Intraluminal Brachytherapy

Dr. Aradhana K
Kidwai Memorial Institute of Oncology, Bangalore

Intraluminal Brachytherapy

- ILBT can be used as monotherapy or in combination with EBRT
    - Radical
    - Palliative

- Advantage:
    - Treatment on out-patient basis
    - Quick dose fall off (Sparing surrounding structures)
    - Providing focal dose escalation
    - Radioactive source placed easily at desired site
    - Normal anatomy is preserved

Intraluminal Brachytherapy

- Sources:
  - Cs-137 (historical)
  - Ir-192
  - Co-60

- Dose rates
  - HDR (>12Gy/hr)
  - LDR (0.4-1Gy/hr /10Gy/d)
  - MDR (2-12Gy/hr)
  - PDR
- Sites of Application
  - Esophagus
  - Bronchus
  - Urethra
  - Biliary Tract

ESOPHAGEAL

J Contemp Brachyther : DOI:10.5114/jcb.2014.43780; Corpus ID: 18852236

Criteria for Selection: Esophagus

Indications

Strong

- Primary tumour <10 cms length
- Tumor Confined to esophageal wall
- Thoracic location
- Without regional node and systemic spread

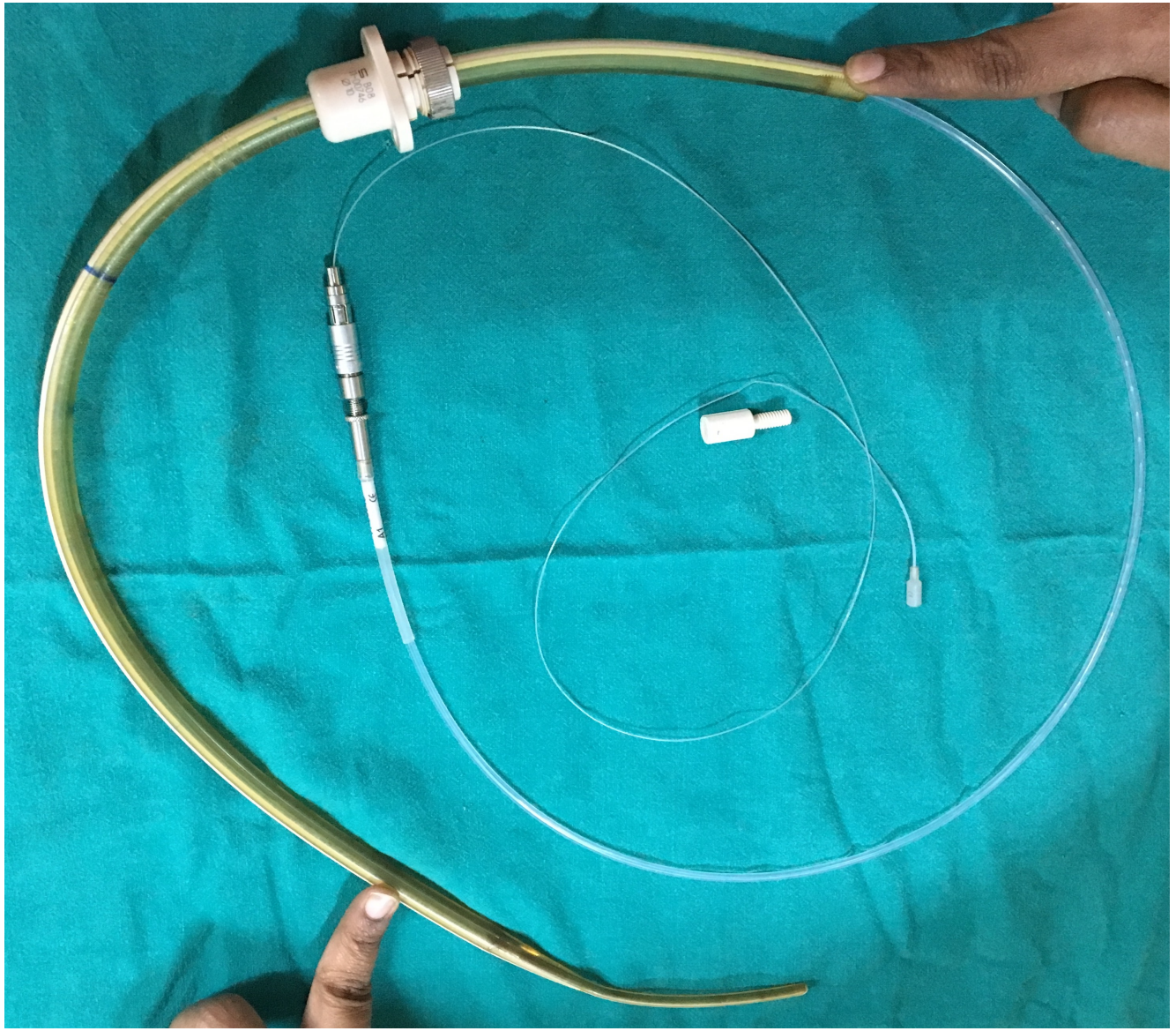
Poor

- Tumors involving GEJ or Cardia
- Extra esophageal extension
- Regional Lymphadenopathy
- Tumors >10cms length

Contraindications

- Tracheo-esophageal fistula
- Deep ulcerative lesion
- Tumors involving Cervical Esophagus (<3cm from sphincter)
- Stenosis which cannot be bypassed

Esophagus Applicator



Oesophagus: ILBT Procedure

Prior dilatation necessary for stenotic lesions

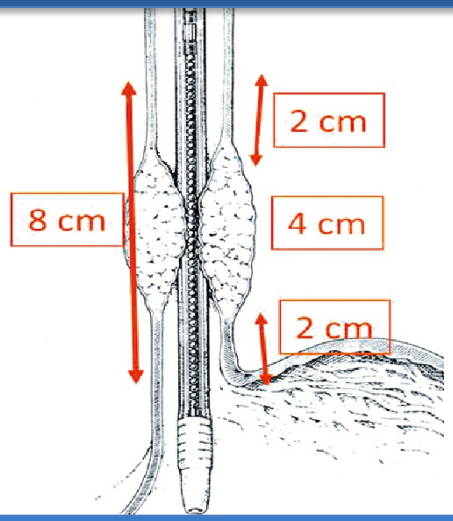
Fasting with secured intravenous line

Vagolytic agents/Local anesthesia can be used

Match applicator diameter to esophageal lumen

Length of treatment:

Pre-treatment tumour with 1-2cm margin proximally and distally on CT Scan, Barium swallow & Endoscopy



Semi flexible applicator introduced blindly/Flouro guided with source guide channel and dummy

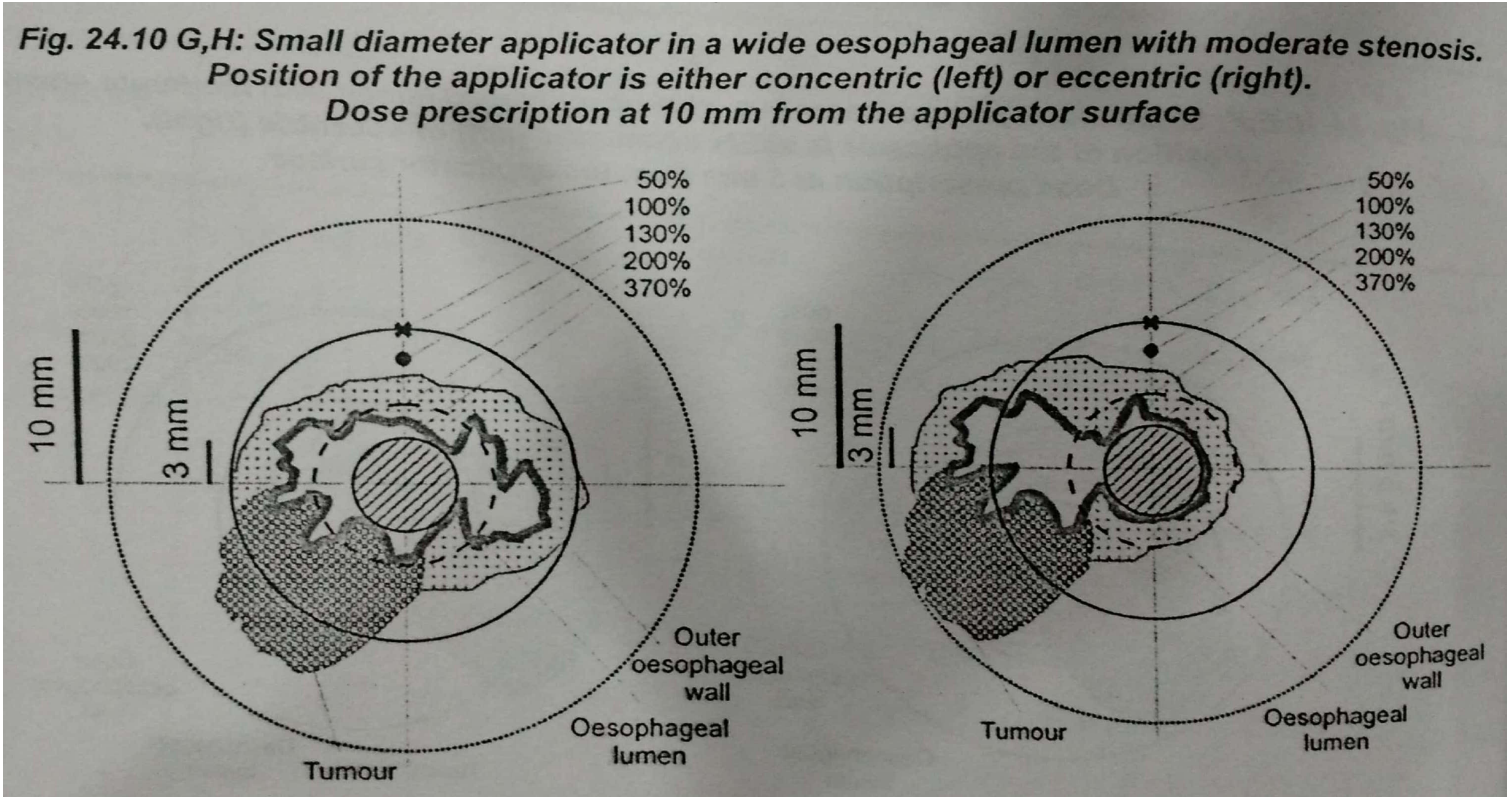
Gently maneuver for obstructive lesions to avoid injury/hemorrhage

CT Scan for 3D /X Ray simulation for 2D planning

Localize extent of the lesion and the treatment length

TPS planning

Treatment Delivery



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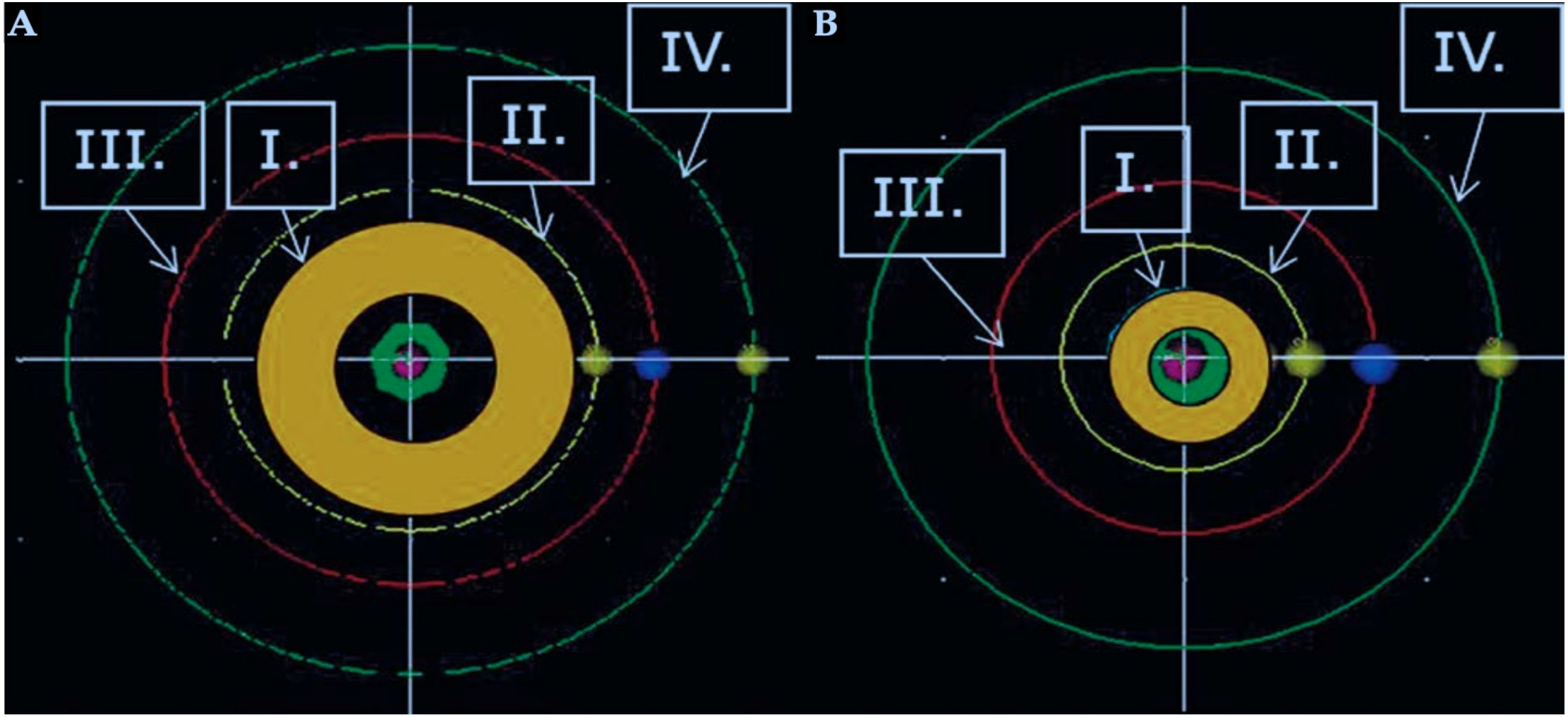

Fig. 7. Dose distribution in relation to applicator diameter. A) Diameter 15 mm. Isodoses I – surface of applicator 175% (8.75 Gy), II – 3 mm 136% (6.8 Gy), III – 5 mm 100% (5.0 Gy), IV – 10 mm 68% (3.4 Gy). B) Diameter 6 mm. Isodoses I – surface of applicator 265% (13.25 Gy), II – 3 mm 160% (8.0 Gy), III – 5 mm 100% (5.0 Gy), IV – 10 mm 58% (2.9 Gy)

J Contemp Brachytherapy. 2014 Jun; 6(2): 236–241


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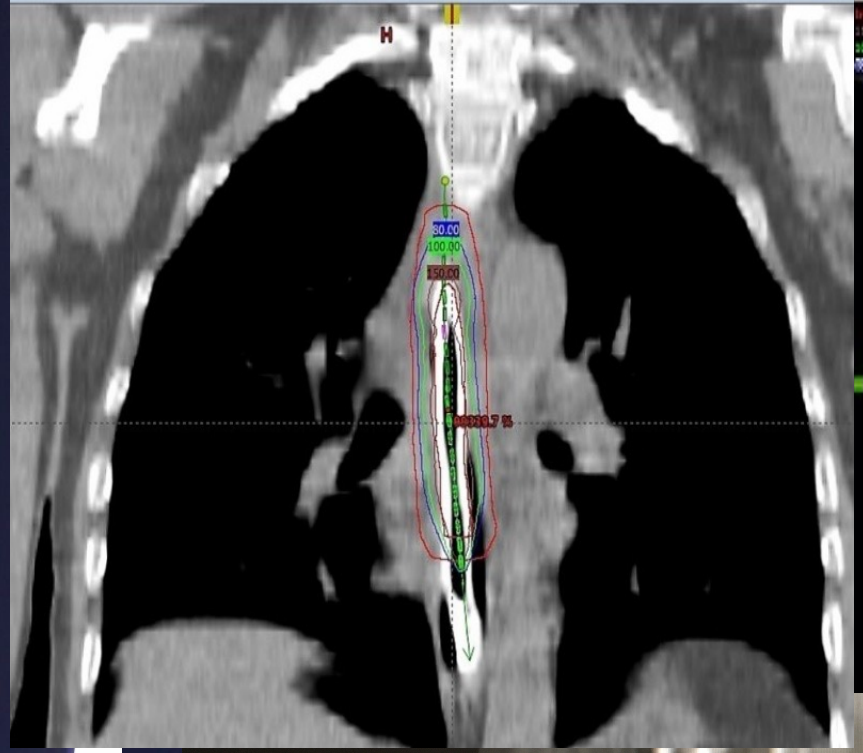
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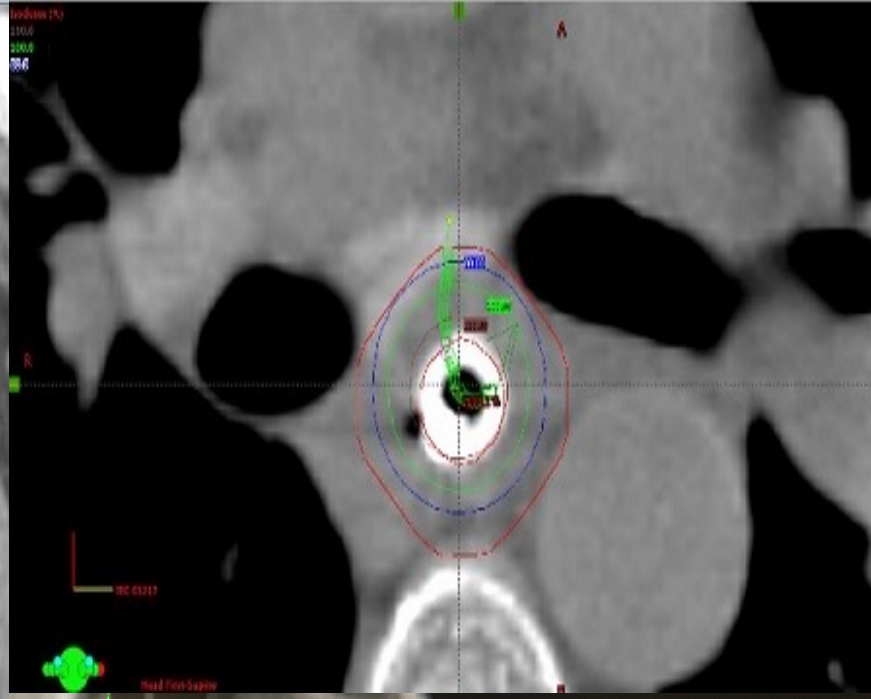
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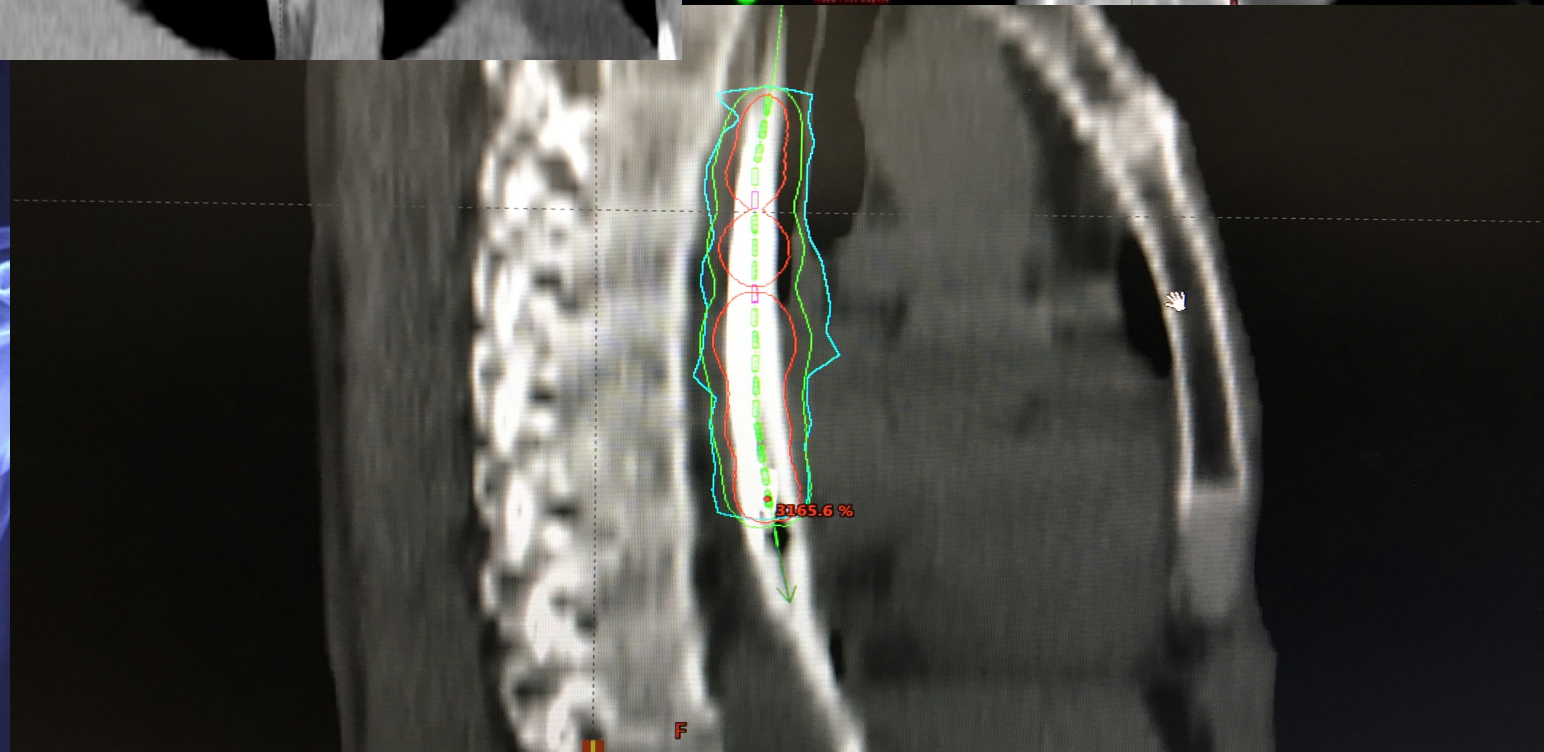
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American Brachytherapy Society Guidelines

- External beam radiation
    - 45 – 50Gy, 1.8 – 2Gy/fr, 5frs/wk 1-5
- Brachytherapy
    - HDR- Total Dose 10 Gy, 5Gy/fr, 1fr/ week
    - LDR- Total Dose 20Gy, single session 0.4-1.0Gy/hr
- Dose prescribed at 1cm from mid source or mid dwell position
- Dose shapes can be modified with use of dwell times
- 2-3 weeks post CT+RT - to allow mucositis resolution
- Concurrent CT with ILBT - not recommended

KMIO: Radical – 50.4Gy/28frs EBRT followed by 5.6Gy X 2frs HDR weekly

Study done at KMIO

Squamous cell carcinoma of esophagus

EBRT-50.4Gy/28fr (3DCRT) with concurrent weekly CDDP 40mg/m2 followed by assessment for ILBT

HDR-ILBT-5.6Gy x 2fr

TREATMENT OUTCOMES

Post treatment response [Assessed with OGD & CT-scan at 6wks]	
CR	19 (63.4%)
PR	11 (36.6%)
Dysphagia free interval	
No DFI	11 (36.6%)
6-12months	13 (43.4%)
>12 months	6 (20%)
Disease free survival	
No DFS	10(33.3%)
6-12months	15 (50%)
>12 months	5(16.7%)
Overall survival	
<6 months	5 (16.7%)
6 -12 months	16 (53.3%)
> 12months	9 (30%)

30 patients: From Dec 2014-Jun 2016

Combination of EBRT+ CT & ILBT

ILBT BOOST FOLLOWING EBRT IN LOCALLY ADVANCED OESOPHAGEAL CARCINOMA- IS IT REALLY CURATIVE OR JUST PALLIATION?

May 2016; Journal of Evidence Based Medicine and Healthcare 3(42); DOI: 10.18410/jebmh/2016/464

- Comparision of NACT (TPF) followed by EBRT with ILBT 40 Gy/20 Fr + 5Gy x 3Fr or EBRT Boost 20Gy/10Fr
- 5yr OS 20% vs 6% respectively
- Strictures were more in ILBT arm

Dose Intensified Chemoradiation and Intraluminal Brachytherapy Improve Outcomes in Middle Third Carcinoma Esophagus: Experience from a Regional Cancer Center

Asian Journal of Oncology 2020; 6(02): 61-64; DOI: 10.1055/s-0040-1708113

- In combination with oral capcetabine
- 5yr OS 47%
- Complication such as TOF, stricture, Gr3 toxicity

Combination of EBRT & ILBT

Studies	No. of Patients	EBRT Dose(Gy)	ILBT Dose	LC	OS
Mujis *et al*.(2012)	62	60	12 Gy/ 2 frs	45% (3y)	11% (5y)
Murakami *et al*. (2011)	87	50-61	10 Gy/4-5 frs	49-75% (5y)	31-84% (5y)
Tamaki *et al*. (2011)	54	56-60	10 Gy/2 frs 9 Gy/3 frs	79% (5y)	61% (5y)
Gaspar *et al*.; phase I/II – RTOG 9207 trial (2000)	49	50	10-15 Gy/2-3 frs		49% (1y)
Yorozu *et al*. (1999)	169	40-61	8-24 Gy/2-4 frs	40-80% (2y)	20-70% (2y)
Okawa *et al*.; phase III trial (1999)	103	60	10 Gy/2 frs		20% (5y)
Kumar *et al*. (1993)	**75**	**40-55**	**8-10 Gy** **10-12 Gy** **12-15 Gy**	**38% (1y)**	**39% (1y)**

J Contemp Brachytherapy. 2014 Jun; 6(2): 236–241

Palliation

- With or without EBRT
    - HDR- Total Dose 10 Gy, 5Gy/fr, 1fr/ week
    - LDR- Total Dose 20Gy, single session 0.4-1.0Gy/hr
- Palliation of Dysphagia is upto 90%

Studies	***no.***	**Comparision with**	**ILBT dose**
Rosenblatt *et al*. (2010)	219	± EBRT 30 Gy/10 frs	16 Gy/2 frs
Rupinski *et al*.,RCT (2011)	87	Photodynamic therapy	12 Gy/1 fr
Bergquist *et al*., RCT (2005)	65	Stent	21 Gy/3 frs
Homs *et al*., RCT (2004)	209	Stent	12 Gy/1 fr

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Complications

Based on

- Length of lesion treated
- Type of initial lesion
- Radiotherapy dose if given
- Chemotherapy,type and timing if given
- Type of applicator

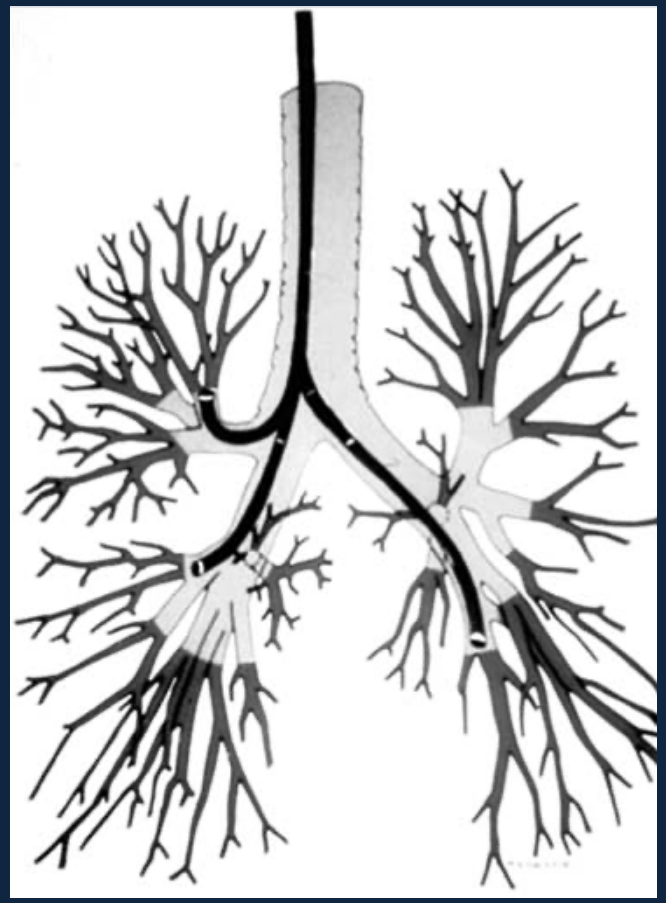
Type

- Esophagitis
- Strictures
- Ulceration
- Bleeding
- Perforation
- Fistula

Conclusion

- Definitive role as a boost in combination with external RT.
- Improves LC and releives dysphagia with curative regimen.
- Offers rapid relief and long lasting symtom free survival without significant toxicity in palliation.

ENDOBRONCHIAL



J Contemp Brachyther 2009; 1, 4: 231-236

ILBT Bronchus

- Performed in
    - Centrally located endobronchial lesions
    - Without extraluminal primary or metastasis
- Intent
    - Palliative
    - Residual
    - Recurrent
    - Curative
- Exclusion
    - Life expectancy <2 months
    - KPS-<60
    - Extrabronchial extension

Indications

- Curative
  - Unresectable tumors (with EBRT)
  - Endobronchial tumor
  - Occult Carcinoma
  - Medically inoperable
- Palliative
  - Dyspnea
  - Hemoptysis
  - Persistent cough
  - Post Obstructive Pneumonitis

Perez & Brady's: Principles and practice of Radiation Oncology; 7th Edi

Endobronchial Procedure

Endobronchial disobliteration like laser/cryocoagulation /stenting prior to the application

Flexible fibreoptic Bronchoscopy guided transnasally

Polythene catheter with radio-opaque wire secured in desired position

Verified fluoroscopically

Bronchoscope removed and catheter secured to the nose of patient

Balloons/sheaths used to maintain radioactive source within the center of the lumen to avoid inhomogeneity

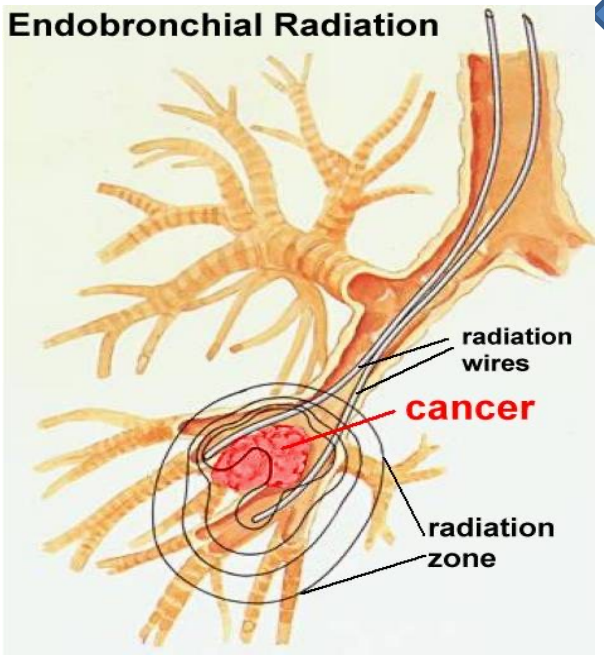
Additional verification done by plain Chest X Ray before removing the dummy & loading the catheter with RAS

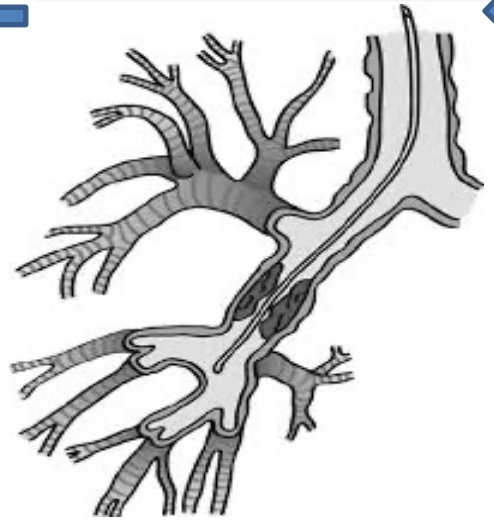
CT Scan for 3D /X Ray simulation for 2D planning

Localize extent of the lesion and the treatment length

TPS planning

Treatment Delivery





Endobronchial applicator

ABS dose recommendations

HDR (per Fr in Gy)	No. of Fr	Total Dose (Gy)
Brachytherapy alone		
10	1	10
15	1	15
7.1-10	2	14.2-20
7.5	3	22.5
6	4	24
5	6	30
Brachytherapy as Boost post EBRT 60 Gy in 30 Fr's		
5	2	10
5	3	15

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Palliation dose in combination with EBRT (30Gy)

Author	No. of Patients	HDR per Fraction (Gy)[a]	No. of Fractions	Percentage Improved	
				Symptoms	Bronchoscopy
Taulelle et al.[173]	189	8–10	3–4	54–74	79
Kelly et al.[174]	175	15	1–2	66	78
Celebioglu et al.[175]	95	7.5–10	2–3	100	100
Gejerman et al.[176]	41	5	3	72	54
Escobar-Sacristan et al.[177]	81	5[b]	4	85	97
Kubaszewska et al.[178]	270	8–10		76–92	80
Ozkok et al.[179]	74[c]	7.5	2	57–94	77
	41	7.5	3	55–78	72
Skowronek et al.[170]	303	7.5	3		88.4
	345	10	1		
Guarnashcelli et al.[180]	52	5–7.5	1–3	92	87
Dagnault et al.[181]	81	5	4	77–100	95
Hauswald et al.[182]	41	5	3	58	73
Niemoeller et al.[171]	60	3.8	4		57.2
	82	7.2	2		70.2
de Aquino Gorayeb et al.[183]	78	7.5	3	87.2	73.4
Totals	2008		1–4	55%–100%	57.2%–100%

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For Occult Lung Carcinoma

Author	No	Dose/Fr	At depth	No.of Fr's	Total HDR dose	Cause specific survival	Mean FU (month)
Perol et al	19	7	1	3-5	35	78	28
Marsiglia et al	34	5	0.5-1	6	30	78	24
Hennequin et al	106	5-7	0.5-1	6	30-42	67.9 (2Yr) 48.5 (5Yr)	NA
Aumont-Le Guilcher et al	226	5-7	1	4-6	24-35	81 (2Yr) 56 (5Yr)	30.4

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Conclusion

- Good palliative treatment in allieiviating symptoms with acceptable complications
- In view of other affordable bronchoscopic ablative techniques availabile like Laser, APC (argon plasma coagulation), electrocautery and cryotherapy, ILBT is not used often .

Complications

- Bronchial fistula
- Bronchospasm
- Stenosis
- Hemoptysis

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URETHRAL

ILBT Urethra

- Urethral cancers extremely rare - 0.02% of all malignant tumors
- Indicated in limited disease
    - males- penile urethra
    - females- whole urethra
- Conservative approach
    - Distal locations - Better prognosis usually with combination with EBRT or limited surgery depending on thickness.
    - Superficial lesions- ILBT alone (monotherpy).
    - Bulky infiltrating lesions -“Sandwich” technique - ILBT is combined with ISBT as a boost after EBRT.

Procedure

- Topography and site of tumor are established by an endoscopic/urethrography examination
- Following endourethral resection-target volume is reduced

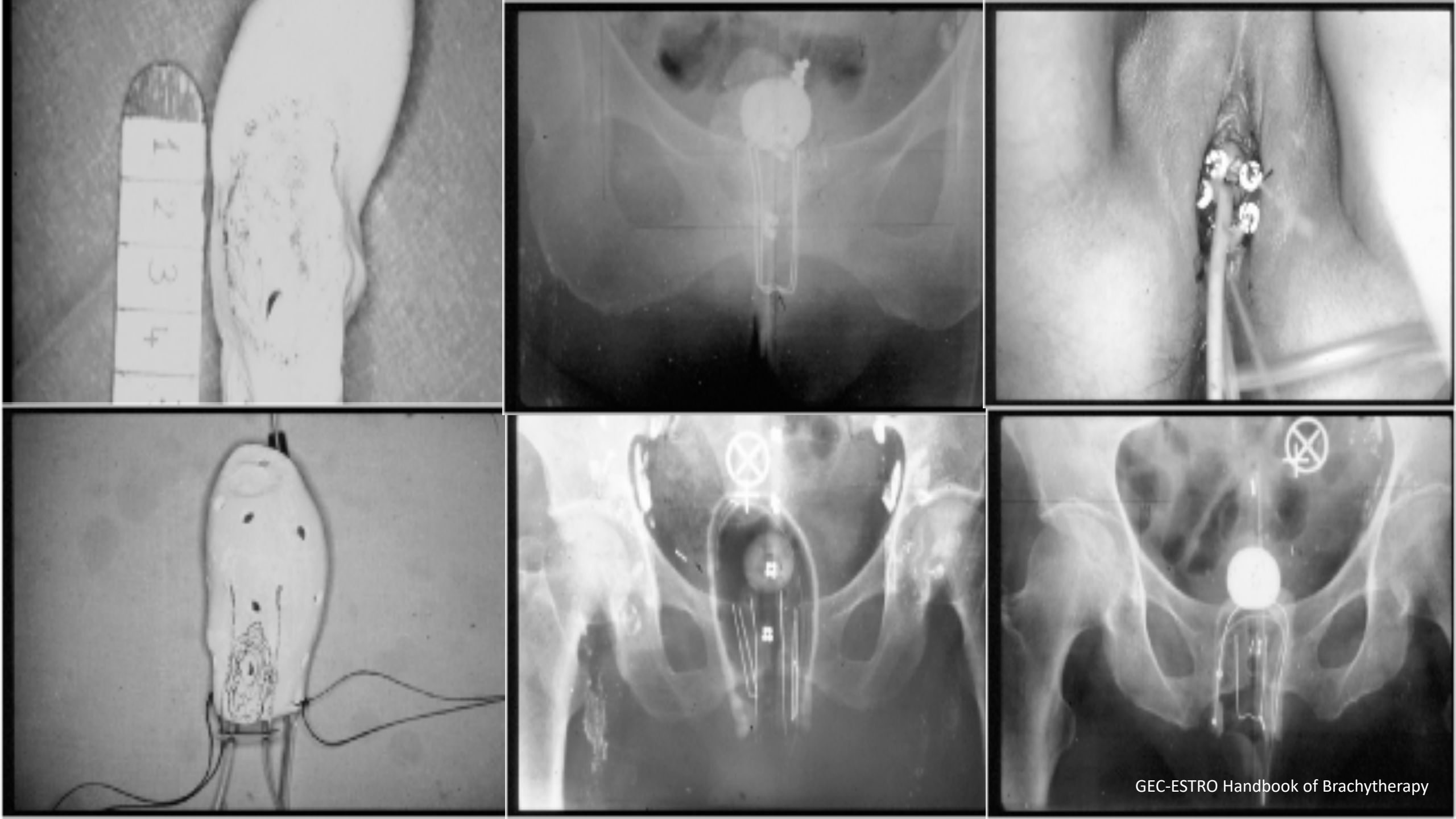
Procedure

- Afterloaded Brachytherapy performed either with
    - catheter (closed at internal end) introduced into urethra (suprapubic urinary diversion is necessary)

      OR
    - Foleys-catheter with inflated balloon

Precautions

- Males - organ is kept as far as possible from the testis by an adapted sponge
- Females - Vaginal mould applicator is recommended which allows customized treatment to irradiate the posterior part of urethral carcinoma through the anterior wall of vagina


GEC-ESTRO Handbook of Brachytherapy

Dose, Dose Rate & Fractionation

- Dose is expressed at a choosen distance according to the depth of tumor and a safety margin (eg. 10 mm)

- Total Dose LDR
    - In brachytherapy alone 60-65Gy in 3-5days
    - As a boost 20-25Gy
- Total Dose HDR
    - 10Gy X 4 frs given in 3-4weeks
    - No need of urinary diversion

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ILBT Urethra

- Milosevic et al. published their experience of 34 patients who were treated with radiation.
- Twenty of these patients received brachytherapy (5 brachytherapy alone, 15 EBRT + brachytherapy).
- The tumors treated with brachytherapy tended to be ≤4 cm, involve the distal urethra, and did not invade adjacent organs.
- The majority of the patients underwent volume implants. Patients who had brachytherapy as part of their treatment had better local control with 7-year local relapse-free rates of 77% versus 32% with EBRT alone

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ILBT Urethra

- Tumor Size
  - 5yr survival depends on

Tumor Size	5Yr Survival
<20mm	>60%
20-50mm	40%
>50mm	<20%

- Tumor site
  - Anterior urethra (50-60%)
  - Posterior urethra(20-30%)

ILBT Urethra

Intraluminal urethral brachytherapy for recurrence of transitional cell carcinoma of urinary bladder in urethral stump

Bikramjit Chakrabarti, MD, DNB, Suman Ghorai, MD, Somapriya Basu Ray, MD, Sanjay Kumar Kar, MD
Institute of Post-Graduate Medical Education and Research, Kolkata, India

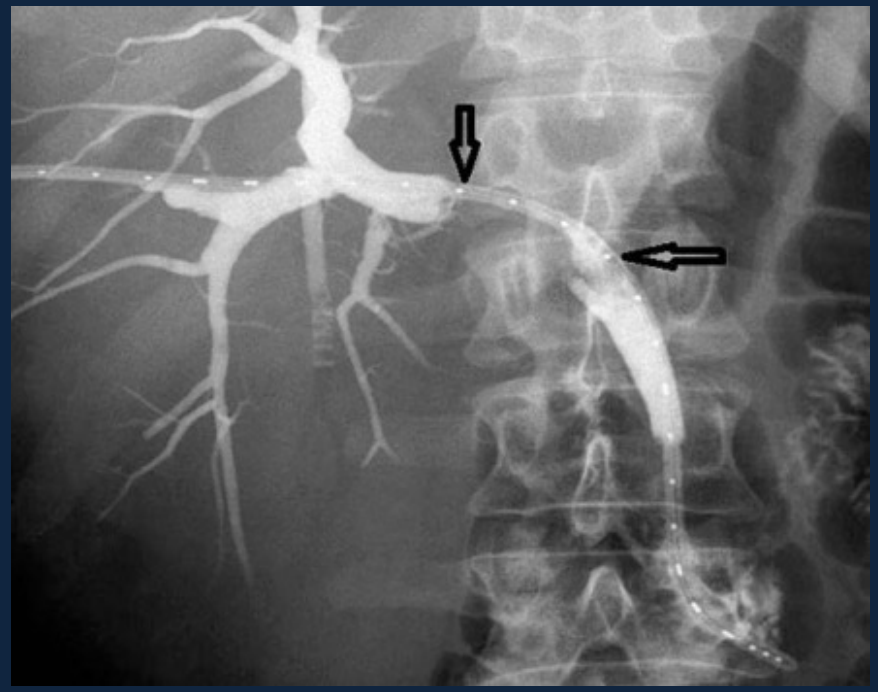
J Contemp Brachytherapy 2013; 5, 1: 42–44 DOI: 10.5114/jcb.2013.34451

intraluminal brachytherapy in low volume superficial local disease in urethra may play a potential role, and should be applied when repeated surgery is not feasible due to technical or medical reasons.

Complications

- Stenosis
- Cystitis/Urethritis
- Urinary incontinence
- Rarely vaginal fistula
- Local necrosis

ENDOBILIARY

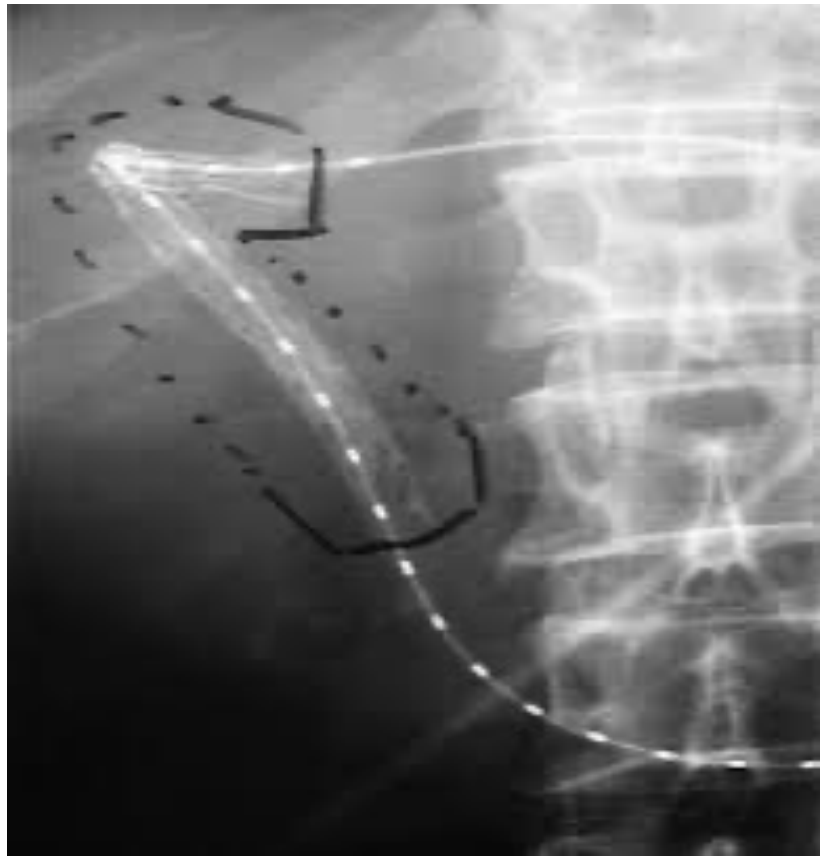


J Contemp Brachytherapy. 2017 Apr; 9(2): 187–195.

Bile Duct Tumors

- Majority lesions involve hepatic duct bifurcation, commonly present with obstructive jaundice .

- Approach :
  - Trans-duodenal endoscopic based on ERC
  - Percutaneous trans-hepatic (post cholangiography)



Procedure & Dose

- Transduodenal approach :
  - Under Fluroscopy through ERCP, advancing a guide wire through malignant stricture
  - Nasobiliary tube is threaded as source carrier over this guide wire
  - Afterloading catheter with radio opaque wire passed through NB tube after removal of guide wire
- Orthogonal films taken to confirm position & calculate the dosimetry

- Boost - 20 to 30 Gy 3-4 Fr at 1 cm along with EBRT
- Monotherapy (not recommended) - HDR - 40 Gy/10 Fr [4 Gy twice daily]

Procedure & Dose

- Transhepatic cholangiogram catheter
  - Under fluoroscopy, the brachytherapy catheter is inserted into the biliary drainage catheter and advanced past the area of obstruction
  - Tuohy-Borst (Y-shaped) adapter attached to the end of the biliary catheter allows concurrent external biliary drainage while holding the HDR catheter in place

- Radical dose: 15 to 20 Gy in 3-4 frs totally to boost 45 Gy EBRT
- Palliative dose of 25-30 Gy in 5-6 fractions

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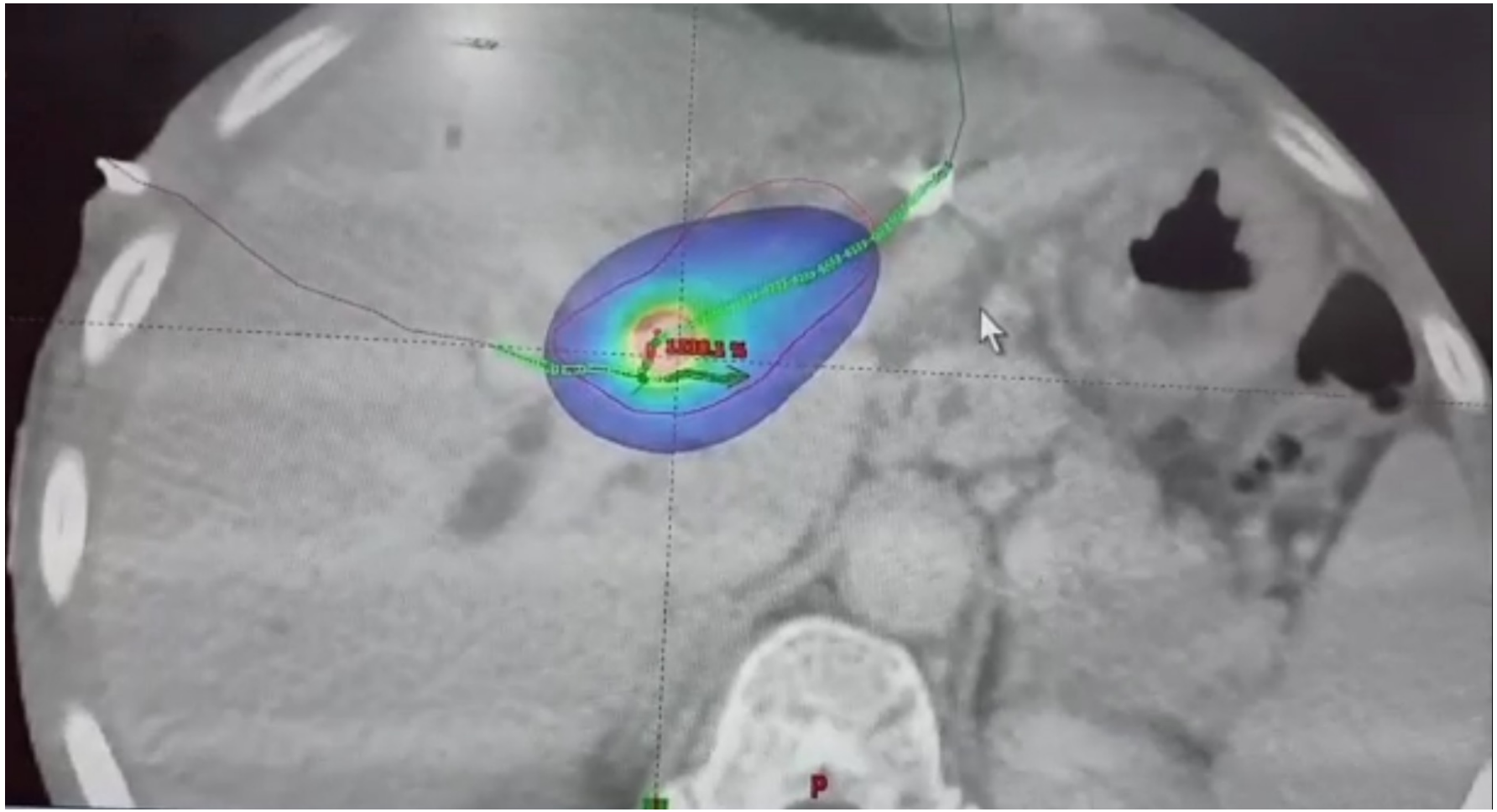
Procedure & Dose



Literature

Author	Number of patients	EBRT, dose	BT, number of fractions, fraction dose, method	Prescription depth	Results of treatment	Statistical analysis
Foo et al.[21]	24	Median: 50.4 Gy, 1.8 Gy/fraction	192Ir seeds, 20 Gy (median)	BT – 20/24 dose prescribed at 10 mm, 2/24 – 5 mm, 7.5 and 7.0 mm in 1/24 patient	MS: 12,0 months 2 yrs: 18,8 months 5 yrs: 14,1 months	p = 0.39
Fritz et al.[28]	30	30-45 Gy in 25 patients	HDR, 5-10 Gy fractions, total dose 20-45 Gy	Dose prescribed at 10 mm	MS: 10 months 2 yrs: 18% 5 yrs: 8%	n.d.
Yoshioka et al. [32]	1. 153 2. 56	Median: 50 Gy, fractions 1.8 or 2.0 Gy	1. No 2. 18 Gy median (3 × 6 Gy fractions) HDR	2. 43/56 cases – dose prescribed at 10 mm, 4/56 – at 12 mm, 5/56 – at 5 mm	1. OS (2 yrs): 40% DSS (2 yrs): 41% LC (2 yrs): 35% 2. OS (2 yrs): 31% DSS (2 yrs): 42% LC (2 yrs): 65%	LC – p = 0.094
Veeze-Kuijpers et al. [37]	42	30 Gy (15 fractions at 2 Gy), since 1985 – 40 Gy in 16 fractions at 2.5 Gy	192Ir wire, 15 Gy/75 hours, 2 sessions (schedules changed for some patients)	Dose prescribed at 10 mm	MS: 10 months15% of patients ≥ 2 yrs	n.d.
Gonzalez Gonzalez et al. [38]	1. Group I – 41 (+ surgery), Group II – 19 (unresectable)	1. 45 Gy (median) 2. 48 Gy (median)	192Ir wire 1. 10 Gy 2. 22-25 Gy	BT – dose prescribed at 10 mm	1. MS: 24 months 2. MS: 10.4 months	n.d.
Eschelmann et al. [39]	11	25-56 Gy, fractions 1.8-2.0 Gy	192Ir wire 25 Gy (mean dose), 15-31 Gy	BT – dose prescribed at 10 mm	MS: 22.6 months	n.d.
Takamura et al. [40]	93	50 Gy, 25 fractions at 2 Gy	192Ir wire 27-50 Gy (median 39.2)	BT – dose prescribed at 5 mm	MS: 2 yrs: 15 months5 yrs: 4 months	n.d.
Shin et al.[41]	1. 17 2. 14	36-55 Gy (median 50.4)	1. No BT 2. 3 × 5 Gy HDR	BT – dose prescribed at 1.5 mm	1. RR: 53% 2. RR: 36% 1. OS (2 y): 0% 2. OS (2 y): 21%	RR – p > 0.05 **OS – p = 0.015**
Schleicher et al. [42]	1. 18 2. 12	Median: 30 Gy, 19 fractions at 1.6 Gy	1. No BT 2. median 40 Gy, 4-5 fractions, HDR	BT – dose prescribed at 5 mm	1. OS: 3.9 months 2. OS: 9.1 months	**OS – p < 0.05**
Kamada et al. [43]	1. 42 2. 103	Median 40-50 Gy, fractions at 2.0-2.5 Gy	192Ir wire 1. No BT 2. 25 Gy	BT – dose prescribed at 5 mm	1. MS: 4.3 months 2. MS: 9.3 months	n.d.
Ghafoori et al. [44]	1. 8 2. 23	30-62 Gy, median – 45 Gy, fractions 1.8 to 3 Gy	192Ir wire 1. Yes (median 25 Gy) 2. No BT	BT – dose prescribed at 5-10 mm	1. MS (2 yrs): 22 months (5 yrs) – 13 months 2. MS (5 yrs): 5 months	p = 0.096

J Contemp Brachytherapy. 2017 Apr; 9(2): 187–195.

Complications

Acute

- Nausea/Vomiting
- Transient elevation of transaminase
- Cholangitis

Late

- GI/Biliary bleeding
- Duodenal/Bile duct Stenosis
- Stricture
- Severe gastrointestinal disturbances

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THANK YOU