Objectives

Review Selection of Normal Organs
- Salivary Glands
  - Parotid
  - Submandibular
- Brachial Plexus
- Esophagus
- Trachea, Bronchial Tree

Target Audience:
- Physicists
- Dosimetrist
- Radiation Therapists

Outline

Why do we have to Contour?
- Which Organs are Important?
- How do I contour?

3 Important Organ Systems
- Xerostomia: Salivary Glands
  - Parotid
  - Submandibular
  - Brachial Plexus
  - Esophagus
  - Trachea, Bronchial Tree
Outline (cont)

For Each Organ System
- Anatomy
- Literature
- Examples

Why do we have to contour?

- Target delineation
- Organ definition

2D → 3D → IMRT
(your fault)

2D Planning
3DCRT

IMRT

IMRT & Contours

• Inverse Planning
• Objective Cost Function
• Computers are Binary
Why take a contouring course?

• IMRT and 3D = standard practice
• Both techniques require (accurate) contours
• Clinical trials require dose constraints
• Consistency (precision)
  • Who:
    • Intra- vs inter-contourer
    • Intra- vs inter-institutional
  • Why:
    • Good practice
    • Dose constraints
    • Dosimetric repositories

Why take a contouring course?

• No formal training
• Few reproducible guidelines
• Everyone assumes consistent contouring
  • NCIC HN6, RTOG 0920, 0615, 0225
  • Spinal Cord:
    • Intra-observer: avg 0.1 cm, max 0.7 cm
    • Inter-observer: avg 0.2 cm, max 0.9 cm
• Long term sequelae

Geets RO 2005

Which organs are important

- Brain (temporal lobe)
- Globe, retina
- Lens
- Optic nerve, Optic chiasm
- Pharyngeal gland
- Brainstem, Spinal cord
- Ear (TMI)
- Mouth
- Larynx
- Oesophagus
- Neck
- Thyroid
- Veins/Arteries, Great Vessels, Heart
- Trachea, Bronchial Tree
- Lung
- Rib
- Skin

Dysphagia- Pharyngeal Constrictors
Xerostomia - Salivary Glands
Plexopathy - Brachial plexus
Dysphagia – Esophagus
Fistula – Trachea, Bronchial Tree
For Each Organ System

- Anatomy
- Literature
- Examples

(No Time For)
- Targets (CTV, PRV)
- Contour editing (surface cropping, overlapping)
- Autosegmentation
- Imaging modalities
- Intra-treatment changes
- Dose volume constraints

How "I" Contour

- Standard CT technique
  - 2.5mm slices, 2.5mm spacing
  - Matrix size 512 x 512
- IV Contrast
- HU Settings
  - Window 400, Level 50
  - Maximize screen real estate
  - Scrolling
  - Software tools: above/below
  - Tablet/Pen
- Consultation: RO, DI

Xerostomia: Salivary Glands

- Anatomy
- Literature
- Examples
Salivary Glands: Anatomy

- Major Salivary Glands
  1. Parotid
  2. Submandibular
  3. Sublingual
- Secrete saliva
  - Speech, taste, swallowing
  - Digestive enzymes
  - Prevent inflammation and dental caries
- Saliva
  - 2.5 L secreted per day
  - Resting: 0.3 mL/min
    - Parotid = 20%
    - Submandibular = 65%
    - Sublingual, Minor = 15%
  - Stimulated: 1.5–2 mL/min
    - Parotid = 50%

Salivary Glands: Parotid

- paired, 25-30 g, accessory gland: 20%
- potential borders:
  - superior: zygomatic arch
  - inferior: hyoid bone
  - anterior: anterior ramus mandibular arch
  - posterior: mastoid process
  - medial: carotid sheath or masseter muscle
  - lateral: skin
- Structures within Parotid
  - External carotid artery, Retromandibular vein
  - Facial nerve
  - Parotid Duct:
    - 5 cm long, 3 mm wide
    - Crosses masseter, right angle, buccal fat pad/buccinator, runs obliquely forwards, opens @ second upper molar

Salivary Glands: Submandibular

- 10-20 g, size of walnut
- Borders:
  - Superior: medial surface of mandible, lingual N
  - Inferior: soft tissues of neck, hypoglossal N
  - Medial/Anterior: floor of mouth (mylohyoid, hypoglossus mm)
  - Posterior: submandibular LN, carotid sheath
  - Lateral: skin
Salivary Glands: Literature

Van de Water et al, RO, 2009

Parotid Glands: Examples

• superior: zygomatic arch
• inferior: hyoid bone
• anterior: anterior ramus mandibular arch
• posterior: mastoid process
• medial: carotid sheath or masseter muscle
• lateral: skin

Parotid Glands: Examples

- superior: zygomatic arch
- inferior: hyoid bone
- anterior: anterior ramus mandibular arch
- posterior: mastoid process
- medial: carotid sheath or masseter muscle
- lateral: skin
Parotid Glands: Use your tools.

Parotid Glands: Examples
Submandibular Glands

- **Superior:** medial surface of mandible, lingual N
- **Inferior:** soft tissue of neck, hypoglossal N
- **Medial/Anterior:** floor of mouth (mylohyoid, hypoglossus mm)
- **Posterior:** submandibular LN, carotid sheath
- **Lateral:** skin

Submandibular Glands: Examples

Submandibular Glands: Inferior
Salivary Glands: Summary

- Parotid most variable
- Submandibular: inferior is easiest
- Know potential limits
- Scroll
- Sup/Inf tool

Brachial Plexus

Anatomy
- Literature
- Examples

Brachial Plexus: Anatomy

- Cutaneous and muscular innervation "most" of upper limb
- Two exceptions:
  - Trapezius muscle (spinal accessory nerve [CN XI])
  - Area of skin near axilla (intercostobrachial nerve)
- The five roots merge to form three trunks:
  - Super: C5, C6
  - Middle: C7
  - Inferior: C8, T1

Hard To See!
** Note **
- Seven cervical vertebrae (C1-C7)
- Eight cervical nerves (C1-C8)
- C1-C7 emerge above Cx
- C8 emerges below C7
- T1 etc emerge below T1

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Brachial Plexus: Landmarks

- C5, T2 (or T1)

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Brachial Plexus: 5 Roots → 3 Trunks

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Brachial Plexus: Ant/Med Scalenus

Anterior Scalenus:
- aka scalenus anterior, scalenus anticus
- transverse processes of C3-C6 to first rib
- anterior to medial scalenus

Medial Scalenus:
- largest and longest of the three scalene muscles
- posterior tubercles of transverse processes C5-C7 to first rib

Brachial Plexus: Axilla

- Behind Axillary Artery

Brachial Plexus: Landmarks

- C5
- T1 or T2
- Anterior scalenus
- Medial scalenus

Axilla:
- Axillary artery
Brachial Plexus: Examples

Brachial Plexus: Axilla

Brachial Plexus: Comments
- Brachial Plexopathy = rare
- Adjacent GTV/LN
- Not contoured off-study @ BCCA
- Reproducible contours possible
- Axilla – Lung SBRT
- Further research
- Dosimetric Repository
**Esophagus**

- Anatomy
- Literature
- Examples

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**Esophagus - Anatomy**

- Hollow, thin-walled, muscular tube
- Peristalsis, from pharynx to the stomach
- Posterior mediastinum
- Behind trachea
- Average = 25 cm long
- Layers
  - Mucosa: muscularis (smooth muscle)
  - Submucosa: mucous secreting glands
  - Muscularis externa (muscularis propria)
  - Adventitia
Esophagus - Literature
- Kong et al
- Cricoid cartilage to GE Junction
- BCCA: 10 cm above/below PTV
- Avoid oral contrast
- Include all 3 layers
- Mediastinal windows

Esophagus - Example
- Main Problems:
  - Kinks
  - Which tissue = esophagus?

- Key Hints:
  - Start with obvious slice
  - SCROLL
  - Software Tool: Above/Below

Esophagus - Example
- Key Hints:
  - Start with obvious slice
  - BEHIND trachea
  - Posterior mediastinum
  - SCROLL
  - Software Tool: Above/Below
Esophagus – Example

• Key Hints:
  • Start with obvious slice
  • SCROLL
  • Software Tool: Above/Below

Esophagus - Example

• Key Hints:
  • Start with obvious slice
  • SCROLL
  • Software Tool: Above/Below

Esophagus - Summary

• Key Hints:
  • Start with obvious slice
  • BEHIND trachea
  • Posterior mediastinum
  • SCROLL
  • Software Tool: Above/Below
Trachea, Bronchial Tree

- Anatomy
- Literature
- Examples

Trachea, Bronchial Tree - Anatomy

- connects larynx to lungs
- pseudostratified ciliated columnar epithelium
  - goblet cells produce mucus
- inner diameter 2.5 cm
- Length 10-16 cm
- ends at carina
- bifurcates into the primary bronchi
- incomplete cartilaginous rings
- esophagus posterior to trachea

Trachea, Bronchial Tree - Literature

- Kong et al.
- Importance of proximal bronchial tree (PBT)
  - Mucosa, submucosa, cartilage rings, airway channels
  - PBT:
    - Distal 2cm of trachea
    - Carina
    - R/L mainstem bronchi
    - R/L upper lobe bronchi
    - Intermediate bronchus
    - RML bronchus
    - Lingular bronchus
    - R/L lower lobe bronchi
  - BCCA: 10 cm above PTV or 5 cm above carina
Trachea, Bronchial Tree - Example

- Key Hints:
  - Start with obvious slice
  - IN FRONT esophagus
  - SCROLL
  - Software Tool: Above/Below

Find carina
Trachea, Bronchial Tree - Example

Key Hints:
- Start with obvious slice
- IN FRONT of esophagus
- SCROLL
- Software Tool: Above/Below
- Find carina
- Keep going inferiorly
- Ignore phantom "airways"

Trachea, Bronchial Tree - Example

Key Hints:
- Start with obvious slice
- SCROLL
- Software Tool: Above/Below
- Find carina
- Keep going inferiorly
- Ignore phantom "airways"

Trachea, Bronchial Tree - Example

Key Hints:
- Start with obvious slice
- SCROLL
- Software Tool: Above/Below
- Find carina
- Keep going inferiorly
- Ignore phantom "airways"
- Go backwards (phantom "airways")
Trachea, Bronchial Tree - Summary

- Key hints:
  - Start with obvious slice
  - SCROLL
  - Software Tool: Above/Below
  - Keep going inferiorly
  - Ignore phantom "airways"
  - Go backwards (phantom "airways")

H&N / Lung Contouring: Summary

- Parotid Gland: variable in shape
- Submandibular Gland: difficult = superior end
- Brachial Plexus: requires further study
- Esophagus, Trachea, Bronchial Tree:
  - Start with obvious slice
  - SCROLL
  - Software Tool: Above/Below
  - Find carina
  - Keep going inferiorly
  - Ignore phantom "airways"
  - Go backwards (phantom "airways")
- Window level, maximize screen real estate
- Tablet/Pen
- Consultation: RO, DI

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