Initial Clinical Evaluation of the Pronumbra Head & Neck Immobilization System

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INTRODUCTION

The CQ Medical Pronumbra Head & Neck System is a new immobilization device with adjustable shims developed specifically for proton therapy. Its dedicated baseplate is designed to ensure consistent patient fixation, enhance patient comfort, improve rigidity, streamline clinical workflows, and accommodate a broad range of proton beam entry angles. This study presents the first clinical implementation of Pronumbra with patients. The primary objective was to characterize the board's water equivalent thickness (WET) and evaluate its clinical performance, focusing on ease of use, setup reproducibility, and seamless integration into routine proton therapy practice.

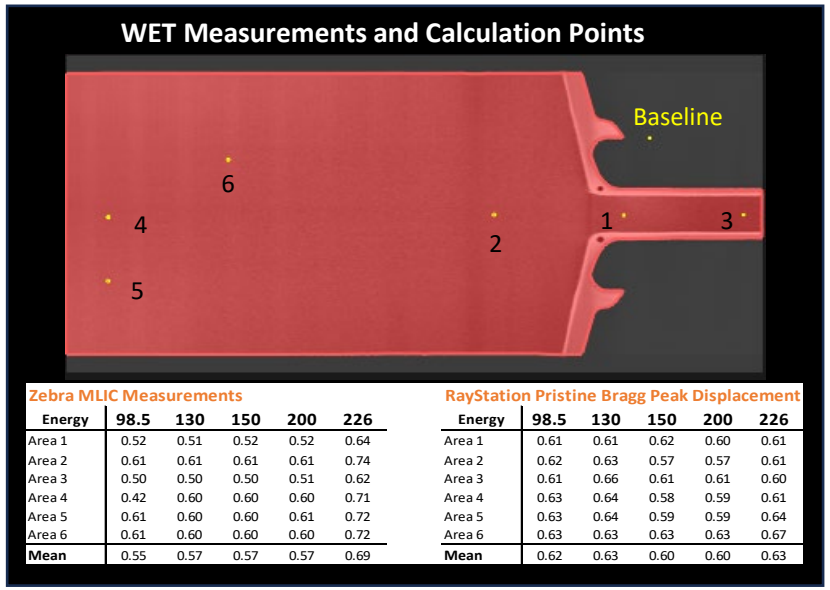
Figure 1: Pronumbra Board (Image courtesy of CQ Medical)

METHODS

Physical characterization of the Pronumbra was performed for pencil beam scanning on an IBA Proteus+ system. Baseline integral depth dose (IDD) profiles for 98.5, 130, 150, 200, and 226 MeV beams were measured with an IBA-Dosimetry Zebra ion chamber array. The board was then placed in the beam path, and six distinct regions were tested to determine WET experimentally. RayStation 23B Monte Carlo was used to calculate WET for the Pronumbra and was also used for all patient treatment plans and QA CT analysis. The rigidity and positional reproducibility of the mask and headrest were quantified by comparing treatment planning CT (TPCT) images with quality assurance CT (QACT) images acquired during treatment. Patient positioning reproducibility was analyzed using daily IGRT imaging

RESULTS

The first four H&N patients worldwide to be treated using this new proton immobilization system completed treatment, generating 11 QACT images and 74 daily IGRT sessions. WET measurements of the immobilization board averaged 5.9 mm, closely matching Monte Carlo predictions of 6.1 mm. The reproducibility of the four aquaplastic mask attachment points based on QACT imaging was ±0.5 mm laterally (right-left), ±0.9 mm anteroposteriorly, and ±0.8 mm superior-inferior. Positional variation at the superior end of the head support measured ±0.6 mm laterally, ±0.8 mm anteroposteriorly, and ±1.0 mm longitudinally. Given the CT image resolution of 0.98 mm in the axial plane and 2.0 mm in the longitudinal direction, these variations are at or below the detectable threshold of the imaging system.



Zebra MLIC Measurements

Energy	98.5	130	150	200	226
Area 1	0.52	0.51	0.52	0.52	0.64
Area 2	0.61	0.61	0.61	0.61	0.74
Area 3	0.50	0.50	0.50	0.51	0.62
Area 4	0.42	0.60	0.60	0.60	0.71
Area 5	0.61	0.60	0.60	0.61	0.72
Area 6	0.61	0.60	0.60	0.60	0.72
Mean	0.55	0.57	0.57	0.57	0.69

RayStation Pristine Bragg Peak Displacement

Energy	98.5	130	150	200	226
Area 1	0.61	0.61	0.62	0.60	0.61
Area 2	0.62	0.63	0.57	0.57	0.61
Area 3	0.61	0.66	0.61	0.61	0.60
Area 4	0.63	0.64	0.58	0.59	0.61
Area 5	0.63	0.64	0.59	0.59	0.64
Area 6	0.63	0.63	0.63	0.63	0.67
Mean	0.62	0.63	0.60	0.60	0.63

Figure 2: Coronal CT Image showing the measurement locations on the Pronumbra Board (Top) and corresponding experimental and Monte Carlo WET results for multiple energies (Bottom).

CONCLUSIONS

The Pronumbra immobilization system demonstrates accurate WET characterization and matches well with TPS calculations, eliminating the need for special density overrides. It provides stable mask fixation, reliable positioning, and improved patient comfort. These findings support its routine clinical use in proton therapy, enhancing workflow efficiency and treatment accuracy.

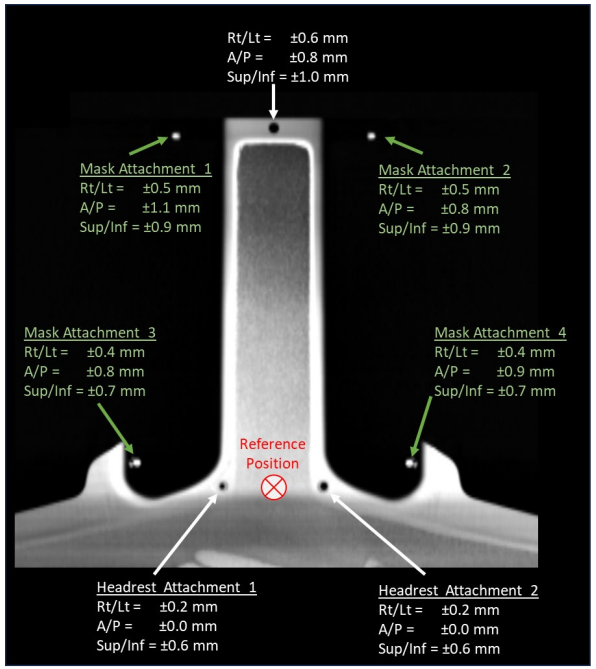


Figure 3. Measurement of positional uncertainties for the mask attachment points (shown in green) and the headrest attachment points measured from QACT images for the first patients treated with the Pronumbra.

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