ICS Impulse and Scleral Search Coil Comparison

Wendy Crumley-Welsh[2], Konrad P. Weber[4,5]
Ian S. Curthoys[1], G. Michael Halmagyi[3]

BALANCE

ICS Impulse and Scleral Search Coil were directly compared.

Simultaneous Testing

For the simultaneous testing, each subject received a test of the vestibular ocular reflex using the ICS Impulse and the Scleral Search Coil (CNC Engineering system with Skalar, Delft Coil). Gain for both devices is the comparison of the head movement to the eye movement.

The data was collected simultaneously meaning that each subject received 1 Head Impulse test, but that data collection was performed on both the ICS Impulse and the Scleral Search Coil simultaneously. See pic below showing the goggles and Coil on the subject at the same time.

Three subjects were tested using ICS Impulse and Scleral Search Coil simultaneously. Two subjects exhibited vestibular symptoms (dizziness, light-headed, tinnitus, vertigo, headaches). A subject exhibiting vestibular symptoms may or may not have an abnormal vestibular ocular reflex response. One subject did not exhibit any symptoms and is considered within normal limits.

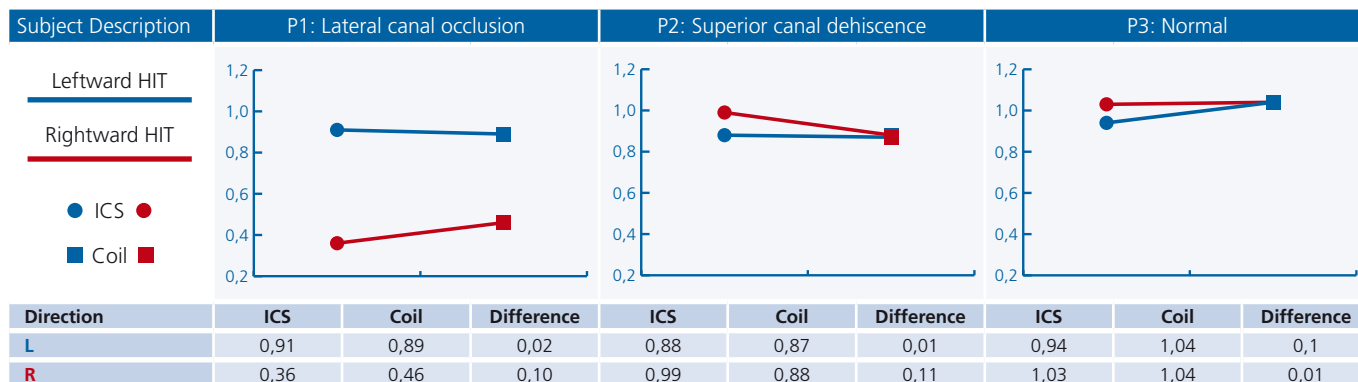**Column Description:**

Subject: subject number

Direction: the direction of the head impulse
(L= leftward; R=rightward)

ICS: the mean gain measurement from the ICS Impulse

Coil: the mean gain measurement for the scleral search Coil

Difference: the difference between the mean gain using the ICS Impulse and the mean gain using the Scleral Search Coil

Diagnosis: the diagnosis for that subject

Subject Description	P1: Lateral canal occlusion			P2: Superior canal dehiscence			P3: Normal		

Leftward HIT
Rightward HIT
● ICS ●
■ Coil ■

Direction	ICS	Coil	Difference	ICS	Coil	Difference	ICS	Coil	Difference
L	0,91	0,89	0,02	0,88	0,87	0,01	0,94	1,04	0,1
R	0,36	0,46	0,10	0,99	0,88	0,11	1,03	1,04	0,01

Conclusion:

ICS Impulse meets our protocol criteria and that all the gains are within +/-0.1 of the scleral search Coil.

ICS Impulse

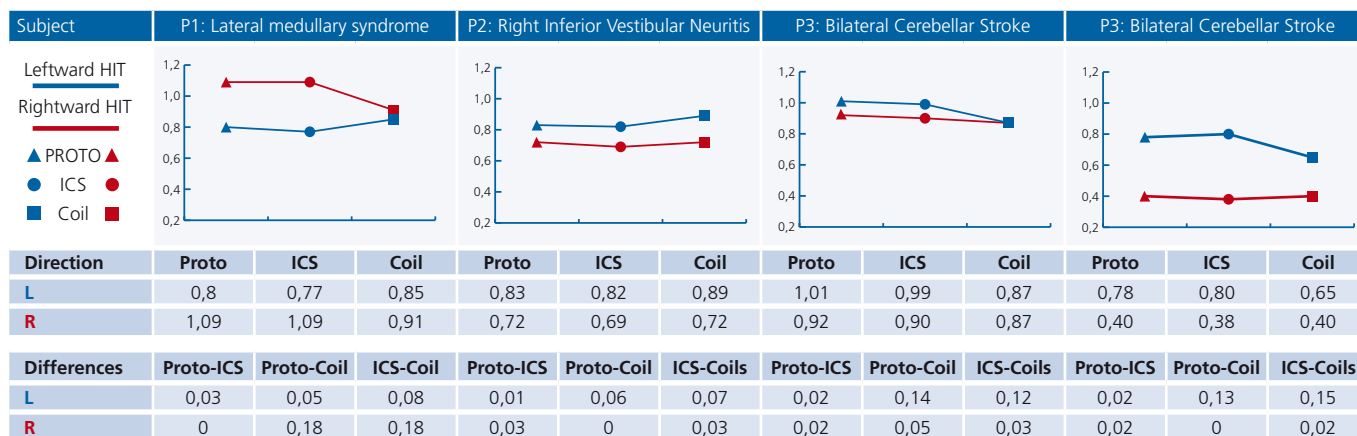otometrics
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Sequential Testing

A second set of data was collected. Four subjects with known abnormality were tested using ICS Impulse, the goggle prototype and Scleral Search Coil. All four subjects exhibited vestibular symptoms (dizziness, light-headed, tinnitus, vertigo, headaches). Again, a subject exhibiting vestibular symptoms may or may not have an abnormal vestibular ocular reflex response. We wanted to challenge ourselves and see what would happen if we collected data sequentially. Typically bigger differences will be seen between sequential tests than for simultaneous tests. For simultaneous tests the subject is responding in the same way for both systems so the differences measured are due to the measurement techniques. When sequential tests are performed additional sources of variability are introduced.

For example if you tested a subject multiple times with a perfect measurement system (hypothetical) you would still expect to see variability in response. This is because we are not machines and all our biological functions fluctuate with attention, fatigue, temperature, circadian rhythm, hormones, etc. etc. This variability alone could easily account for differences between sequential test results of at least 10%.

Also if you tested a perfectly consistent subject (hypothetical) with exactly the same response multiple times with the same equipment, then again you would expect to see some variability because equipment function fluctuates with temperature, electrical and magnetic interference, Coil slip, goggles slip, etc. This equipment variability could also easily account for differences between sequential test results of at least 10%.

So when you do sequential testing you are comparing results that are influenced by all these sources of variability as well as by differences between different measurement systems. These differences can easily add up such that the very strict average difference of 10% purposed in the protocol with the simultaneous tests can't be applied to sequential testing.

For the sequential testing, each subject received a test of the vestibular ocular reflex using the ICS Impulse, the goggle prototype and the Scleral Search Coil (CNC Engineering system with Skalar, Delft Coil). Gain for all three devices is the comparison of the head movement to the eye movement. The data was collected sequentially meaning that each subject received 3 Head Impulse tests, one per device.

Column Description:

Subject: subject number

Direction: the direction of the head impulse
(L= leftward; R=rightward)

Proto: the mean gain measurement from the goggle prototype

ICS: the mean gain measurement from the ICS Impulse

Coil: the mean gain measurement for the scleral search Coil

Proto to ICS: the difference between the mean gain using the goggle prototype and the mean gain using the ICS Impulse

Proto to Coil: the difference between the mean gain using the goggle prototype and the mean gain using the Scleral Search Coil

ICS to Coil: the difference between the mean gain using the ICS Impulse and the mean gain using the Scleral Search Coil

Diagnosis: the diagnosis for that subject

Subject	P1: Lateral medullary syndrome			P2: Right Inferior Vestibular Neuritis			P3: Bilateral Cerebellar Stroke			P3: Bilateral Cerebellar Stroke		
Direction	**Proto**	**ICS**	**Coil**	**Proto**	**ICS**	**Coil**	**Proto**	**ICS**	**Coil**	**Proto**	**ICS**	**Coil**
L	0,8	0,77	0,85	0,83	0,82	0,89	1,01	0,99	0,87	0,78	0,80	0,65
R	1,09	1,09	0,91	0,72	0,69	0,72	0,92	0,90	0,87	0,40	0,38	0,40

Differences	**Proto-ICS**	**Proto-Coil**	**ICS-Coil**	**Proto-ICS**	**Proto-Coil**	**ICS-Coils**	**Proto-ICS**	**Proto-Coil**	**ICS-Coils**	**Proto-ICS**	**Proto-Coil**	**ICS-Coils**
L	0,03	0,05	0,08	0,01	0,06	0,07	0,02	0,14	0,12	0,02	0,13	0,15
R	0	0,18	0,18	0,03	0	0,03	0,02	0,05	0,03	0,02	0	0,02

Conclusion:

Even with the added sources of variability based on the above data we clearly demonstrate that the prototype to ICS Impulse meets our protocol criteria and that all the gains are within +/-0.1 of each other. And we further show that the Coil to ICS Impulse also meets our strict criteria and that all the gains are within +/-0.1 of each other. Regarding P1 rightward head impulse which had a mean gain difference of 0.18 it is not surprising that the prototype and the ICS Impulse performed exactly the same as the ICS Impulse is a copy of the prototype goggles and software algorithms. Again what causes this slight increase in variation? It could be any of the mentioned sources of variability when performing sequential testing. But based on the fact that sequential testing can be performed and result in a 10% difference or less is very gratifying.

1. Vestibular Research Laboratory, School of Psychology, the University of Sydney, NSW, Australia.
2. Product Manager/Audiologist, Otometrics.
3. Department of Neurology, Royal Prince Alfred Hospital, Sydney, Australia.
4. Department of Neurology, University Hospital, Zurich, Switzerland.
5. Department of Ophthalmology, University Hospital, Zurich, Switzerland.

References:

MacDougall HG, Weber KP, McGarvie LA, Halmagyi GM, Curthoys IS, (2009) The Video Head Impulse Test: Diagnostic accuracy in peripheral vestibulography. Neurology 73: 1134-1141. DOI: 10.1212/WNL.0b013e3181bacf85

MacDougall HG, McGarvie LA, Halmagyi GM, Curthoys IS, Weber KP (2013) The Video Head Impulse Test (vHIT) Detects Vertical Semicircular Canal Dysfunction. PLoS ONE 8(4): e61488. doi:10.1371/journal.pone.0061488