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Preliminary Evaluation of the HS-1000 Acoustic Neuromonitoring Device in the Diagnosis and Assessment of Sport-Related Concussion

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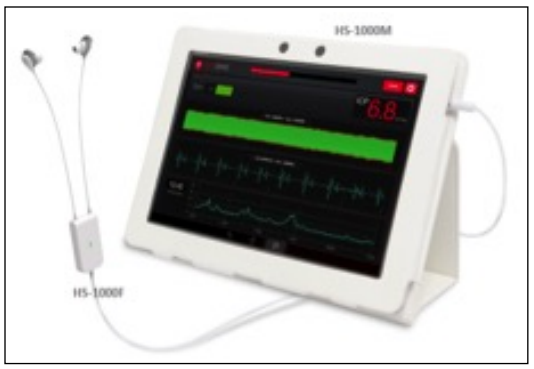

Introduction

The diagnosis of sport-related concussion (SRC) can be difficult due to poor symptom disclosure and heterogeneous presentation. Our objective was to evaluate the ability of the HS-1000, a non-invasive multi-modality acoustic neuromonitoring device to distinguish between acutely concussed and non-concussed athletes.

Learning Objectives

By the conclusion of this session, participants should be able to:

1)Describe the importance of the HS-1000 acoustic neuromonitoring device in the diagnosis of sport-related concussion.

2)Discuss future application and areas of improvement of the HS-1000 to better diagnose acute concussion.

Methods

A prospective, case-control study of acutely concussed and control (age and gender matched) participants was conducted. All SRC diagnoses were made based on the international Concussion in Sport Group (CISG) guidelines. With the HS-1000, participants in both groups were monitored for 15min per recording for multiple recordings by placing ear buds in each ear (Figure1A-B). Concussed subjects were recorded 4 times: acute/baseline, 48hr, 1wk, 1mo. Controls were recorded 2 times: baseline, 2wk. For algorithm development, raw data was separated into training and validation phases using artificial neural networks to calibrate the algorithm to differentiate between healthy and concussion recordings (Figure2). Raw data from all 20-minute recording sessions were separated into 3-minute statistically independent recording epochs.

Group	N	Males	Females	Age	1 Concussion	≥2 Concussions
Concussed	25	21	4	19.64 (15-23)	8	4
Healthy	54	30	24	19.58 (15-24)	6	1
Total, Average	**79**	**51**	**28**	**19.61 (15-24)**	**14**	**5**

Results

The final sample included 25 concussed and 54 control participants (Table1-2). The average age for each group was 19 years. Prediction of concussion was based upon a multi-parameter algorithm developed to recognize acoustic patterns unique to confirmed concussion recordings. Post-processing of HS-1000 signals predicted concussion group membership with a sensitivity and specificity of 99.4% and 95.0%, respectively (Table3).

Group	Healthy (predicted)	Concussed (predicted)	Total
Healthy (true)	324	2	**326**
Concussed (true)	7	132	**139**
Total	**331**	**134**	**465**

Conclusions

In the current pilot study of an investigational device to diagnose SRC, the HS-1000 demonstrated strong predictive accuracy with practitioner-defined clinical diagnosis. However, limitations of SRC chronicity and the cumulative impact of prior concussions exist. Armed with this preliminary information, improvements can be made to use the HS-1000 immediately at the occurrence of injury to diagnose concussion in real-time rather than in the clinic setting. The development of a real-time diagnostic algorithm holds promise for the diagnosis of SRC.