjugate gaze and strabismus, with the chief complaints of diplopia and the restricted eye movements.[8]

The seventh cranial (facial) nerve consists of a large motor root and a smaller sensory root (Nervus intermedius) (Figure 4).[9,10] CISS-FIESTA-bFFE-like strong T2W sequences are often used to evaluate the cisternal and intracanalicular portions of VIIth and VIIIth cranial nerves since they show the anatomic details more precisely.[3,4,7,10] The disorders of the facial nerve may be an upper or a lower motor neuron lesion. Upper lesions cause dysfunction of the contralateral muscles of facial expression but spare the forehead muscles, while lower motor neuron lesions involve all facial expression and forehead muscles.[9-11]

The eight cranial (vestibulocochlear) nerve consists of two distinct nerves: cohlear and vestibular (Figure 4).[9-11] The vestibulocochlear nerve paralysis most commonly produce sensorineural hearing loss and balance disordes.[9-11] Both VIIth and VIIIth nerve disorders can be discussed together be-

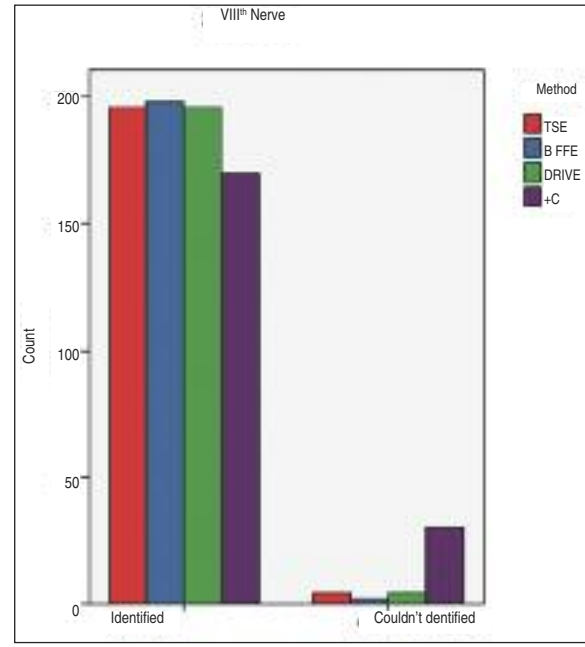
TABLE 3: Statistical analysis of identification status of VIIIth nerve (partially identified group added to non identified group).

VIIIth Nerve	Observation	Identified	n	196	198	196	170	760	56.421(d)	3	0.000
			%n	25.8%	26.1%	25.8%	22.4%	100.0%			
		Could not identified	n	4	2	4	30	40			
			%n	10.0%	5.0%	10.0%	75.0%	100.0%			
	Sum		200	200	200	200	800				
			%n	25.0%	25.0%	25.0%	25.0%	100.0%			

cause of their close proximity. The lesions affecting both nerves are mainly the CPA neoplasms especially schwannomas and menengiomas as well as infections, vascular lesions infarctions, immunologic problems, idiopathic lesions and etc.[10,11]

To visualize all these nerves, the anatomic details, cisternal and intracanalicular courses, MR imaging is the gold standard for the trigeminal, abducent, facial and vestibulocochlear nerves due to its high spatial resolution and contrast advantages. Newer MR sequences and MR cysternography can easily show the anatomic and pathologic relationships of the neural roots with the adjacent vessels and dura matter and can easily show the courses of all nerves in the brain stem, CPA and IAC.[4,7,12] For depicting the Vth to VIIIth cranial nerves regularly, heavily T2 weighted sequences may be important because of their high sensitivity in detecting the cranial nerve nuclei, root entry zones and their foraminal courses.[3-5,7,12] With using the high spatial resolution and heavily T2W sequences, trunks of the all four nerves and their cisternal-intracanalicular courses can be detected more accurately.[4,7,12]

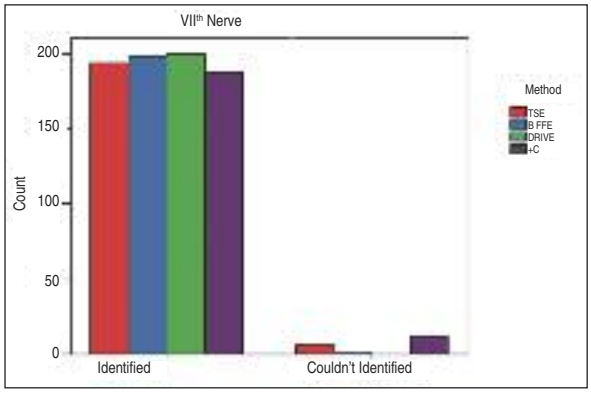
Nowadays sequences with Steady State Free Precession (SSFP) and the Driven Equilibrium RF Reset Pulse (DRIVE) techniques are generally preferred. SSFP sequences are basically gradient echo sequences. BFFE-BTFE-True and FISP-FIESTA are the most frequently commercially used sequences.[3-7,12] Using a large flip angle, very short time of repetition (TR) and symmetrical and balanced gradient around the echo time (TE), the SSFP regimen can be achieved that allows very fast imaging and a high signal to noise ratio (SNR).[3-5,12] This imaging provides very high signals from tissues with large T2\T1 ratios such as fluid, blood and fat. Therefore, SSFP imaging



GRAPHIC 5: Identification of VIIIth nerve on different squences, partialy identified group added to not identified group.

TABLE 4: Statistical analysis of identification status of VIIth nerve (partially identified group added to dentified group)

7. Nerve	Observation	Identified	n	194	198	200	188	780	17.231(c)	3	0.001
			%n	24.9%	25.4%	25.6%	24.1%	100.0%			
		Could not identified	n	6	2	0	12	20			
			%n	30.0%	10.0%	0.0%	60.0%	100.0%			
	Sum		n	200	200	200	200	800			
			%n	25.0%	25.0%	25.0%	25.0%	100.0%			



GRAPHIC 6: Identification of VIIth nerve on different squences, partialy identified group added to identified group.

can identify cranial nerves in cisternal segments because of the excellent CSF-nerve contrast and high spatial resolution.[4-7,12] Scanning time is quite shorter and cisternal segments of the cranial nerves are depicted more clearly.[3-5,12]

DRIVE applied at the end of a TSE echo train to accelerate the relaxation and return to equilibrium of the magnetization.[6] It is based on a 3D TSE sequence with a set of recovery pulses that pushes the residual transverse magnetization back to longitudinal axis.[4,6] Drive makes a T2 contrast to TSE sequences and CSF is achieved brighter.[4] The shortened TR helps to reduce the flow void artifacts and further increasing the brightness of fluids. It also decreases the scan time while preserving high fluid signal, making less time available for flow voids caused by CSF motion and recovering magnetization at the end of a long echo train.[4,6]

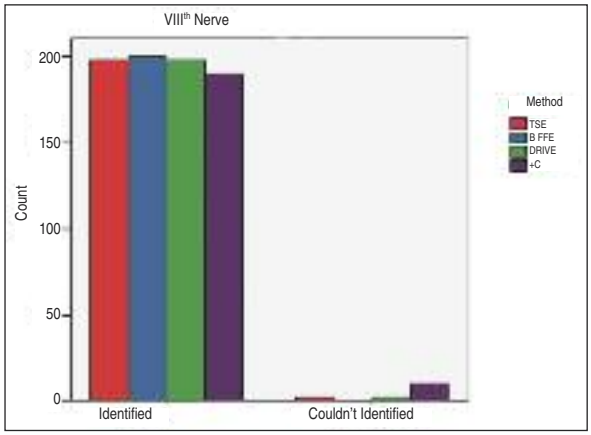
In the literature, few reports have been published up to now with MR imaging for the visualization of the trigeminal, abducent, facial and vestibulocochlear nerves. Yousry et al. studied 40 patients and visualized the fifth-seventh and eighth cranial nerves 100% with the 3D-CISS sequence and visualized the abducent nerve with the same sequence 97.5%.[7] With the T2W FSE sequences, their identification ratios were as follows; 90% for Vth nerve, only 12.5% for VIth nerve and 47.5% for both VIIth and VIIIth cranial nerves. Their 3D-CISS visualizing rates are slightly higher than ours in all sequences however their T2W FSE rates are much lower than our results for Vth-VIIIth nerves alltogether with 2D-TSE sequence.

Cheng et al. studied 25 volunteers and succeeded in identifying the Vth, VIIth and VIIIth cranial nerves as 100% by using the 3D-FIESTA sequence. They identified the VIth nerve with 82% certainity and idendified 18% of the nerves partially.[12] With 2D-FSE sequence, their results were as follows; 50-76% for trigeminal nerve (V1-V3 components), only 10% for VIth nerve and 100% for both VIIth and VIIIth cranial nerves. Like Yousry et al., their 3D-FİESTA results of visualizing all nerve complexes plus their FSE results of VIIth and VIIIth cranial nerves were higher than our all sequence results, however our findings with T2W 2D-TSE sequence in visualizing fifth and sixth nerves were far more superior.

Hatipoglu et al. in their study on 50 patients by using the 3D-FIESTA sequence, succeeded 100% in visualizing the Vth, VIIth and VIIIth nerve complexes, and this value was 95% for the VIth nerve.[4] With T2W FSE, they showed 100% success in Vth, VIIth and VIIIth nerves, but only 20% in visualizing the abducent nerve. Unlike the above papers, their all 3D-FIESTA and T2W FSE results for three nerves were far more successful than our findings, however their incidental findings for VIth nerve visualization with T2W FSE were far more lower than our T2W 2D-TSE results.

TABLE 5: Statistical analysis of identification status of VIIIth nerve (partially identified group added to identified group).

8. Nerve	Observation	Identified	n	198	200	198	190	786	17.157(d)	3	0.001
			%n	25.2%	25.4%	25.2%	24.2%	100.0%			
		Could not identified	n	2	0	2	10	14			
			%n	14.3%	0.0%	14.3%	71.4%	100.0%			
	Sum		200	200	200	200	800				
		%n	25.0%	25.0%	25.0%	25.0%	100.0%				



GRAPHIC 7: Identification of VIIIth nerve on different sequences, partialy identified group added to identified group.

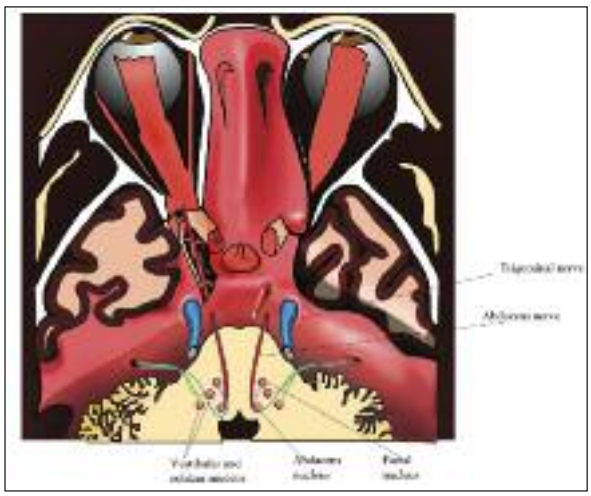


FIGURE 4: Posterior fossa anatomy and cranial nerves.

Ciftci et al. studied Vth-VIIIth cranial nerves of 45 patients with T2W TSE and T2W DRIVE sequences.[6] With both sequences, they showed 100% success for Vth, VIIth and VIIIth cranial nerves, and abducent nerve was visualized 88.9% by 3D TSE and 91.1% by DRIVE sequences. Their results for all nerves were higher than our findings with TSE and DRIVE sequences.

Cassellmann et al. presented a 3D-CISS sequence with an effective slice thickness of 1mm, and showed Vth, VIIth and VIIIth cranial nerves 100% in all of their cases.[14] Their rates for showing the nerves were higher than ours in respect to our all sequences.

Fischbach et al. studied Vth-VIIIth cranial nerve complexes of 20 volunteers with 1.5 T and 3.0 T MRI systems.[13] They applied T2W FSE and FRFSE sequences in both systems. With using 1.5 T system, they had 100% success in shoeing Vth-VIIth and VIIIth nerves and 70% success for 6th cranial nerve with FSE; 100% success in 5th-7th and 8th nerves and 65% for abducent nerve with FRFSE sequences. In 3.0 T system; the results were also the same for 3 nerves by both sequences; while the ratio for showing VIth nerve with FSE was 60% and 90% with FRFSE sequence. They concluded that 3.0 T system is more accurate and FRFSE sequence was better in visualizing the all nerves. Except for the visualization of abducent nerve, their results with both 1.5 and 3.0 T systems compared to our T2W TSE and T2W DRIVE sequences, are better and superior.

Our study is probably the first paper in the literature that analyzes the best sequence for visualizing the cisternal and intracanalicular courses of the nerve complexes, V-VIIIth nerves and moreover we applied 4 sequences to 100 patients: BFFE, T2W 3D-DRIVE, T2W 2D-TSE and post contrast T1W sequences and tried to analyze 800 nerves on both sides. According to our results, the least importance in visualizing the fifth, sixth, seventh and eighth cranial nerves belongs to the post-contrast T1W series. Alltogether 522 nerves were visualized (130 fifth-54 sixth-168 seventh and 170 eighth cranial nerves) in our work with a score of 2. With using the DRIVE T2W TSE; 750 nerves were visualized, 190 of fifth nerves-170 of abducent nerves-194 of seventh nerves and 196 of vestibulocochlear nerves with score 2. In T2W 2D-TSE sequence, 674 nerves were certainly depicted, 178 of fifth-108 of sixth-192 of seventh and 196 of eighth cranial nerves with score 2. With T2W DRIVE sequence, 26 nerves were partly identified-score of 1-and by T2W 2D-TSE sequence, 78 of Vth-VIIIth nerve complexes were partly identified-score of 1. By using B-FFE sequence, 782 nerves among 800 were clearly depicted; 192 of fifth nerves-196 of sixth nerves-196 of seventh nerves and 198 of vestibulocochlear nerves were identified with score of 2. For visualizing all four nerve complexes, 97.75% average success was obtained with this sequence (Table 2).

B-FFE sequence has much more advantages in determining the cisternal and intracanalicular courses of Vth-VIIIth nerve complexes when compared to all other sequences.

T2W 3D-DRIVE was much more superior to the T2W 2D-TSE sequence for determining the Vth-VIIth cranial nerve complexes. T2-DRIVE and T2 TSE sequences were almost equal in visualizing the vestibulocochlear nerve.

CONCLUSION

B-FFE, an SSFP gradient echo sequence of high spatial resolution, with shorter duration of scanning and 1.0 mm slice thickness-308*320 matrix-50 degree flip angle- 3 NSA is the sequence of choice in assessing the cisternal and intracanalicular parts of fifth-sixth-seventh and eighth nerves. In our study, there was 96-98-98-99%, average 97.75% success in determining the all four nerves. This sequence enabled more advantages in visualizing the Vth-VIIIth cranial nerves among other sequences. T2-DRIVE images was the second choice for V-VIIth nerves and more superior than T2W TSE sequence. T2 TSE sequence is far more important in determining the all nerves than the post-contrast T1W series. The worst sequence was the post-contrast T1W series and for assessment of the trigeminal-abducent-facial and vestibulocochlear nerves, contrast agent application had only limited value.

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