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Perverted (non-coplanar) compensatory saccades after head impulses in Unilateral Posterior Semicircular Canal Hypofunction and Superior Vestibular Neuritis.

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Video sequences after head impulses in patients with Unilateral Posterior Semicircular Canal Hypofunction (UPSCH) and Superior Vestibular Neuritis (SVN) were studied in slow motion, and the direction of compensatory saccades was controlled for non-coplanar (perverted) responses.

Between 2020 and 2023, 37 outpatients presenting isolated UPSCH at the Video Head Impulse Test (VHIT) were studied: 19 of them had an upward sliding of the eyes, followed by a downward oblique compensatory saccade during the horizontal impulse of the head towards the healthy side. The correlation between these saccades and the relative functional imbalance of the Vertical Semicircular Canals (VSCs) of the affected side was studied (Figure 1)

Later (2021-2024) 37 patients suffering from SVN underwent VHIT and were checked for Perverted Compensatory Saccades (PCS) after head impulses in all the tested planes (horizontal and oblique): 29 of them (78,4%) presented PCS in one or more test conditions. (Table: Superior Vestibular Neuritis. Perverted Compensatory Saccades).

The results have been interpreted based on labyrinthine response models from the scientific literature, which take into account the diffusion of kinetic action across multiple semicircular canals simultaneously.

It is proposed that perverted saccades in the acute stage of SVN are mainly the result of the static imbalance between the labyrinths, whose expression is modulated by the action of all the semicircular canals involved in the kinetic stimulus; this dynamic interference predominantly drives eye movements in the late stages of the disease.

Perverted responses may interfere with the VHIT causing rejects and reducing the gain value (pseudo-deficit); their analysis is not currently supported by VHIT systems.

The operator deserves to know if eye movement occurs in planes other than the one tested, so that this can be taken into proper account in evaluating the results of the VHIT and investigated when they are unexpected.

Keywords

Video Head Impulse Test (VHIT), Posterior Semicircular Canal Hypofunction, Superior Vestibular Neuritis (SVN), Vestibulo-Ocular Reflex (VOR) Anomalies, Perverted Compensatory Saccade.

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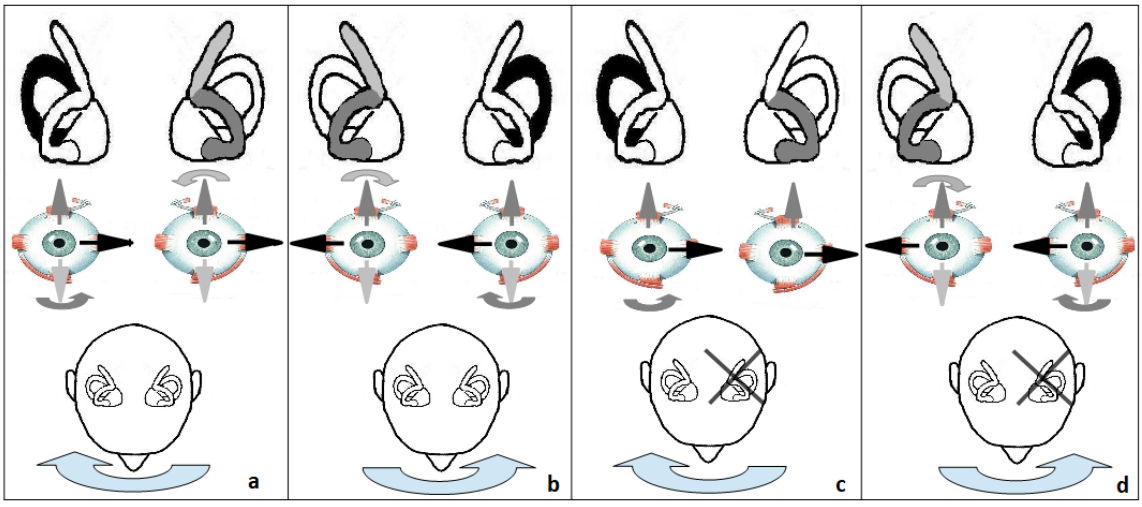
Figure 1



Activation of SCs and their effects on eye movements during horizontal head impulse in normal conditions (a and b) and in left PSC isolated hypofunction (c and d). Activated SCs are highlighted (LSC: black, ASC: dark grey, PSC: light grey). Black arrows: effects of LSC activation; dark grey arrows: effects of ASC activation; light grey arrows: effects of PSC activation. In normal conditions (a and b), activation of both vertical SCs stabilizes the eyes in the vertical plane; only the action of LSC moves them. In case of isolated left PSC deficit, during a rotation of the head towards the healthy side (c), eyes rotate in the horizontal plane due to the action of right LSC; however, due to the action of left ASC alone, they improperly move upward as well. During the impulse of the head towards the affected side (d), eyes move as in normal condition.

Table: Superior Vestibular Neuritis. Perverted Compensatory Saccades.

				C-ASC			C-PSC			C-LSC			I-ASC		I-PSC			I-LSC	
	sex	age	time	gain	HCS	*RCS*	gain	HCS	*RCS*	gain	VCS	*RCS*	gain	*RCS*	gain	HCS	*RCS*	gain	*RCS*
1	m	61	A	1			0,86			0,79			0,59		0,92			0,44	
2	f	54	SA	0,93			0,62			0,79			-0,05		0,85	**CL**	*CL*	0,06	*CL*
3	m	77	EX	0,66	**CL**		0,58			0,4			0,09		0,68			0,01	
4	f	75	EX	0,97			0,69			0,71			0,54		0,58			0,2	
5	f	67	EX	1,11			0,96			0,78			0,49		1,01			0,65	
6	f	67	EX	0,69			0,44			0,48			0,04		0,56			0,03	
7	f	47	EX	0,99	**CL**	*CL*	0,84			1	**UB**		0,05		0,84			0,04	
8	m	60	SA	0,9	**CL**	*CL*	0,59			0,85		*HL*	0,34		0,69			-0,05	
9	m	60	SA	0,79		*CL*	0,65			0,52	**UB**	*CL*	-0,05		0,56			-0,04	
10	f	52	A	1,11		*CL*	0,85			0,9	**UB**		0,25	*CL*	0,94			0,31	*CL*
11	f	45	EX	1,03			0,74			0,77			0,4		0,76			0,36	
12	m	75	SA	1,01		*CL*	0,7			0,62	**UB**		0,26		0,82			0,14	*CL*
13	m	77	A	0,88	**CL**	*CL*	0,31			0,65	**UB**		-0,05		0,31	**CL**	*CL*	-0,05	*CL*
14	f	47	EX	0,96			0,71			0,59			0,35		0,58			0,11	
15	m	37	A	1,05	**CL**		0,8	**CL**	*CL*	0,91	**UB**		-0,02		0,79			-0,03	
16	m	76	A	0,89	**CL**	*CL*	0,67		*CL*	0,57	**UB**	*CL*	0,07	*CL*	0,39		*CL*	-0,04	*CL*
17	m	56	A	0,84		*CL*	0,91		*CL*	0,83	**UB**	*CL*	0,03		1,01			0,01	*CL*
18	m	57	SA	0,79	**CL**	*CL*	0,74	**CL**	*CL*	0,67		*CL*	0,2		0,66			0,35	*CL*
19	m	73	A	1,02		*CL*	0,5		*CL*	0,8	**UB**	*HL*	0,48		0,63			-0,05	*CL*
20	m	55	A	0,93		*CL*	0,79		*CL*	0,78	**UB**	*CL*	0,09		0,98			-0,02	*CL*
21	f	70	A	0,69		*CL*	0,64		*CL*	0,39	**UB**	*CL*	-0,05		0,47		*CL*	0,13	*CL*
22	m	64	SA	0,88	**CL**	*CL*	0,44		*CL*	0,71			0,09		0,46			0	
23	m	72	A	1,14	**CL**	*CL*	1,02		*CL*	1,01			0,34	*CL*	1,1	**CL**	*CL*	0,05	*CL*
24	m	73	EX	0,9		*CL*	0,39			0,8	**UB**		0,15		0,81			0,25	*CL*
25	m	56	EX	1		*CL*	0,96			0,9			0,39		1,03			0,19	*CL*
26	f	66	EX	0,98			0,47			0,73	**UB**		0,26		0,57			0,02	*CL*
27	f	64	SA	1,02			0,72			0,85	**UB**	*CL*	0,38		0,78			-0,01	*CL*
28	f	86	EX	0,68			0,49			0,57	**UB**	*HL*	0,09		0,55			-0,05	*CL*
29	m	82	A	1,02			0,52			0,63	**UB**	*CL*	-0,05		0,62	**CL**	*CL*	0,06	*CL*
30	m	67	EX	0,92			0,63		*CL*	0,53	**UB**	*HL*	-0,01	*HL*	0,94			-0,05	*CL*
31	f	47	A	0,79			0,72	**CL**	*CL*	0,9	**UB**	*CL*	0,25		0,57			0,04	*CL*
32	m	66	EX	1,05			0,73		*CL*	0,79			0,47		0,72	**CL**		0,06	*CL*
33	m	54	EX	1,3			0,87	**IL**		1,04			0,11		0,74			0,2	
34	m	74	SA	1,01			0,61	**CL**	*CL*	0,86			0,38		0,66			0,24	
35	f	67	EX	0,78			0,74			0,9			0,51		0,7			0,29	
36	m	66	A	1,03			0,68		*CL*	0,82			-0,04		0,44	**CL**		-0,04	*CL*
37	f	47	EX	0,97			0,8			0,9			0,24		0,7			0,05	

I-ASC: Ipsi-lateral Anterior Semicircular Canal; I-PSC: Ipsi-lateral Posterior Semicircular Canal; I-LSC: Ipsi-lateral Lateral Semicircular Canal; C-ASC: Contra-lateral Anterior Semicircular Canal; C- PSC: Contra-lateral Posterior Semicircular Canal; C-LSC: Contra-lateral Lateral Semicircular Canal;

VCS: Vertical Compensatory Saccade; HCS: Horizontal Compensatory Saccade; RCS: Rotatory Compensatory Saccade;

Up-Ueating (UB)/ Down-Beating (DB); Ipsi-Lateral (IL)/ Contra-Lateral (CL); A: Acute; SA: Sub Acute; EX: Outcomes

Biography

Dott. Francesco d'Onofrio, otorhinolaryngologist in private practice since 2023.

Co-founding member of the Italian Cenacle of Audio-Vestibology. (www.facebook.com/cenavest)

Graduated with honors in Medicine and Surgery in 1991 at the Federico II University of Naples;
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Medical Assistant at the U.O.S. of Otorhinolaryngology of the "Maria SS dello Splendore" hospital in Giulianova (TE) with a high specialization assignment in ENT Neurophysiology from 2000 to 2023
Medical Assistant at the Autonomous Unit of Otorhinolaryngology of the hospital of Dolo (VE) from 1998 to 2000
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