ICD-10-PCS Presentation
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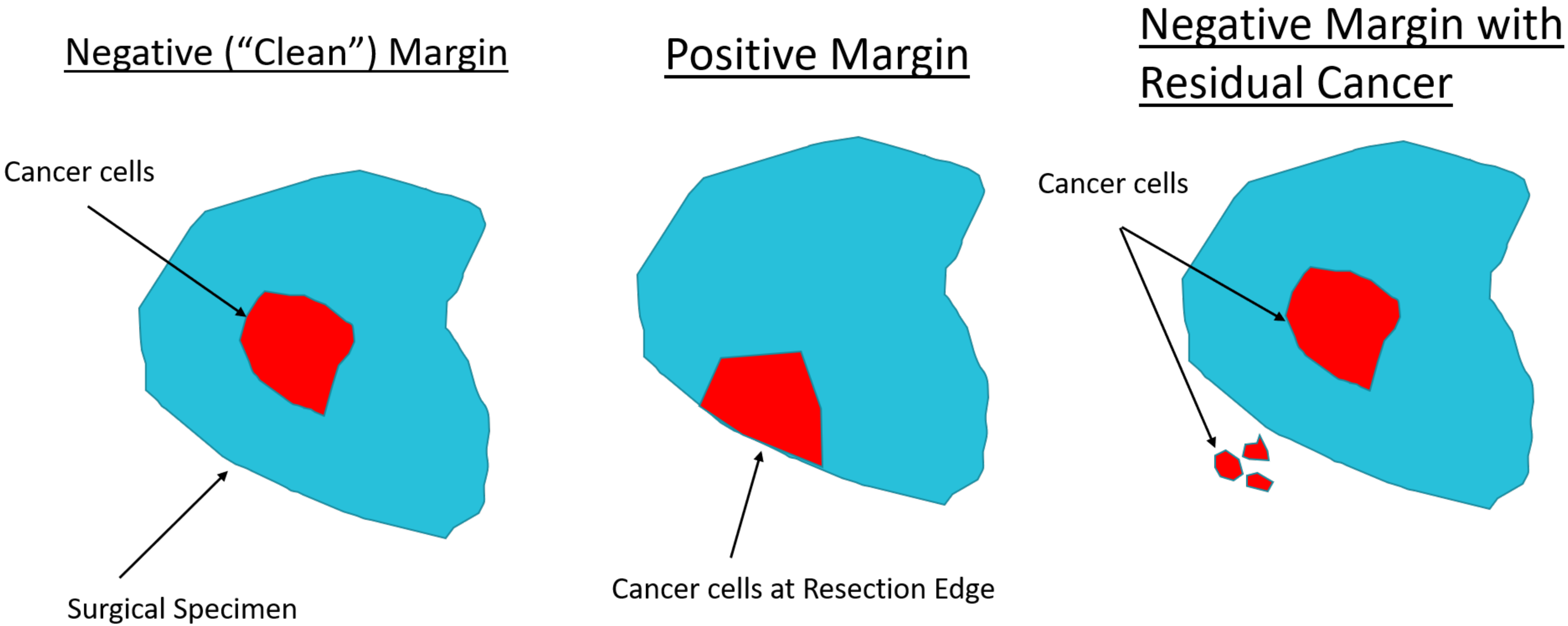
The Role of Surgery in Cancer Treatment



Prevalence of Positive Surgical Margin

Prevalence of Positive Surgical Margin (PSM) for individual tumor sites as a function of gender, race, age, tumor category, tumor grade. (1998-2002 and 2008-2012: 10 years total)

	BLADDER	COLON & RECTUM	ORAL CAVITY	LUNG & BRONCHUS	KIDNEY & RENAL PELVIS	UTERINE	OVARIAN	TOTAL
Number of Cases (n)	241,791	1,218,834	120,826	462,482	361,240	391,997	92,058	2,889,228
Number of PSM Cases	23,317	83,241	15,411	33,861	20,691	16,938	32,217	225,676
Overall PSM Rate (%)	9.64	6.83	12.75	7.32	5.73	4.32	35	7.81%

Data Reference:

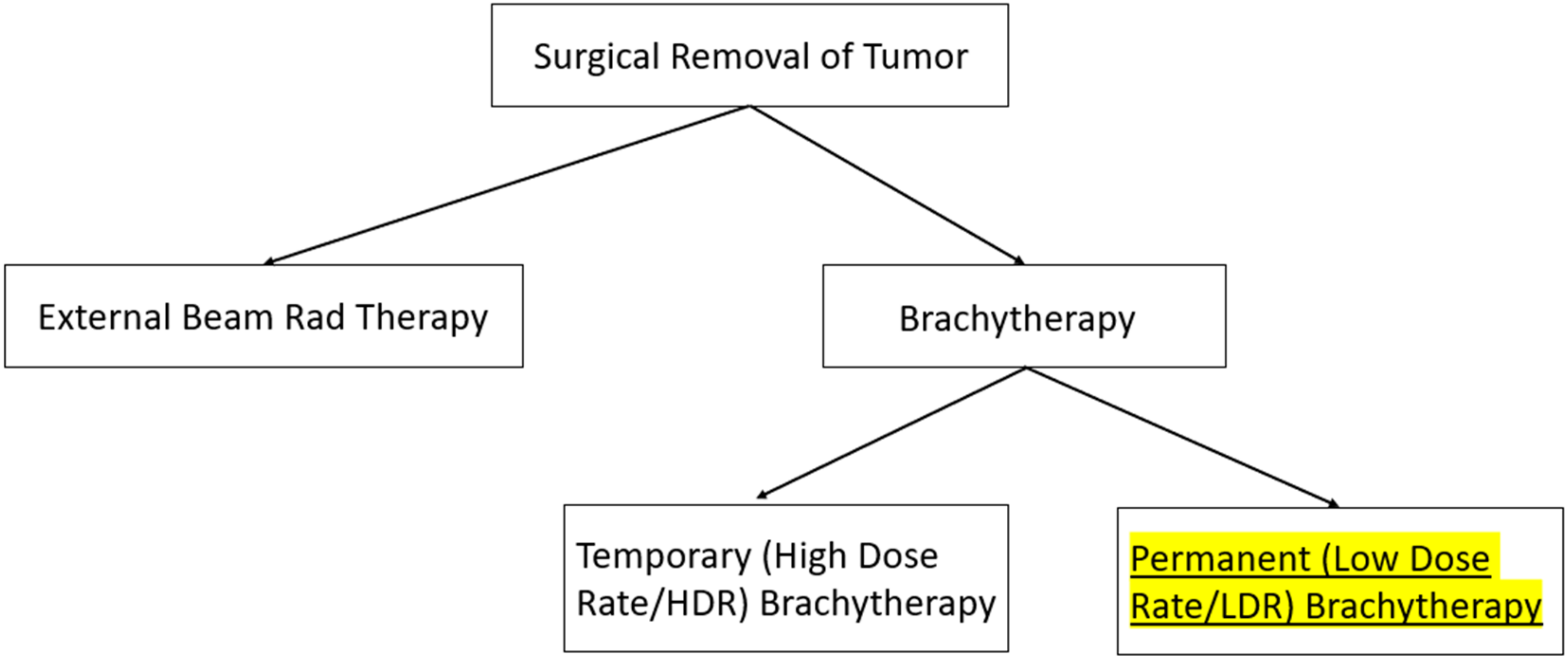
Orosco RK, et al. Scientific Reports **volume 8**, Article number: 5686 (2018)

URL: https://www.nature.com/articles/s41598-018-23403-5

Role of Adjuvant Therapy

- In general terms, an adjuvant treatment is a secondary treatment added to a primary treatment in order to achieve better disease control
- “Adjuvant” -- intended to “assist” the primary treatment
- In the surgical setting, intended to therapeutically impact possible or known residual disease either before or after surgery
- Typically delivered as chemotherapy or radiation therapy
- Can be neo-adjuvant (administered prior to surgery) or adjuvant (administered at time of surgery or following surgery)

Types of Adjuvant Radiation Therapy



Benefits of Adjuvant Brachytherapy as Compared to Adjuvant EBRT

- Surgical brachytherapy (close radiation) delivers therapeutic dose to a highly confined volume of tissue where residual cancer is thought to remain at the surgical event
- Relatively little time is added to the surgical procedure due to the exposure of the site of interest at surgery and the pre-configured strands and meshes delivered to the operating room (OR)
- Since External Beam Radiation Therapy originates outside of the patient, the therapeutic beam must transit uninvolved tissue in order to reach deep internal targets
- External Beam Radiation Therapy is typically delivered once the patient has recovered from surgery
- EBRT typically requires multiple patient visits in the outpatient setting in order to deliver a sufficient number of treatments (fractions)

Dose Rate of Brachytherapy Isotopes

Dose (Grays) = Dose Rate (Grays/hour) * Time (hours)

- **High Dose Rate (Temporary) – Iridium-192, Cesium-137, e.g.**
  - Generally placed at site of interest using an applicator
  - Dose may be delivered over period of 10 to 20 minutes
  - High energy / High activity

- **Low Dose Rate (Permanent) – Iodine-125, Cesium-131, e.g.**
  - Generally placed at site of interest in strands or mesh
  - Dose is delivered over period of weeks to months (depending on half-life)
  - Low energy / Low activity

Logistics of Temporary (HDR) and Permanent (LDR) Brachytherapy

- **High Dose Rate (Temporary) – Iridium-192, Cesium-137, e.g.**
  - Requires a heavily shielded containment housing due to high activity/energy of radiation source
  - Unwieldy due to shielding requirements and radiation protection of OR personnel

- **Low Dose Rate (Permanent) – Iodine-125, Cesium-131, e.g.**
  - Light shielding is employed until LDR source is implanted into patient, then little to no shielding is required
  - Patient is discharged with sources in place, sources decay to inert over life of implant

Cesium-131 is *NOT* Cesium-137

Cs-131 decays at a rate 1000 times faster than Cs-137 and each decay is 95.4% less energetic than Cs-137

Cesium-131 Properties	Cesium-137 Properties
Occurs in nature in trace quantities	Not naturally occurring
Can be produced in a nuclear reactor	Nuclear fission product
Half-life = 9.7 days	Half-life = 30.2 years
X-ray emission = 30 keV	Gamma-ray emission = 660 keV
Shallow penetration in tissue ~ 1 cm	Deep penetration of radiation into tissue
Permanent implant of multiple sources	Temporary placement of source
Therapeutic dose delivered over ~ 2 months	Therapeutic dose delivered in 3 to 5 short fractions

Permanently Implantable Brachytherapy Isotopes Compared

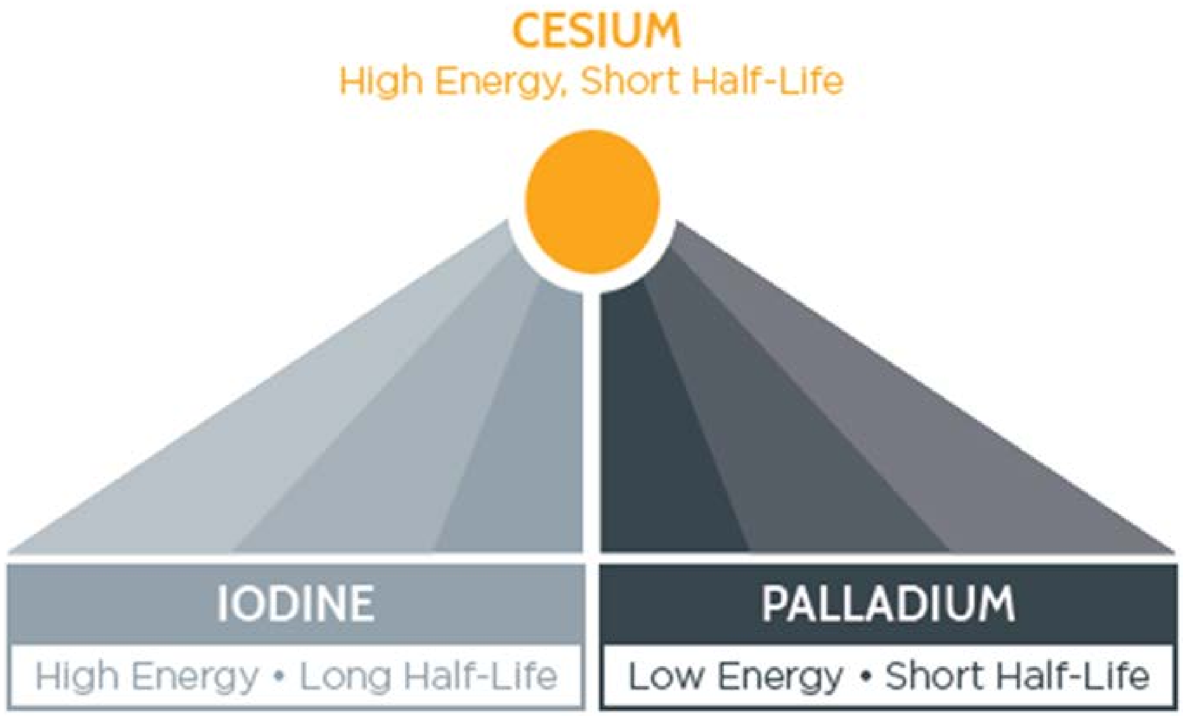
Cesium-131	Iodine-125	Palladium-103
Half-life - 9.7 days	Half-life - 60 days	Half-life - 17 days
X-ray emission - 30 keV	X-ray emission - 29 keV	X-ray emission - 21 keV
90% of prescription dose delivered in 33 days	90% of prescription dose delivered in 204 days	90% of prescription dose delivered in 58 days

Cs-131 was first used in 2004 for prostate cancer and starting in 2009 Cs-131 was used for treatments in other parts of the body where it continues to be used today.

Below is a timeline of when Cs-131 was first used to treat cancers in different locations in the body:

- October 2004 – Prostate
- June 2009 – Head and Neck
- August 2009 – Lung
- August 2010 – Gynecological
- September 2010 – Brain

Cs-131 Combines the Positive Attributes of a High Energy Photon and a Short Half-Life from I-125 and Pd-103

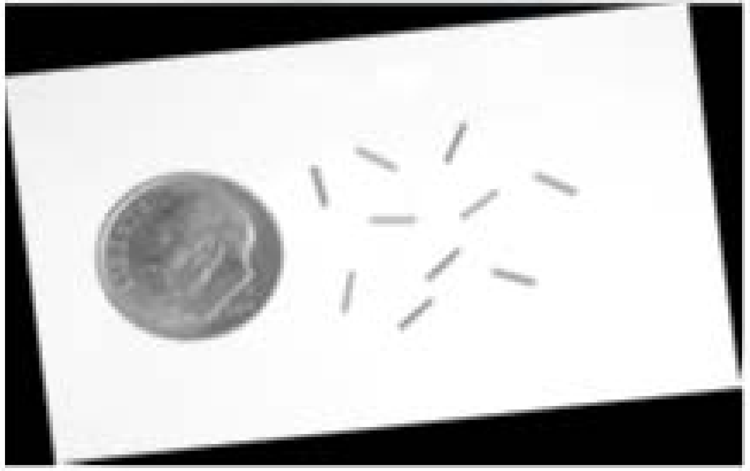


- I-125's significantly longer half-life means the patient will harbor radioactivity for over 6 months during which time the possibility for change in position (and thus radiation) may occur prior to dose delivery.
- Pd-103's weaker radiation emission has more difficulty in penetrating tissue to the desired depth to eradicate the distant cancer cells and therefore requires a higher individual seed strength.
- Patient treatment plans are customized, and vary greatly for different locations in the body, from patient to patient and from isotope to isotope. One patient my only require 20 individual sources while another 140. For these reasons, the costs of the treatments may vary.

Cesium-131 Sources

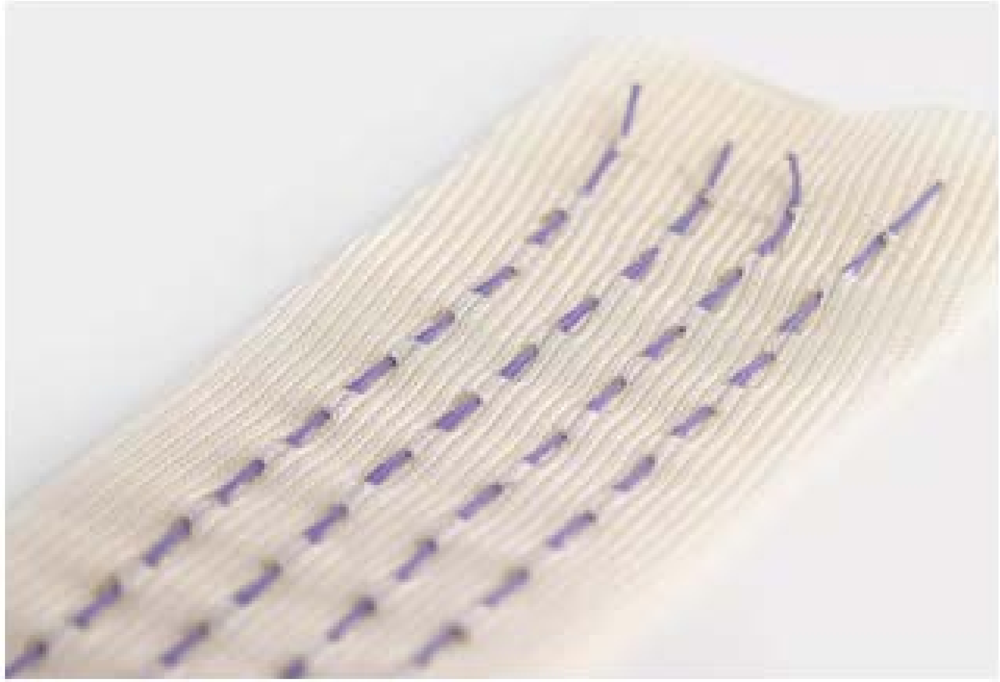
Cs-131 Seed

Close-up photograph of cylindrical seeds measuring 0.45 cm long and 0.08 cm in



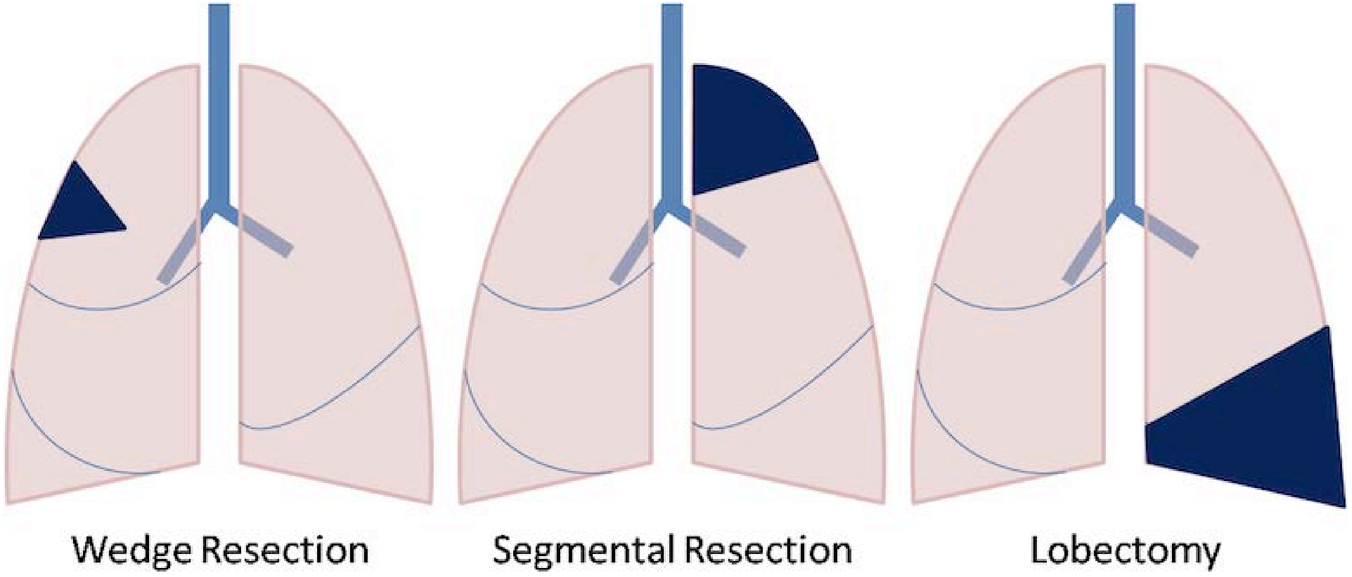
Mesh

Sutures containing seeds is sewn into a piece of bio-absorbable mesh equally spaced which then can be sewn or stapled into tissue by the physician for use in the lung or pelvic floor.



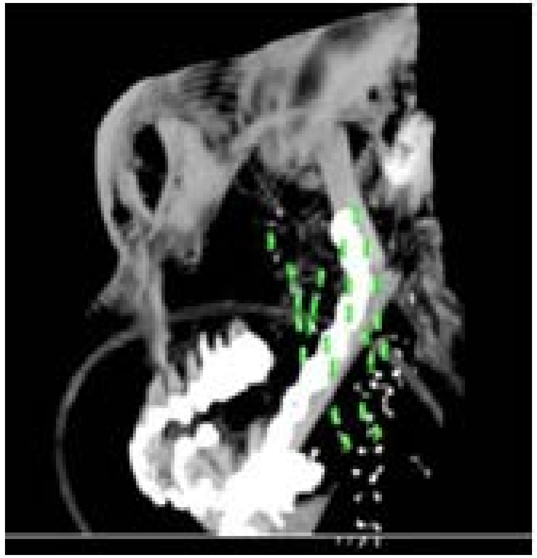
Cesium-131 Brachytherapy in NSCLC Treatment

Surgical Approaches to Early Stage (Stage I) NSCLC



- Lobectomy has long been the preferred operation
- Many patients with existing lung disease (COPD, emphysema) cannot tolerate the removal of ~20% of aeration capacity
- These patients may benefit from a smaller ("sub-lobar") resection, sparing lung tissue
- Local recurrences tend to happen along the "staple line" following sub-lobar resections
- Cesium-131 meshes are delivered in physician-requested configurations for adjuvant brachytherapy in sub-lobar resections of NSCLC

Cesium-131 Brachytherapy in the Treatment of Recurrent H&N Carcinomas



- Resectable carcinomas of the Head & Neck are often treated via surgical resection and adjuvant external beam radiation therapy (EBRT)
- These cancers often recur in the head & neck and may need to be resected more than once
- Given the number of structures in the head & neck that may be irradiated by EBRT (spinal cord and vasculature for instance), a second course of adjuvant EBRT may not be possible due to complication concerns
- Cesium-131 strands and meshes are delivered in physician-requested configurations for adjuvant brachytherapy in recurrent cancers of the head & neck