Purpose: Proton therapy for the intracranial, base-of-skull and ocular tumors has a number of dosimetric and radiobiological advantages for cancer patients[1]. In the same time, it necessitates rigorous quality assurance (QA) techniques of patient immobilization and registration to ensure the reproducibility of the patient setup and enable monitoring of the intrafraction motion. Traditionally, when thermoplastic immobilization masks are used for treating Head&Neck and Brain tumors, they encompass the full surface of the patient face, so the xray-based imaging system (either orthogonal portal images or CBCT) is the go-to imaging modality for the patient setup. The previously tried open face mask evaluations at our institution were not successful, as a densely perforated Kevlar material (traditionally used in our institution for the head and neck patients, together with the base-of-skull frame) does not provide the necessary degree of immobilization after being cut out to open the facial landmarks. The recent reports of the evaluations of several head mold based patient registration methods [2,3] for the radiation therapy of brain tumors, use the surface rendering system mainly as a patient motion monitoring modality.

This work is a report of the successful preclinical evaluation of the commercial prototype open face mask (Fibreplast, Q-Fix™) used with surface rendering imaging system (AlignRT™, London, UK) for setup and monitoring of proton therapy patients with cancers of the brain and head.

Materials and Methods: Fibreplastic open face masks (Qfix Systems™) were used for immobilization, with Base of Skull frame and moldcare pillow accessory. Two sizes of the pre-made cutouts of the masks were investigated: I) pre-made cutout stretched to leave open skin surface in the oval-shaped area between upper lip and forehead boss, II) between mandible and forehead boss in superior-inferior direction; and both (I) and (II): between zygomatic (cheek-) bones/sphenoid bones laterally. Figure 1 (a) shows the BOS mask with the cutout; Figure 1 (b) and (c) demonstrates the final look of the masks on a volunteer. The calibration of the AlignRT system was verified using the SRS cube phantom (supplied by VisionRT, London, UK) and 2D X-ray patient positioning system (DIPS, IBA). The accuracy of translational shifts and rotations was a) verified using a rando head&neck phantom and b) tested using volunteers. Within the AlignRT software, only the open skin area was used as the region of interest (ROI) for the registration; the option of Intracranial SRS was used for the surface capture.

Results: For the isocenter determination accuracy within 0.3mm/0.2 degrees, the head&neck phantom registration was performed with the 0.5mm/0.5 degree accuracy; the volunteer tests showed the registration accuracy within 0.5mm ±0.2mm (1 σ)/0.7±0.2 (1 σ) degree. The simulation of the noise in the surface data such as eye blinking and attempts to swallow/chew was performed, with negligible effect on the registration. No significant differences between the study results between the masks of type (I) and (II) were noticed.

Conclusions: The AlignRT surface rendering system has sufficient accuracy when used with the open face head&neck mask for localization/registration of the proton therapy patients with tumors of the head and brain.

References.

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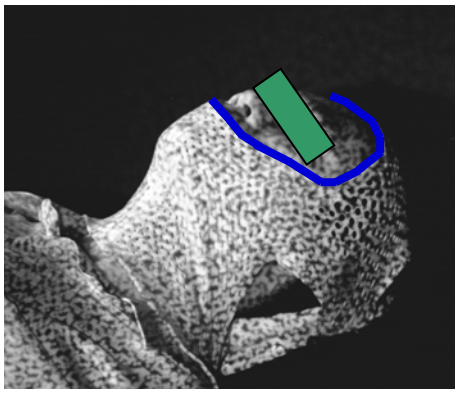
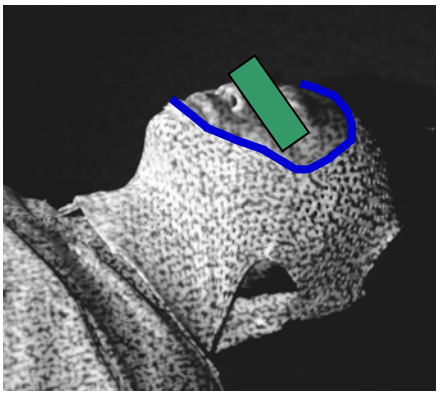
Figure 1. a. The base-of-skull fibreplastic mask with a cutout (Q-Fix™), b. the mask on a volunteer (type I, covered lip area) and c. the mask on a volunteer (type II, open lip area).

a.



b.



c.