Conventional planning and treatment delivery for Head-Neck cancers

Pre-planning
- Clinical evaluation and staging
- Treatment intent: radical or palliative
- Choice of treatment: surgery, radiotherapy or chemotherapy

Planning RT treatment
- Description of treatment
- Method of patient immobilization
- Image acquisition of tumor and patient data for planning
- Delineation of volumes (GTV, CTV, PTV)
- Choice of technique and beam modification
- Computation of dose distribution

Treatment delivery
- Dose prescription
- Implementation of treatment
- Verification
- Monitoring treatment
- Recording and reporting of treatment
- Evaluation of outcome
Road map

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Patient position and immobilization: why is it necessary?

- Position must be technically ideal and yet comfortable. Treat patient in one position only: as if you alter position between fields, you risk under or over dosage.

- Think about your treatment strategy BEFORE you tell the technologist to make the immobilization cast (or send for a RTP CT scan!)
  
  - Mouth bite for depressing tongue into field (to save hard palate & minor salivary glands)
  
  - Positioning of head for treatment of cancer maxilla (or placing a wet gauze within the maxillary cavity)
  
  - Extension of neck for early vocal cord tumors
Why head extension for cancer of the maxilla?
Any other reason to immobilize?

- So that there is an assured relationship between external marking and internal anatomy
- If the immobilization device fits loosely such that the patient head can tilt or shift what might be the consequences or solution?
So, if the patient moved within the head cast...

One simple solution is to increase the field size...

But that means radiating more of normal tissues and therefore...

Potentially compromising tolerance, lower doses, lower TCP, more late effects or risking a geographic miss!!
Rephrased in technical jargon in ICRU 62!!!

- Internal margin (IM) is added to account for variations in position and/or shape and size of CTV in relation to anatomic (internal) reference points. IM is due to physiologic process, which are difficult or impossible to control (but may be possible with gating / tracking in real time).

- Set up margins (SM) is added for variations / uncertainties in patient-beam positioning. This can be reduced by more accurate setup and immobilisation of the patient (as well as improved mechanical stability of the machine).
Image acquisition for tumor and patient data

- Localization of the target volume within the patient in relation to external reference marks: done exactly under same conditions as treatment delivery
- External markers should be accurately aligned by laser (before the patient is sent for RTP scans)
- Ensure complete contours and constant FOV on CT machine. Appropriate window. Use of contrast does not perturb dose calculations on the TPS.
**Changing FOVs on CT machines**

Field of view (FOV) is defined as the maximum diameter of the reconstructed image. Its value can be selected by the operator and generally lies in the range between 12 and 50 cm.
When simulating a H&N patients be mindful of

- Incorporating all information (clinical, endoscopy, imaging and pathology)
- Use contrast: barium for oral tongue, solder wire for neck nodes and scar
- Since you often use bone anatomy (as a surrogate for soft tissues) for landmarks, think on you plan:
  - will it encompass my main area of interest (GTV)
  - with a margin for sub-clinical spread of disease (CTV)
  - with a margin for relocation uncertainty and physiologic motion (PTV)
  - and is my choice of field border appropriate for my machine??
  - ALSO: some where in between, factor in tumor shrinkage during RT (including weight loss of patient) which changes separation and loosens the grip of the cast on the head
So let's take one example of field placement.

Node outlined

Nodes + primary outlined

Split ant neck field
Techniques

- Single lateral port (BM with small chance of contra-lateral nodal spread, and to spare opposite salivary gland) Problems are dose gradient through PTV
- Ant + lateral for eg: maxilla
- Two field (parallel pair) or 3-field (with split anterior neck) (depends upon how critical is the need to address level IV LN)
Localization using the simulator: concept of isocentre
What is there to choose between SAD and SAD technique: SAD first
And now SSD...

Which is quicker and less error prone: SSD or SAD?
But some times we still choose SSD: When and why?

- Single fields (say buccal mucosa, low anterior neck field)
- Electron ports (obviously)
- And because the percentage depth dose is better with SSD (of relative importance in caesium machines with short SSD of 50cm)
- If you need to introduce beam modifying devices onto the treatment head: collision avoidance
On the use of wedges...

- Used for treating maxillary tumors or buccal mucosa lesions (with low risk of contralateral metastasis) or boosting dose after a basic course (i.e., 45-50 Gy)
No wedges vs. with wedges for and ant-lat pair
Compensators: why we need them?

Dose gradient throughout the treatment volume is to be kept below 5%.
So how do we make them?
The junction between parallel pair and ant neck

Nodes + primary outlined

Split ant neck field

Midline shield
Various permutations of junctions
(Think where you do and do not need a mid line shield)

Hot match

Cold match

Half beam block for lower field

Half beam block for both fields
How is reproducibility of immobilisation quantified? (i.e. verification)

Compare portal image and reference image = displacement for one session
(combination of systematic and random component)
So how calculated?

- Let's say shift to right is + and shift to left is –
- So for 11 measurements we might get (in mm)
  - Example A: +5, +4, +3, +2, +1, 0, -1, -2, -3, -4, -5
  - Example B: +10, +8, +6, +4, +2, 0, -2, -4, -6, -8, -10
- Q: What is the mean or average shift?
  
  Answer: 0 for both

- Any better way of quantifying discrepancy?
  
  How about standard deviation? 3.3mm vs. 6.6mm

- Another data set: Example C: +9, +8, +7, +6, +5, +4, +3, +2, +1, 0, -1

  Mean = 4, SD 3.3. compare with example A: same SD, different mean, so there is a systematic shift to right in example C, but the random shift is similar.
Systematic ($\Sigma$) and random errors ($\sigma$)

1. Displacement over days
2. Displacement, 1st day
3. Compute SD of random errors
   - Population ($\sigma$) random error
4. Mean displacement
   - Systematic error for patient #1
5. Subtract daily displacements from mean displacement
   - Random errors for patient #1
6. Compute SD of means of different patients
   - Population ($\Sigma$) systematic error
Conclusions

- Clarify in your mind what you wish to achieve
- Immobilization: very crucial. Think about it
- RTP scans can go wrong if you are not careful enough
- Define your GTV, CTV and PTV (even when using the simulator)
- Aim for dose homogeneity. Shield carefully
- Verification is useful to see what you have actually delivered

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