

IMRT with micro-MLC for Nasopharyngeal Carcinoma

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Background

- Over the last decade, major progress has been made in radiation therapy of head and neck carcinoma. One of the most improvements has led to the use of intensity modulated radiotherapy (IMRT), and aimed at better tumor dose coverage and/or reduction of radiation-induced side effects. The volume of original nasopharyngeal carcinoma is usually not large, but the total target volume is increased times when embracing the neck lymph node. Therefore, we designed multi-isocentric strategies for primary nasopharyngeal carcinoma patients.

Brainlab micro-MLC

- leaf span – 10.0cm
- leaf junction from project X1-jaw edge -2mm
- Field size- 10.0cm X 9.8cm
- Maximum leaf traveling speed - 2cm/s

Equation of geometric penumbra width(20%-80%)

$$P_{g(80\%-20\%)}(lp) = \frac{0.6 \cdot s \left\{ F - c - R \cdot \sin \left[\arctan \left(\frac{lp}{F} \right) \right] \right\}}{c + R \cdot \sin \left[\arctan \left(\frac{lp}{F} \right) \right]}$$

R Tonolnaki and U A van der Heide
Phys. Med. Biol. 53 (2008) 3007-3021

Parameter

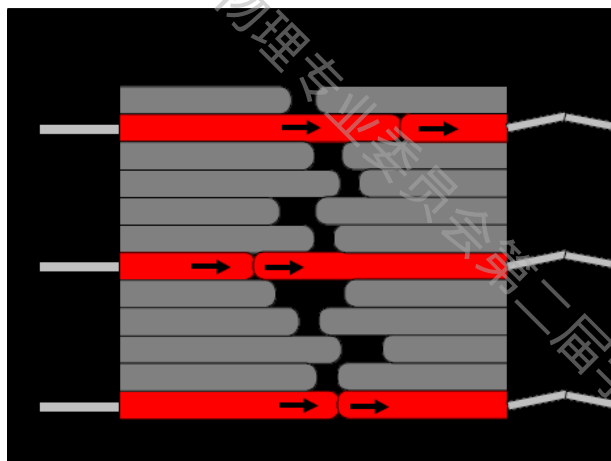
- Leaf width
- Leaf thickness (lt)
- Leaf position/length (lp)
- Source-leaf distance (c)
- Source-isocenter distance (F)
- Field size (Fs)
- Source size (s)
- Radius of leaf tips (R)

Leaf width

- Not influence penumbra directly
- Limit the maximum field size
- Limit the possibility of Inter-digitations
- Limit the spatial resolution

Advantage of micro-MLC

- Conformity
- Uniformity
- Accurate leaf traveling
- Small leaf gap
- OAR sparing

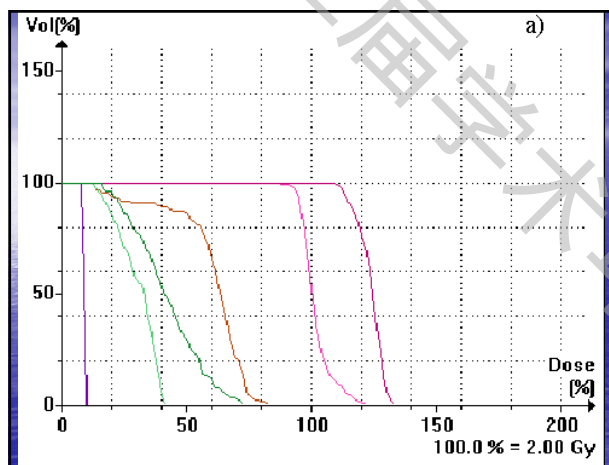
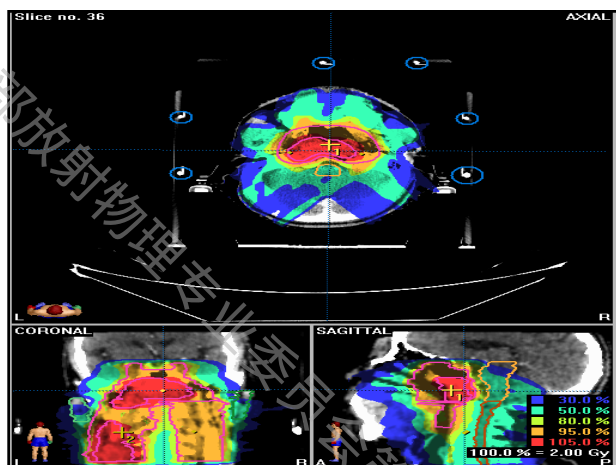


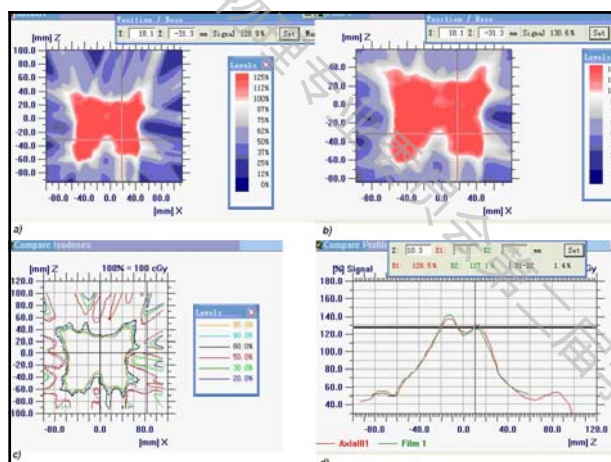
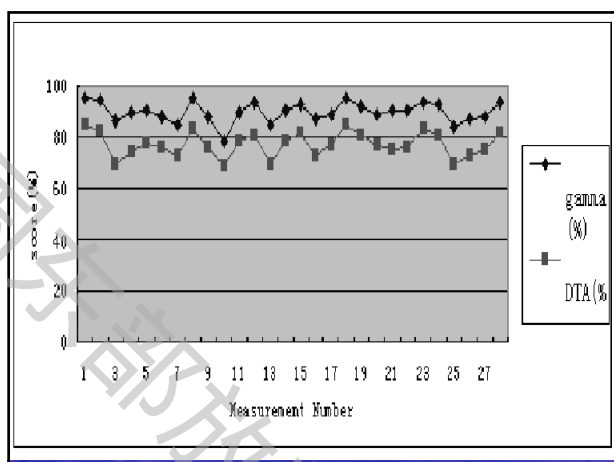
Disadvantage of micro-MLC

- Limited field size
- Normal tissue risk for large volume tumor
- Treatment time for large volume tumor

Use of multi-isocenters IMRT with micro-MLC

- Due to the physical characteristic restrictions of Multi-leaf collimator (MLC), IMRT treatment on large target volumes by using methods has been long studied. Our experience and study on multi-isocentric IMRT treatment indicated that the multiple isocenters IMRT was satisfactory for the BrainLAB system to treat nasopharyngeal carcinoma patients with large PTV volume.





GTV/CTV/PTV/OAR	Triple isocenters IMRT (small MLC)	Single isocenter IMRT with separate lower neck field	Single isocenter IMRT with extended SSD (large MLC)	Single isocenter IMRT
Mean dose (Gy) to GTV	68.19±0.93	67.69±0.93	66.54±0.76	68.42±0.89
Mean dose (Gy) to CTV	58.14±2.19	57.34±1.89	56.84±2.32	58.60±1.81
V95% of CTV (%)	96.14±1.19	95.14±2.19	93.14±2.66	95.84±1.43
Conformal index of PTV	2.23±0.25	2.48±0.27	2.82±0.47	2.43±0.27
homogeneity index of PTV	0.996±0.003	0.996±0.003	0.994±0.004	0.998±0.003
Mean max dose (Gy) of brainstem	42.00±1.98	40.27±2.16	41.37±2.28	40.67±2.28
Mean max dose (Gy) of cord	39.93±1.03	39.29±1.47	40.59±1.69	38.98±1.36
Mean max dose (Gy) of Ipsilateral parotid	36.77±5.57	34.37±4.88	39.47±8.52	35.37±5.98
Mean max dose (Gy) of Contralateral parotid	26.87±1.17	33.92±2.58	35.24±6.68	33.99±2.85

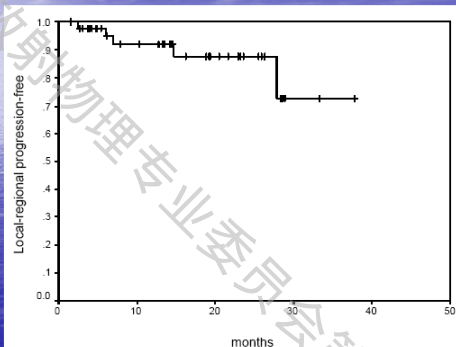
Clinical Effect

With a median 19 months of follow-up ranged from 2 to 38 months, Of 45 patients, six patients had developed local-regional relapse and one patient had metastasis to lungs.

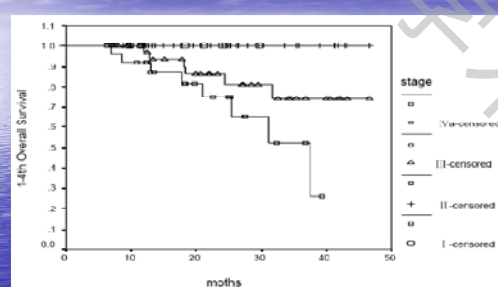
The 3-year overall survival was 91.7% (95%CI: 76.0-100%). The 3-year local relapse free survival and regional relapse free survival were 97.1% (95%CI: 91.4-100%) and 77.7% (95%CI: 52.5-100%), respectively.

In contrast, the 3-year overall survival of 110 patients treated with IMRT was 78.3% (95%CI: 66.7-90.0%). The 3-year local relapse free survival and regional relapse free survival were 97.9% (95%CI: 95.1-100%) and 78.5% (95%CI: 65.2-91.8%), respectively.

3-year local-regional metastasis free survival (45 patients with GTV boost)



Stage stratified 3-year survival (110 patients with IMRT treatment)



Conclusion

- Our experience and study indicated that the multiple isocenters IMRT with micro-MLC was satisfactory for the BrainLAB IMRT system to treat nasopharyngeal carcinoma patients

