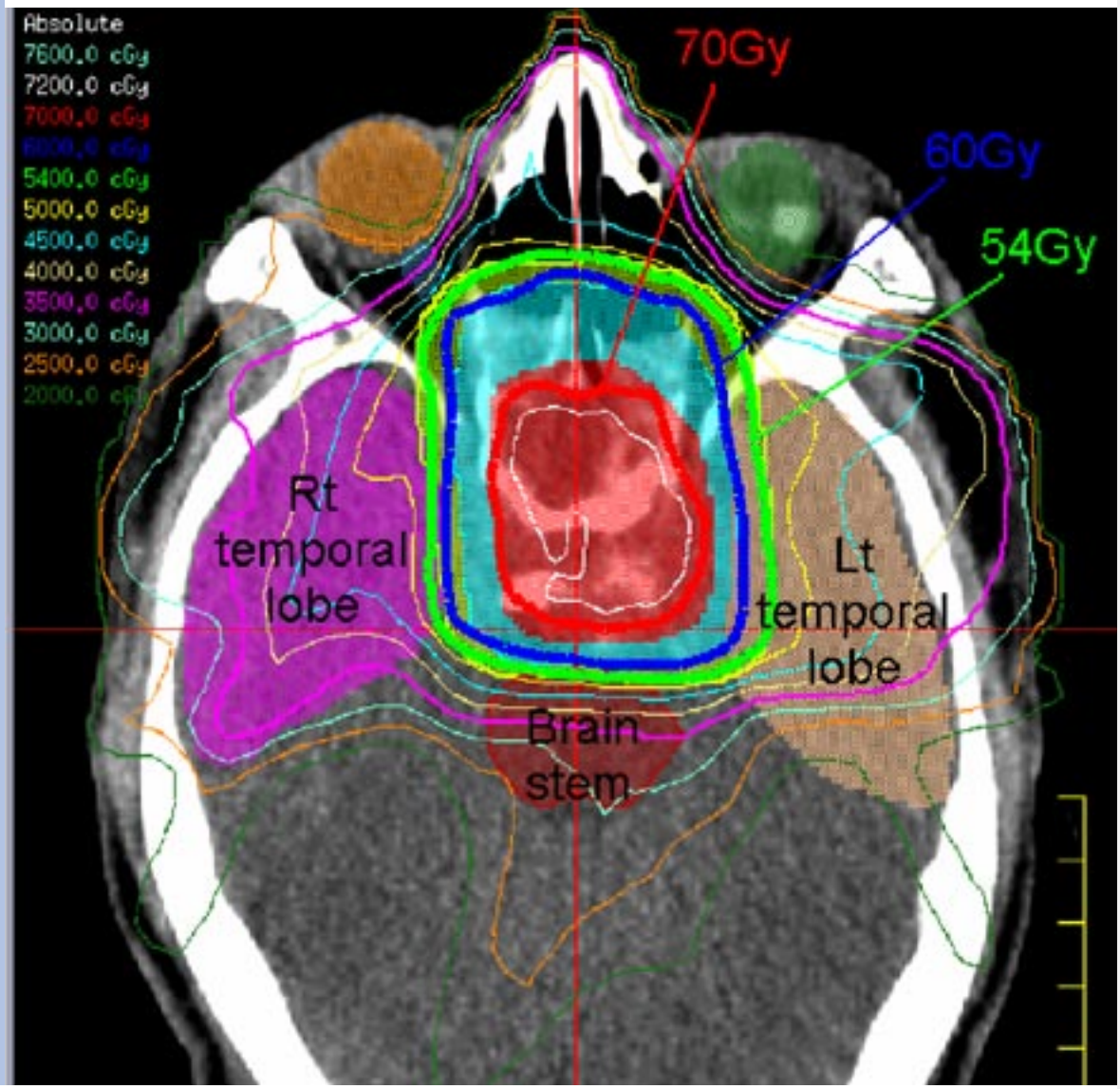
Case Study




# Application of 3D Elekta VolumeView™ image guided radiation therapy (IGRT) in treatment of locally advanced nasopharyngeal carcinoma

| | |
|---|---|
| **Institution:** | Tuen Mun Hospital, Hong Kong |
| **Patient:** | Male, 34 years |
| **Diagnosis:** | Nasopharynx carcinoma T4 N2 M0 |
| **Plan:** | 12-beam IMRT |
| **Image guidance:** | Elekta VolumeView™ on-line protocol |
| **Treatment:** | 70Gy, 60Gy and 54Gy in 33 fractions to gross primary tumor/gross nodal volume, planned target volume with margins and elective nodal region respectively |

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# Application of 3D Elekta VolumeView™ image guided radiation therapy (IGRT) in treatment of locally advanced nasopharyngeal carcinoma

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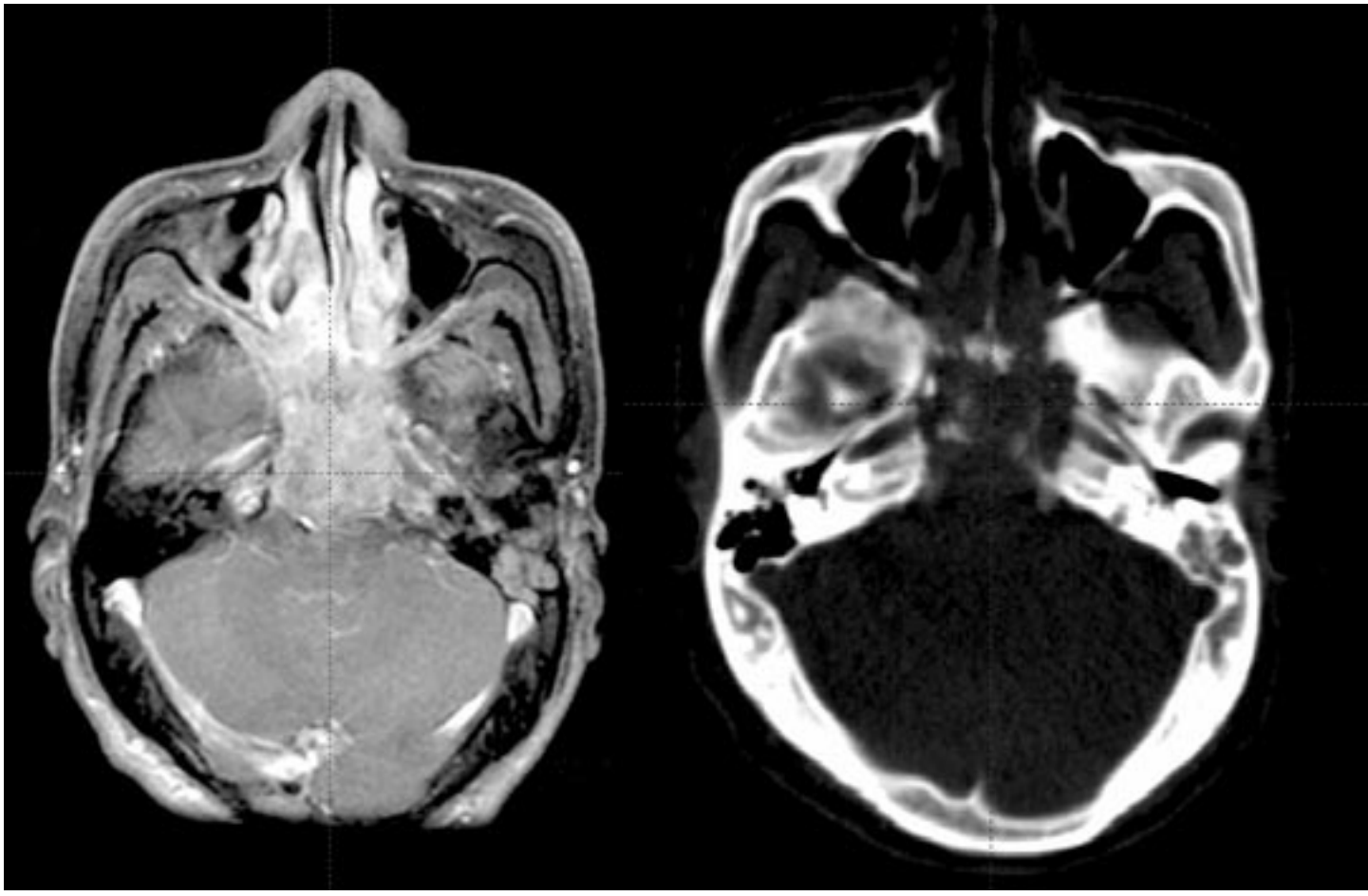


*Figure 1:*
*left) MRI showing massive tumor with extensive involvement*
*right) CT scan showing skull base destruction*

## Patient history

A 34-year-old man was diagnosed to have a stage IVA ($T_4$ $N_2$ $M_0$) NPC (nasopharyngeal carcinoma). Medical imaging showed a large tumor mass in the nasopharyngeal region with extensive involvement of neighboring structures including base of skull, sphenoid sinus, ethmoid sinuses and pituitary fossa. Multiple enlarged lymph nodes in both cervical regions were also reported.

## Planned treatment

Three cycles of q3 week adjuvant chemotherapy (Cisplatin and 5FU) were given prior to concurrent chemo-irradiation with another three cycles of q3 week Cisplatin. A twelve beam IMRT plan was generated for treatment on Elekta Synergy® (see figure 2). Two isocenters were used because of the long treatment volume. SMART (simultaneous modulated accelerated radiation therapy) boost was employed to improve tumor control with reduced overall treatment time. Total doses of 70Gy, 60Gy and 54Gy were respectively prescribed to gross primary tumor/gross nodal region, planned target volume with margins, and elective nodal region in 33 daily fractions. Geometric accuracy is particularly important because of the close proximity of critical structures (especially brain stem and temporal lobes) to the high dose targets.

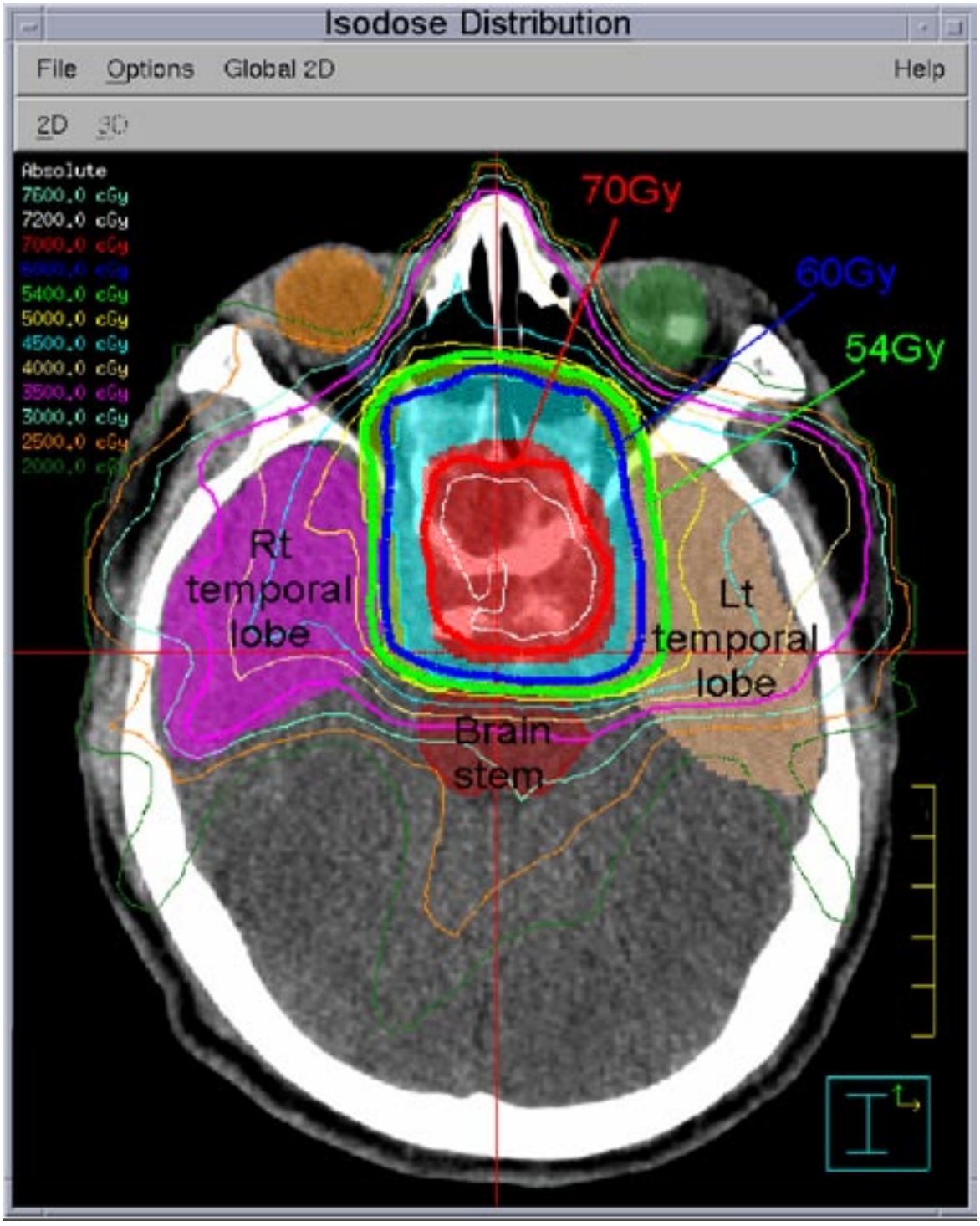



*Figure 2: Transverse section showing dose distribution*

## Treatment using image guidance technique

Isocenters were preliminarily verified through simulation and Elekta iViewGT™ planar portals prior to the first treatment. Elekta VolumeView™ cone beam CT-based IGRT using automatic grey scale matching algorithm (see figure 3) was performed in 18 out of the total 33 fractions on alternate days (about twice a week evenly distributed over the whole treatment course). Displacements of both isocenters and the patient's body weight were recorded accordingly. A total of seven on-line corrections were performed to correct linear displacements exceeding our protocol tolerance level of 2mm.

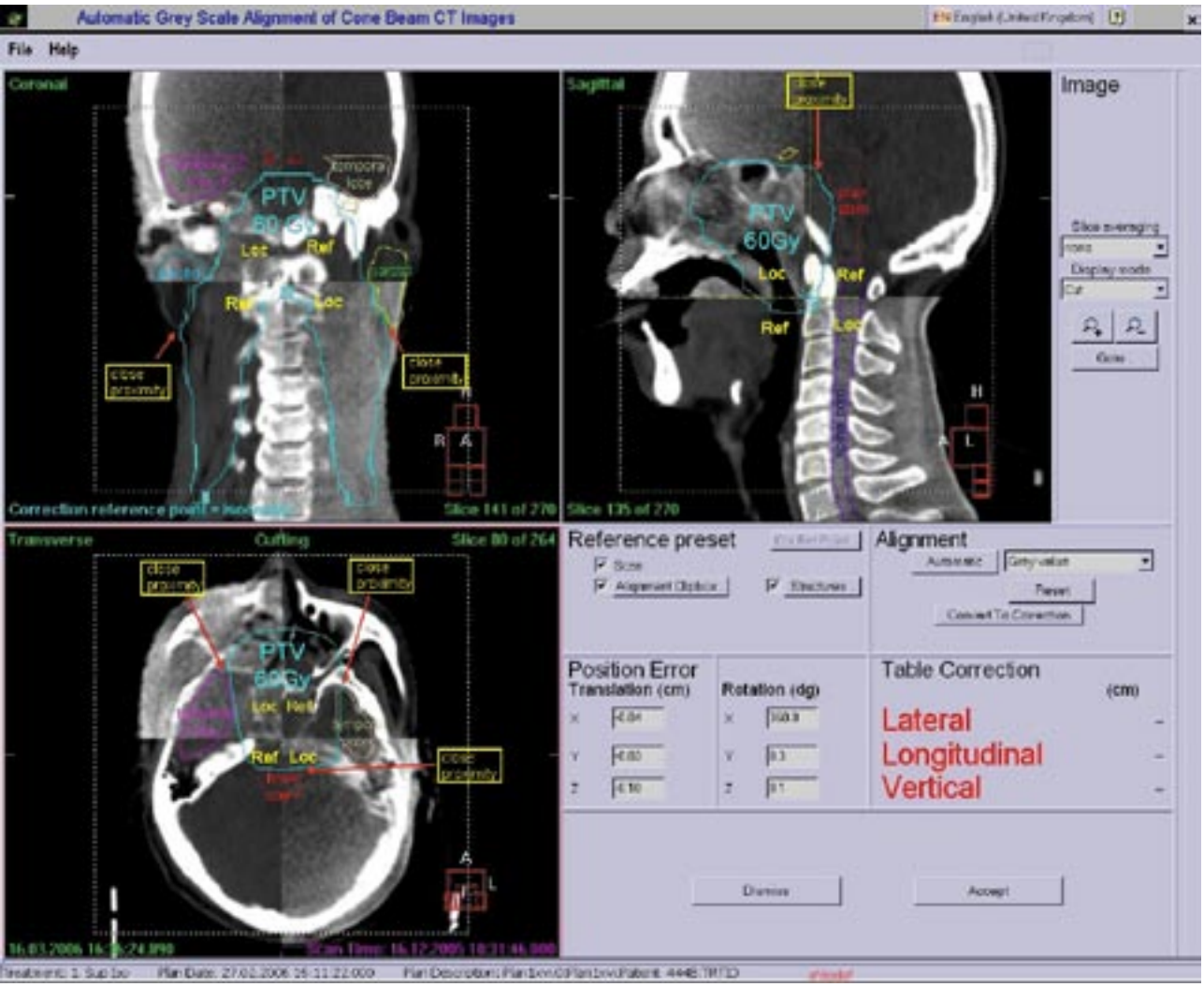


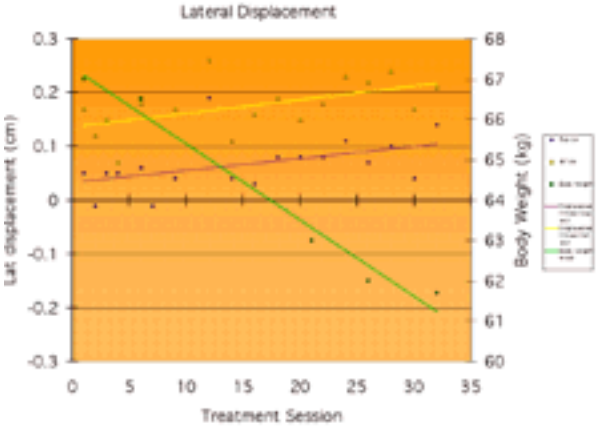

*Figure 3: Automatic grey scale alignment of cone beam CT images*

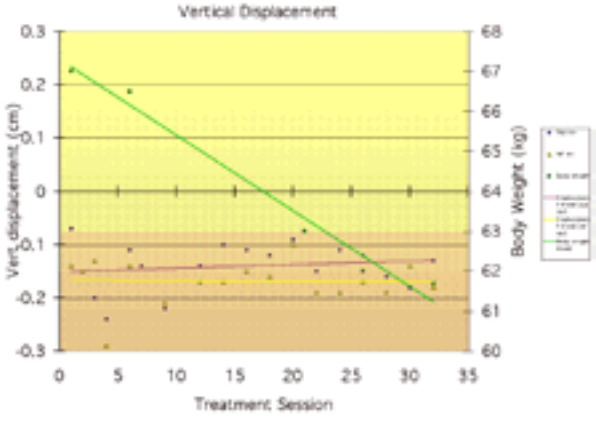
**Treatment time = ~40 minutes (two isocentre technique):**

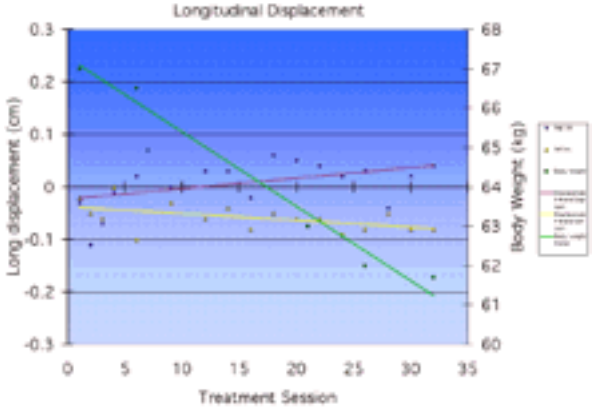
| | |
|---|---|
| 7 mins. | patient set-up |
| 1.5 mins. | acquisition |
| 1 min. | image registration |
| 1.5 mins. | on-line correction (and couch adjustment if needed) |
| 25 mins | IMRT treatment delivery |

## Outcome

| | Average displacement (cm) | | | Standard deviation (cm) | | |
|---|---|---|---|---|---|---|
| | lat | long | vert | lat | long | vert |
| Superior iso. | 0.07 | 0.01 | –0.14 | 0.05 | 0.05 | 0.05 |
| Inferior iso. | 0.18 | –0.06 | –0.17 | 0.05 | 0.03 | 0.04 |




Measurement of linear displacements showed that there was a high level of consistency of set-up across the whole treatment course. The highest accuracy was found in the sup-inf aspect (longitudinal displacement) and perhaps worst in the ant-post direction (vertical displacement) but all with a narrow range of variability (SD < 0.05cm). In general, larger displacements were recorded for the inferior isocenter (inf iso) than for the superior isocenter (sup iso) in all directions. The patient had a significant loss of weight of 5.3Kg over the treatment course.

With simple linear projection, it is estimated that 13 out of the 33 treatments (~40%) would have linear displacements exceeding our tolerance of 2mm in any one direction and needing on-line correction. Since we have already corrected seven of them on line, it means that 27 fractions or 82% of the entire course of this case were treated accurately within 2mm tolerance level.

## Conclusion

This case study has shown that our current immobilization system for head-and-neck treatments is highly effective. Perhaps future improvement should particularly be focused onto the cervical region. The result also revealed that there were systematic errors of less than 1mm (right-left), 0.5mm (sup-inf) and 1.5mm (ant-post) for the superior isocenter and less than 2mm (right-left), 1mm (sup-inf) and 2mm (ant-post) for the inferior isocenter. A strategy to correct these systematic errors could further improve the overall treatment accuracy.

Double isocenter technique should be replaced by single isocenter treatment to shorten treatment time and to eliminate the need for border matching.

*(continued on back page)*

Elekta VolumeView™ has enabled an even more precise treatment by its 3D volumetric verification and facilitates the practice of on-line correction if deviation is greater than a preset tolerance level. Vital structures like brain stem and temporal lobes, which are particularly close to the high dose regions in locally advanced disease, can be more confidently protected with an additional 10 minutes for each Elekta VolumeView™ session. Moreover, computer-guided couch correction by the XVI software eliminates potential errors in the interpretation of directions of any corrective moves.

Despite a net weight loss of 5.3kg recorded in this case over the treatment course, displacements were found to be minimal and insignificant although different trends of displacement were noted in different dimensions. It is worthwhile to conduct further study to assess the full impact of weight loss to the overall treatment reproducibility.



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