CASE STUDY

This case study demonstrates the rapid detection of a concussion by observing the changes in a subject's cranial nerves II, III, IV and VI neurological response performance.

Test equipment: The **Intellig-EYES™** headgear manufactured by Axon Medical Technologies

Patient: A 23-year-old female (Patient# 2128) with existing baseline data that was later involved in an automobile accident and received a concussion diagnosis from the emergency room physician.

Case description: The patient was involved in a car accident and received trauma to the left side of her head on 8/5/2019. She complained of headaches, diminished concentration, and sensitivity to light. The attending physician at the urgent care unit diagnosed her with a mild concussion. In order to quantify the level of concussion she sustained, three days after the accident, on 8/8/2019, the **Intellig-EYES™** headgear was used to test her. The device determined the level of changes to her cranial nerves II, III, IV and VI neurological response performance. This patient had a similar 87-second test performed using the same type of equipment on 2/17/2019. The data from her previous test results were stored in Axon Medical's servers and served as a comparative baseline data for this differential analysis.

Assessment/Results: Comparing the patient's scan data from after the accident to her baseline data revealed the following significant changes:

- **Maximum pupil diameters** were significantly **lower** after the concussion
  (Left eye: 5.6 mm before, 4.5 mm after, change: **-19.6%)** (Right eye: 6.4 mm before, 4.6 mm after, change: **-28.1%)**
- **Pupil constriction rates** show **higher** rates after the concussion
  (Left eye: 3.22 mm/s before, 3.54 mm/s after, change: **+9.03%**) (Right eye: 3.79mm/s before, 4.85 mm/s after, change: **+21.85%**)
- **Pupil deviation** from ortho were significantly **higher** after the concussion
  (Left eye: 0.3 mm before, 0.9 mm after, change: **+300%)** (Right eye: 0.5 mm before, 1.5 mm after, change: **+300%)**
- **Re-convergence rates** were significantly **higher** after concussion
  (Left eye: 2.84 mm/s before, 2.92 mm/s after, change**: +2.8%**) (Right eye: 3.11 mm/s before, 9.03 mm/s after, change: **+290%)**
- **Near point pupillary distance** (PD) **increased** after the concussion: (58.1 mm before, 60.1 mm after, change: **+ 2 mm**)

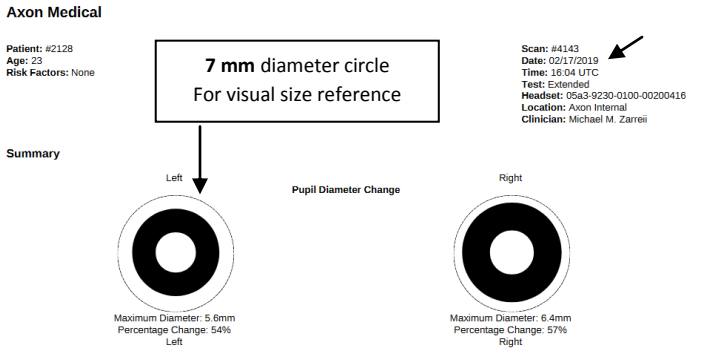
Discussion: The cranial nerves II and III control the pupil diameter and the rate its size change as a response to external stimuli. Clearly, a concussed patient exhibits noticeable decrease in pupil size and an increase in the constriction rate of their pupil autonomic control system (more than 6%). This increase in speed can be due to the brains neuro-elasticity function, which re-wires the path through new healthier neurons take bypassing the damaged neurons. The re-assigned neurons seem to fire faster but with less control. Re-training time will be necessary to learn optimal control for their new function. The cranial nerves IV & VI control the ocular movements. The increase in the pupil deviation from ortho is a biomarker that represents the accumulated amount of neuro-degenerative damage sustained by a patient. We have only seen this value go up in patients. This increase is definitely more predictable in patients with multiple concussions, or those suffering from other neuro-degenerative conditions. We have not seen any decline for this value in the past 12-years of data.

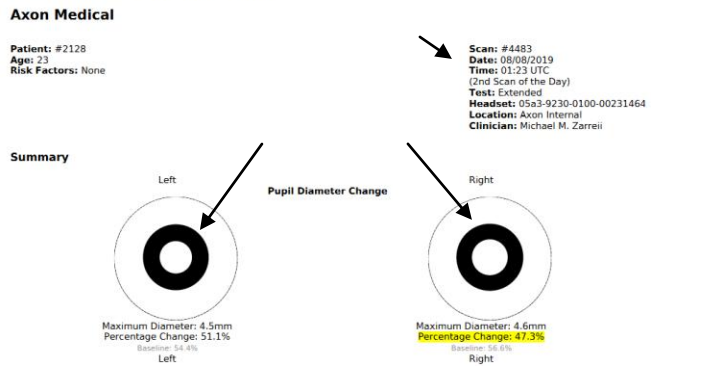
Conclusion: The **Intellig-EYES™** headgear objectively quantified the performance changes to the patient's cranial nerves II, III, IV, and VI. Through its rapid analysis, an objective diagnosis of severity of concussion is easily established. The comparative analysis results can also represent the severity of concussion with color-coded bands, such as Green, Yellow and Red. Each color code represents a rapid view of the severity of concussion sustained by a subject. For example, sports-medicine personnel can make informed decisions: Green return to play Yellow hold the player for further evaluation Red send the player to the hospital.

Athletic teams and physician offices can achieve a better concussion management protocol using the **Intellig-EYES™** headgear. This device is advantageous, because it is portable, precise, objective, easy to use, and delivers rapid tests and results (87 seconds for baseline tests, 30 seconds for sideline quick tests).

Patient # 2128 baseline data collected on 2/17/2019

Patient # 2128
Three days post concussion, confirmed by ER physician
Data collected on: 8/8/2019
Confirmed concussion date: 8/5/2019

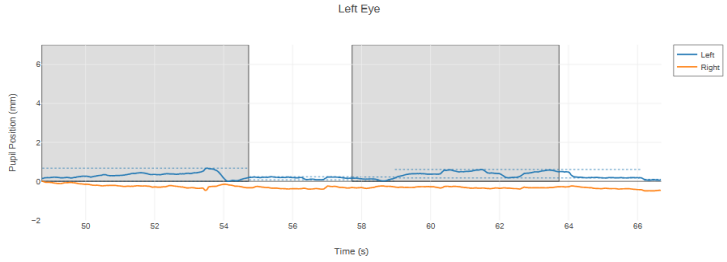




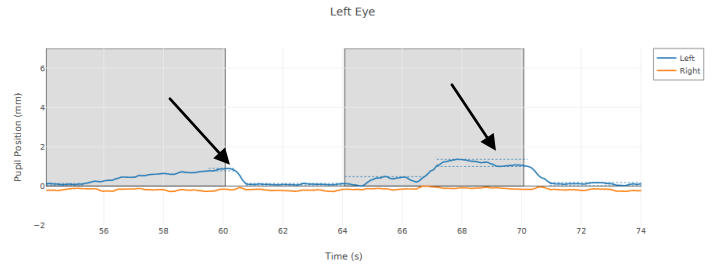
Baseline pupil deviation and convergence rates

Post concussion pupil deviation and convergence rates

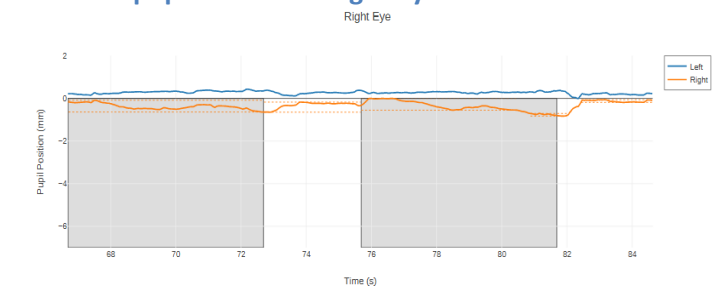
Baseline pupil deviation –left eye



Post concussion pupil deviation -left eye



Baseline pupil deviation -right eye



Post concussion pupil deviation -right eye