OC-0075 Simple spatula improves the geometrical accuracy of a cranial mask for brain tumor radiotherapy

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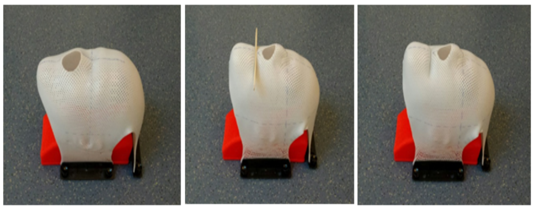
Purpose or Objective

The demands on accuracy in radiotherapy have increased especially in stereotactic treatments using IMRT or VMAT techniques where margins to the PTV are as small as 1 or 2 mm, but also for non-stereotactic treatments. Commercial systems providing better geometrical accuracy in patient positioning than conventional standard three-point masks, entail high costs. Although translations can be corrected with a couch shift, rotations cannot be corrected with a standard treatment couch and need to be prevented as much as possible. Therefore we aim to investigate whether the use of a dental fixation created with an inexpensive and simple wooden spatula, will improve accuracy in patient positioning.

Material and Methods

In 40 patients receiving non-stereotactic cranial radiotherapy, 144 conebeam CTs (CBCT) were acquired prior to treatment. Twenty patients had a standard three-point thermoplastic mask with a standard base (MacroMedics®, Waddinxveen, The Netherlands); next 20 patients had an identical mask and base, but with the addition of a dental fixation moulded by a wooden spatula, to create an extra point of fixation between the teeth rows. Patients were asked to bite gently on the wooden spatula during moulding of the mask to create an indentation in the mask for dental fixation. After cooling and hardening of the mask, the wooden spatula is removed. During the acquisition of the planning CT and all treatment fractions patients are instructed to bite gently on the indentation. All CBCTs were registered on bony anatomy of the skull. For patients with an online correction protocol, all data were included. For patients with extended NAL correction protocol, only the data of the first 'NAL'-phase were included. Thereby, the position inaccuracy was calculated on position errors before a position correction was applied. Individual systematic (Σ) errors were calculated and analyzed with Levene test. Individual random errors (σ) were calculated and analyzed with the Mann-Whitney test.



a b c

a = Three-point mask with standard base

b = Three-point mask with standard base with indentation by a wooden spatula

c = Three-point mask with standard base with indentation after removing the wooden spatula

Three-point mask and standard base

	Translations mm			Rotations °		
	X (LR)	Y (CC)	Z (AP)	X (LR)	Y (CC)	Z (AP)
Σ (group)	1.0	1.8	0.6	1.0	1.0	1.2
σ (group)	0.8	1.2	0.7	0.8	0.9	0.7

Three-point mask with dental fixation and standard base

	Translations mm			Rotations °		
	X (LR)	Y (CC)	Z (AP)	X (LR)	Y (CC)	Z (AP)
Σ (group)	1.0	1.2	1.0	0.6 *	0.8	0.7
σ (group)	0.8	0.9	0.6	0.5 *	0.6*	0.6

* (p=0.038), * (p=0.017), * (p=0.004)

Results

The table summarizes the group setup errors for both fixation systems. Most errors are smaller when using the three-point mask with dental fixation created with a simple wooden spatula compared to the three-point mask alone. Geometrical accuracy shows significant improvement in the systematic and random error for the rotation over the X axis and the random error for rotation over the Y axis.

Conclusion

Adding a dental fixation point to a standard three-point cranial mask by a simple wooden specula improves geometrical accuracy, particularly by reducing rotational errors. This may be of clinical importance, since rotational errors cannot be corrected by a standard treatment couch. Although the absolute errors are already small for the standard three-point mask, but given the small effort and the low additional costs of a simple wooden spatula, we decided to accept the mask with dental fixation as our standard for non-stereotactic brain tumor radiotherapy.

OC-0076 Motion Capture Pillow shows potential to replace thermoplastic masks in H&N radiotherapy

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Purpose or Objective

A key challenge to improve patient comfort is the common use of a thermoplastic mask for patients with head and neck cancers. Patients suffer from discomfort and the claustrophobic effect of the mask, or, as they lose soft tissue due to treatment and gain undesirable movement in the mask. A prototype system using a robotic Motion Capture Pillow (MCP) is investigated for proof-of-concept and is pictorially presented for the potential replacement of thermoplastic masks.

Material and Methods

A radiographer nurtured a concept with robotics engineers and consulted with physicists regarding materials. A 3D head position tracking device – the MCP (Fig. 1) was designed and tested by robotics engineers in a limited user study. The pillow is a biologically-inspired sensing device based upon the deformation of the epidermal layers of the human skin. Deformation of MCP-head interaction is measured optically by tracking the movement of internal artificial papillae pins on the inside of the pillow skin(Fig.1). These papillae pins create an image with a matrix of dots captured by a single camera inside the pillow. The head position image on the pillow has been matched with an absolute head position captured by an optical infrared system (Polararis NDI,™) with a tracking tool attached to the person's mouth. The aim of the study was to validate accuracy of the MCP by measuring its resolution (smallest detectable input) and repeatability (the maximum deviation of output for the same input) (Fig. 2).

Results

Five basic movements of the head were detected 1. two translations across the MCP – laterally (Tx, x-axis) longitudinally (Ty, y axis) and one translation n vertical to the pillow (Tz, z axis) and 2. two rotations of the head: roll (α) and pitch (β). A graphic user interface was created in Matlab™ to view and analyse the two sets of data – Polaris ™(Tx, Ty, Tz, α, β) and MCP data. A minimum detectable deformation of the MCP in translation is 1mm, and in rotation is 0.3° (α) and 0.6° (β). The repeatability test showed a maximum of one pixel output deviation for the same position.

Conclusion

The prototype MCP has been patented (1609040.9) and proof of concept has shown potential for consideration in clinical practice. The sensing resolution of the MCP can be improved by a larger number of dots per area or adaptations to the software algorithm. There is a small ambiguity between lateral translation and yaw rotations that can be resolved by an initial MCP calibration. The current challenge and future work is to develop a clinical system that will cause limited radiation attenuation, preserve some skin sparing, and is non-ferrous when considering magnetic resonance imaging. The preliminary prototype data calls for further investigations in the laboratory, including how to reduce jaw and cranium movement prior to being investigated in clinical practice.

OC-0077 Comparison of setup accuracy, intrafractionmovement and comfort for two stereotactic masks

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Purpose or Objective

Intracranial stereotactic radiosurgery (SRS) requires high precision for setup and during treatment. On Brainlab Novalis system, noninvasive repositioning with dedicated proprietary thermoplastic mask is as accurate as with the invasive ring. Macromedics developed a new full head mask dedicated to SRS, fully compatible with the Brainlab couch and localization system, named the Double Shell Positioning System (DSPS) with documented submillimetric and subdegree intrafraction accuracy. The aim is to prospectively compare both fixation systems in a randomized trial for setup and intrafraction accuracy, as well as patient reported comfort.

Material and Methods

Study was approved by the Ethics Committee of CHU-UCL-Namur. All patients approved written informed consent. Sixty patients with various pathologies (metastases, vestibular schwannoma, meningioma or pituitary adenoma) had to be recruited. Randomization between Brainlab and DSPS masks was stratified according to disease and fractionation (one *vs* multiple fractions). For each treatment session, initial setup accuracy was measured and corrected with Brainlab exactrac system and 6 degrees of freedom (6DoF) values (tx, ty, tz, rx, ry, rz) were recorded in mm or degree and resultant vectors for translations were calculated. The same was made at the end of the session (intrafraction movement). Patient reported comfort with a Visual Analog Scale (VAS) at the end of confection time and for treatment (for fractionated treatments average value of all scores was considered). VAS went from 0 (most uncomfortable) to 10 (very comfortable). Comparisons for accuracy and comfort were made with mixed model linear regression (R 3.0.1, package *nlme*). Regarding accuracy, the variable was the mean movement (resultant vector) for each patient.

Results

We report the results for 58 patients, two patients are not treated yet. Among the 28 patients of the DSPS group, seven received a fractionated treatment (either 3 or 28 fractions). In the Brainlab group, it was the case for six of the 30 patients. Setup accuracy and intrafraction motion are recorded in Table 1. Initial setup accuracy was significantly better with the DSPS mask ($P < 0.01$), particularly in the y direction (longitudinal) and around the x rotation (head tilt) where it showed less variability. There was no significant difference for intrafraction motion ($P = 0.88$), both masks showing submillimiter and subdegree accuracy on average. During confection, both masks were rated as comfortable (average VAS scores 8.7 and 8.4 for DSPS and Brainlab, $P = 0.53$). For treatment, DSPS was scored as more comfortable than Brainlab (average VAS scores 7.2 and 6.0, $P = 0.04$).

Table 1: setup positioning and intra fraction accuracy for DSPS and Brainlab masks. Mean translation error (x, y and z directions) in mm, mean resultant vector in mm +/- SD and mean rotation error (around x, y and z rotation axes) in °.

TIME	MASK	TRANSLATIONS (mm)			VECTOR (mm ± SD)	ROTATIONS (°)		
		x	y	z		x	y	z
positioning	DSPS	-1.1	0.7	-0.6	2.5 ± 1.1	-0.3	0.9	0.8
	BRAINLAB	-1.8	2.3	-0.4	3.6 ± 1.8	-0.7	0.3	0.8
intrafraction	DSPS	-0.1	0.2	0.1	0.5 ± 0.2	0.0	-0.1	0.0
	BRAINLAB	-0.2	0.1	0.1	0.5 ± 0.3	0.0	0.0	-0.1

Conclusion

We could demonstrate that DSPS and Brainlab dedicated masks are both viable alternatives to invasive head frame for SRS, showing submillimeter and subdegree intrafraction motion. Initial setup accuracy was significantly better with DSPS, maybe due to the higher comfort reported by the patients.

Symposium with Proffered Papers: Novel approaches in gut matters

SP-0078 Best of both worlds: can novel pathways be targeted for reduced gut toxicity but improved tumour response?

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Radiotherapy is an effective treatment strategy for cancer, but a significant proportion of patients still