Plan Evaluation in Carcinoma Nasopharynx- Understanding the Targets

Dr Trinanjan Basu
Consultant Radiation Oncologist
HCG Cancer Centre
Mumbai
Disclaimer

• This is an overview of the plan evaluation in carcinoma Nasopharynx.

• Details to be discussed on actual webinar day.
Points to be discussed

• Essential background knowledge.
• Brief overview of Targets and OAR for carcinoma Nasopharynx-IMRT.
• Brief on plan evolution – 2D to 3D to IMRT.
• IMRT plan evaluation- Target volume, OAR.
• IMRT technical details.
• Future directions.
Essential background evidence

CT-based delineation of lymph node levels and related CTVs in the node-negative neck: DAHANCA, EORTC, GORTEC, NCIC, RTOG consensus guidelines

Proposal for the delineation of the nodal CTV in the node-positive and the post-operative neck

Vincent Grégoire, Avraham Eisbruch, Marc Hamoir, Peter Levendag

Original article
Delineation of the neck node levels for head and neck tumors: A 2013 update. DAHANCA, EORTC, HKNPCSG, NCIC CTG, NCRI, RTOG, TROG consensus guidelines

Vincent Grégoire, Kian Ang, Wilfried Budach, Cai Grau, Marc Hamoir, Johannes A. Langendijk, Anne Lee, Quynh-Thu Le, Philippe Maingon, Chris Nutting, Brian O'Sullivan, Sandro V. Porceddu, Benoit Lengele

Selection of lymph node target volumes for definitive head and neck radiation therapy: a 2019 Update

Julian Bian, Michel Lapeyre, Idriss Troussier, Wilfried Budach, Jordi Giralt, Cai Grau, Joanna Kazmierska, Johannes A. Langendijk, Mahmut Ozsahin, Brian O'Sullivan, Jean Bourhis, Vincent Grégoire
Original article

International guideline for the delineation of the clinical target volumes (CTV) for nasopharyngeal carcinoma

Accepted Manuscript

Delineation of neck clinical target volume specific to nasopharyngeal carcinoma based on lymph node distribution and the international consensus guidelines

Li Lin, M.D., Yao Lu, Ph.D., Xiao-Ju Wang, M.D., Hui Chen, B.S., Sha Yu, Ph.D., Jioming Tian, M.S., Guan-Qun Zhou, M.D., Lu-Lu Zhang, M.D., Zhen-Yu Qi, Ph.D., Jiang Hu, M.S., Jun Ma, M.D., Ying Sun, Ph.D.

PMI: S0360-3016(17)34083-X
DOI: 10.1016/j.ijrobp.2017.11.004
Reference: ROB 24588
Selection of lymph node target volumes for definitive head and neck radiation therapy: a 2019 Update

Julian Biau, Michel Lapeyre, Idriss Troussier, Wilfried Budach, Jordi Giralt, Cai Grau, Joanna Kazmierska, Johannes A. Langendijk, Mahmut Ozsahin, Brian O’Sullivan, Jean Bourhis, Vincent Grégoire

Table 5
Selection of low risk nodal target volumes for nasopharyngeal cancers (according to recent international guidelines [68]).

<table>
<thead>
<tr>
<th>Nodal Category (AJCC/UICC 8th ed.)</th>
<th>Levels to be included in the CTV-N-LR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ipsilateral Neck</td>
</tr>
<tr>
<td></td>
<td>Contralateral Neck</td>
</tr>
<tr>
<td>N0</td>
<td>II-V, Vlla, Vllb&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>N1, N2</td>
<td>II-V, Vlla, Vllb&lt;sup&gt;1,2,3,4&lt;/sup&gt;</td>
</tr>
<tr>
<td>N3</td>
<td>Ib-IVb, Va,b,c, Vlla, Vllb</td>
</tr>
</tbody>
</table>
OAR in Npx

- Spinal cord / BS/ optic apparatus.
- Mandible + TMJ.
- Parotids.
- DARS- pharyngeal constr, larynx. Oesophagus, oral cavity.
- Cochlea.
- Temporal lobes.
- Brachial plexus.
- Pituitary.
Important points

- Serial Vs parallel organs.
- Delineation guideline as per diff OAR.
- Consider adding PRV to serial structures.
- Delicate balance between PTV vs OAR.
- Additional help from secondary images like MRI – especially in optic chiasm, brainstem, brachial plexus.
- Keep in mind acute and late toxicity profile.
- QOL scales.
Radiotherapy of NPC

Recommendation for a contouring method and atlas of organs at risk in nasopharyngeal carcinoma patients receiving intensity-modulated radiotherapy

Ying Sun a,1, Xiao-Li Yu a,1, Wei Luo a,1, Anne W.M. Lee b,1, Joseph Tien Seng Woe c,1, Nancy Lee d,1, Guan-Qun Zhou e, Ling-Long Tang f, Chang-Juan Tao f, Rui Guo g, Yan-Ping Mao g, Rong Zhang e, Ying Guo f, Jun Ma a,1

Head and neck guidelines

CT-based delineation of organs at risk in the head and neck region: DAHANCA, EORTC, GORTEC, HKNPCSG, NCIC CTG, NCRI, NRG Oncology and TROG consensus guidelines

---

**Chapter 1**

**Overview of Important "Organs at Risk" (OAR) in Modern Radiotherapy for Head and Neck Cancer (HNC)**

Trinanjan Basu and Nithin Bhaskar

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.80606
Spinal cord & Brainstem

SC:
2 ways to delineate: spinal cord itself Vs vertebral canal.
Recommend to add PRV 3-5 mm when drawing cord itself.
Cranial: Disappearance of cerebellum.
Caudal: 2 cm below the last PTV slice.

BS:
Brain stem comprises of midbrain, pons and medulla.
Cranial: level of inferior section of lateral ventricle. The organ is better visualized better in MRI.
Caudal: till the level of the tip of dense of C2 vertebra or foramen magnum.
Add PRV 3-5 mm.
Optic apparatus

- Entire eyeball, optic nerves and optic chiasm.
- Craniocaudally: optic nerve is seen below the superior rectus.
- The nerve is 2-5 mm thick and is delineated from the posterior margin of retina and continued along its course posteriorly till it merges with the optic chiasm after passing through the superior orbital fissure.
- Optic chiasm: average it measures 8 x 14 mm (APxTrans) and is about 2–5 mm thickness in the super-inferior dimension.
- MRI helps in delineation: T1 bright signal.
- Combine all these and form PRV optics adding 2-3 mm.
Overlap 1 slice between SC and BS: Monroe et.al. – to avoid dose dumping.
Inferior most section of lateral ventricle
Teaching Case

**A radiation oncologist’s guide to contour the parotid gland**

Laura Freedman MD, Charif Sidani MD

---

**Table:** Anatomic boundaries of the parotid gland

<table>
<thead>
<tr>
<th>Organ at risk</th>
<th>Remarks</th>
<th>Anatomic boundaries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cranial</td>
</tr>
<tr>
<td>Parotid gland</td>
<td>Include carotid artery, retromandibular vein and extracranial facial nerve.</td>
<td>External auditory canal, mastoid process</td>
</tr>
</tbody>
</table>
Parotid-sparing intensity modulated versus conventional radiotherapy in head and neck cancer (PARSPORT): a phase 3 multicentre randomised controlled trial

Christopher M Nutting, James P Morén, Kevin J Harrington, Teresa Guerrero Urbano, Shreerang A Bhide, Catharine Clark, Elizabeth A Miles, Aisha B Miah, Kate Newbold, MaryAnne Tiong, Fauzi Adab, Sarah J Jeffries, Christopher Scrase, Beng K Yap, Roger P A’Hem, Mark A Sydenham, Marie Emerson, Emma Hall, on behalf of the PARSPORT trial management group
# DARS – Swallowing structures

<table>
<thead>
<tr>
<th>Organ at risk</th>
<th>Anatomic boundaries</th>
<th>Anterior</th>
<th>Posterior</th>
<th>Lateral</th>
<th>Medial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior PCM</td>
<td>Inferior tip of pterygoid hamulus</td>
<td>Pterygoid hamulus, BOT, pharyngeal lumen</td>
<td>Prevertebral muscles</td>
<td>Medial pterygoid muscles</td>
<td>Pharyngeal lumen</td>
</tr>
<tr>
<td>Middle PCM</td>
<td>Superior edge of C3</td>
<td>BOT, hyoid</td>
<td>Prevertebral muscles</td>
<td>Hyoid—greater horn</td>
<td>Pharyngeal lumen</td>
</tr>
<tr>
<td>Inferior PCM</td>
<td>First slice inferior to inferior edge of hyoid</td>
<td>Soft tissue of supraglottis/glottis</td>
<td>Prevertebral muscles</td>
<td>Superior horn of thyroid cartilage</td>
<td>Thyroid gland</td>
</tr>
<tr>
<td>Cricopharyngeal muscle</td>
<td>First slice inferior to arytenoid cartilage</td>
<td>Posterior edge of cricoid</td>
<td>Prevertebral muscles</td>
<td>Thyroid gland/cartilage, fatty tissue</td>
<td></td>
</tr>
<tr>
<td>EIM</td>
<td>First slice inferior to cricoid</td>
<td>Tracheal lumen</td>
<td>Prevertebral muscles</td>
<td>Thyroid gland, fatty tissue</td>
<td></td>
</tr>
<tr>
<td>Cervical esophagus</td>
<td>1 cm inferior to the cricoid</td>
<td>Sternal notch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOT</td>
<td>Inferior edge of C1</td>
<td>Posterior 1/3 from mandibular bone to pharyngeal lumen</td>
<td>Pharyngeal lumen</td>
<td>Width of the lumen of pharynx</td>
<td></td>
</tr>
<tr>
<td>Supraglottic larynx</td>
<td>Tip of epiglottis</td>
<td>Hyoid, thyroid cartilage, preepiglottic space</td>
<td>Pharyngeal lumen, inferior PCM</td>
<td>Thyroid cartilage</td>
<td>Pharyngeal lumen (lumen to be excluded)</td>
</tr>
<tr>
<td>Giotic larynx</td>
<td>Superior edge of arytenoid cartilage</td>
<td>Thyroid cartilage</td>
<td>Inferior PCM, pharyngeal lumen/ocradoid</td>
<td>Thyroid cartilage</td>
<td>Pharyngeal lumen (lumen to be excluded)</td>
</tr>
</tbody>
</table>
Accepted Manuscript

A Radiation Oncologist’s Guide to Contouring the Larynx

Laura Freedman MD

PII: S1879-8500(15)00375-6
DOI: doi: 10.1016/j.prro.2015.10.007
Reference: PRRO 546
**Most Superior Larynx Contour:**
On the first image where you do not see the hyoid bone as you go inferiorly.

**Most Inferior Larynx Contour:**
The last image where you see the cricoid cartilage as a complete ring. The larynx contour is the outer surface of the cricoid cartilage.

The boundary of the larynx contour is the inner edge of the thyroid cartilage anteriorly and the posterior edge of the cricoid cartilage posteriorly.
Sparing and larynx and oesophageal inlet: relation to late dysphagia and tube dependency
Head and neck chemoradiotherapy

Correlation between dose to the pharyngeal constrictors and patient quality of life and late dysphagia following chemo-IMRT for head and neck cancer

Shreerang A. Bhide \textsuperscript{a,b,\ast}, Sarah Gulliford\textsuperscript{a}, Rehan Kazi\textsuperscript{b}, Iman El-Hairy\textsuperscript{b}, Kate Newbold\textsuperscript{b}, Kevin J. Harrington \textsuperscript{a,b}, Christopher M. Nutting\textsuperscript{b}

\textsuperscript{a} The Institute of Cancer Research, London, UK; \textsuperscript{b} The Royal Marsden NHS Foundation Trust Hospital, London, UK
Deliniation of oral mucosa

A novel method for delineation of oral mucosa for radiotherapy dose–response studies

Jamie A. Dean^a,*, Liam C. Welsh^b, Sarah L. Gulliford^a, Kevin J. Harrington^b, Christopher M. Nutting^b
Cochlea

Small spiral structure of about 0.6cm³ volume located in the petrous part of temporal bone. The small bony cavity can be visualized better with a setting of 120/1500 on CT. The structures of inner ear are visualized more in T2 weighted MRI images. The semicircular canals should not be contoured.
Sensorineural hearing loss after concurrent chemoradiotherapy in nasopharyngeal cancer patients

Limiting dose to cochlea reduces SNHL.
Review Article

Toxicity with radiotherapy for oral cancers and its management: A practical approach

ABSTRACT
Radiotherapy-induced damage in the oral mucosa is the result of the deleterious effects of radiation, not only on the oral mucosa itself but also on the skin, adjacent salivary glands, bone, dentition, and masticatory apparatus. From basic skin care to dental and oral health maintenance, several ointments and lotions, oral and parenteral medications, biological response modifiers, cytoprotective drugs, newer radiation techniques and surgery have been introduced to combat and more importantly to prevent the development of these complications. Radiotherapy-induced oral complications involve complex and dynamic pathobiological processes. This in the immediate- and long-term course lowers the quality of life and predisposes patients to serious clinical disorders. Here, we focus on these oral complications of radiotherapy, highlight preventive and therapeutic developments, and review the current treatment options available for these disorders.

KEY WORDS: Future directions, management, pathobiology, QOL, radiation toxicity
The European School of Oncology

certifies that
Trinanjan Basu
has attended the
3rd ESO-ESTRO Masterclass in Radiation Oncology
Cascais, Portugal – 8/12 November 2014
and is pleased to recognize her/his active and diligent participation

<table>
<thead>
<tr>
<th>Topic in the questionnaire</th>
<th>Most troublesome response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin over the irradiated region</td>
<td>Subcutaneous edema.</td>
</tr>
<tr>
<td>Oral cavity</td>
<td>Dryness of mouth and sticky saliva</td>
</tr>
<tr>
<td>Dental status including jaws.</td>
<td>Dental sensitivity.</td>
</tr>
<tr>
<td>Swallowing capability.</td>
<td>Increased time to swallow.</td>
</tr>
<tr>
<td>Speech.</td>
<td>Change in voice quality.</td>
</tr>
<tr>
<td>Nutrition.</td>
<td>Dietary modifications.</td>
</tr>
<tr>
<td>General physical status.</td>
<td>Generalised fatigue.</td>
</tr>
<tr>
<td>Personal life.</td>
<td>Fear of disease recurrence.</td>
</tr>
<tr>
<td>Professional life.</td>
<td>Regular working.</td>
</tr>
<tr>
<td>Any specific concerns not addressed in the above.</td>
<td>None.</td>
</tr>
</tbody>
</table>
Brief Communication

Head-and-neck cancer patients beyond 2 years of disease control: Preliminary analysis of intensity-modulated radiotherapy late-effect assessment scale

ABSTRACT

Over a decade of intensity-modulated radiotherapy (IMRT) improved the toxicity profile among head-and-neck cancer patients and also improved the quality of life (QOL). Several parameters’ few subjective and few objectives have documented various aspects related to QOL. Patients surviving beyond a certain period will have few unattended concern. A single questionnaire-based evaluation might answer few untouched issues. This brief communication formulated such an indigenous single-institution scale named IMRT late-effect assessment scale (ILEA). The preliminary analysis identified concerns related to dryness of mouth, swallowing habit change, and fear of disease recurrence. Future large-scale prospective evaluation is needed.

KEY WORDS: Head-and-neck cancer, intensity-modulated radiotherapy, quality of life, survival

Trinanjan Basu, Shikha Goyal, Tejinder Kataria, Deepak Gupta
Division of Radiation Oncology, Medanta – The Medicity, Gurgaon, Haryana, India

2D to 3D to IMRT

• The background.
• Drawbacks of 2D/3D.
• Why the need of IMRT in Npx plan?
• Plan evaluation?
• Acceptance criterion.
• ICRU 83 parameters.
Limitation of conventional two dimensional radiation therapy planning in nasopharyngeal carcinoma

Phase III randomised trial
A prospective, randomized study comparing outcomes and toxicities of intensity-modulated radiotherapy vs. conventional two-dimensional radiotherapy for the treatment of nasopharyngeal carcinoma
The impact of dosimetric inadequacy on treatment outcome of nasopharyngeal carcinoma with IMRT

Review

Evolution of treatment for nasopharyngeal cancer – Success and setback in the intensity-modulated radiotherapy era
Clinical Investigation

International Guideline on Dose Prioritization and Acceptance Criteria in Radiation Therapy Planning for Nasopharyngeal Carcinoma

INTRODUCTORY PAPER

QUANTITATIVE ANALYSES OF NORMAL TISSUE EFFECTS IN THE CLINIC (QUANTEC): AN INTRODUCTION TO THE SCIENTIFIC ISSUES

SØREN M. BENTZEN, Ph.D., D.Sc.,* LOUIS S. CONSTINE, M.D.,† JOSEPH O. DEASY, Ph.D.,‡ AVI EISBRUCH, M.D.,§ ANDREW JACKSON, Ph.D.,‖ LAWRENCE B. MARKS, M.D.,¶ RANDALL K. TEN HAKEN, Ph.D.,§ AND ELLEN D. YORKE, Ph.D.,‖
Basic points in IMRT

• Immobilisation.
• Reproducible and accurate set up.
• Image verification.
• Serial Online image matching.
• Check for need of adaptive RT (ART).
• Re-planning.
• *MR guided RT (MgRT).*
Technical guidelines for head and neck cancer IMRT on behalf of the Italian association of radiation oncology - head and neck working group

A review of Image Guided Radiation Therapy in head and neck cancer from 2009–2019 – Best Practice Recommendations for RTTs in the Clinic
Planning concepts from ICRU 83
Important points

• Beam related issues
• DVH analysis issues
• Overlapping volumes
• RVR
• Differential PTV in head neck
• Developing a systematic approach
• Dmax and Dmin…..Change to D98 and D2, D50.
• DVH.
• OAR.
• Homogeneity index, CI, Heterogeneity-hot/cold spot.
CB-CHOP: A simple acronym for evaluating a radiation treatment plan

Mary Dean, MD; Rachel Jimenez, MD; Eric Mellon, MD, PhD; Emma Fields, MD; Raphael Yechieli, MD; Raymond Mak, MD