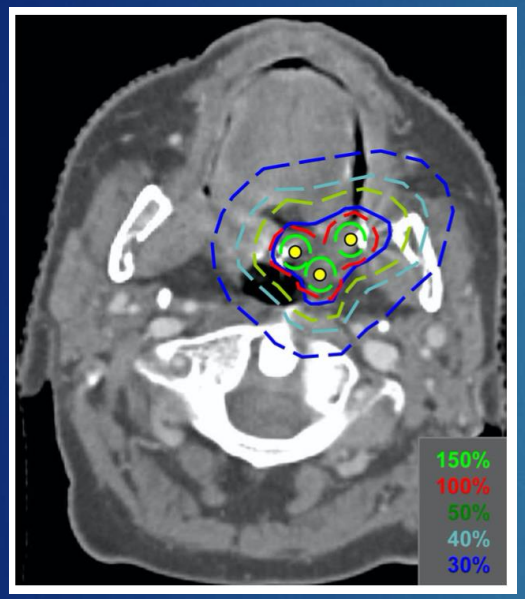
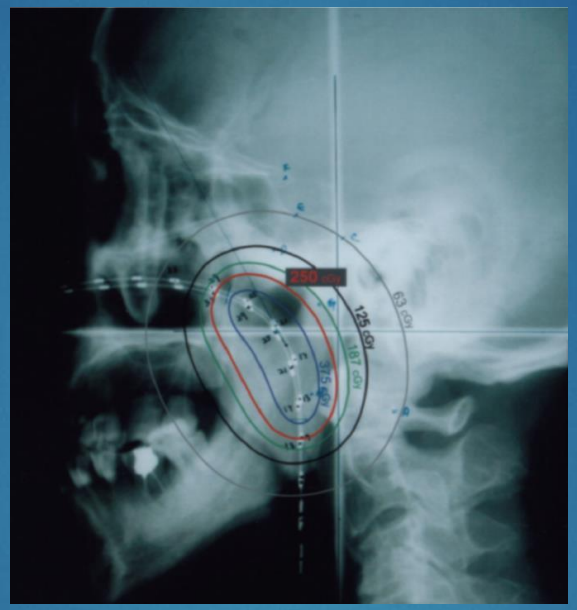
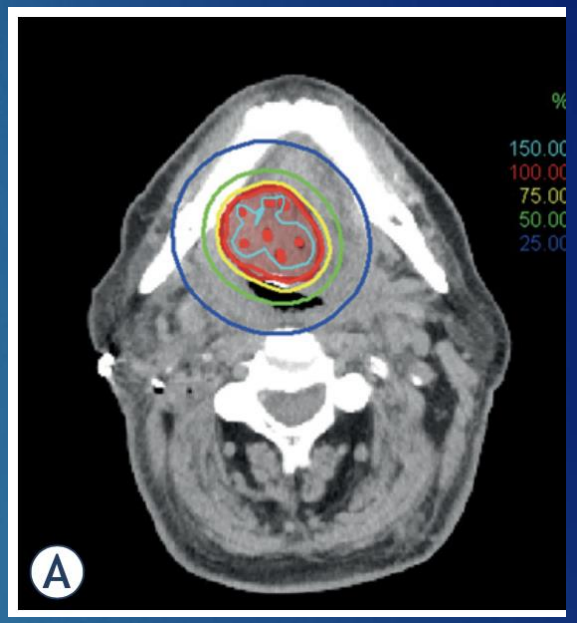
35th ICRO PG Teaching Program
"Brachytherapy in Carcinoma Oropharynx and Nasopharynx"







Dr Ajeet Kumar Gandhi
MD (Radiation Oncology, AIIMS, New Delhi)
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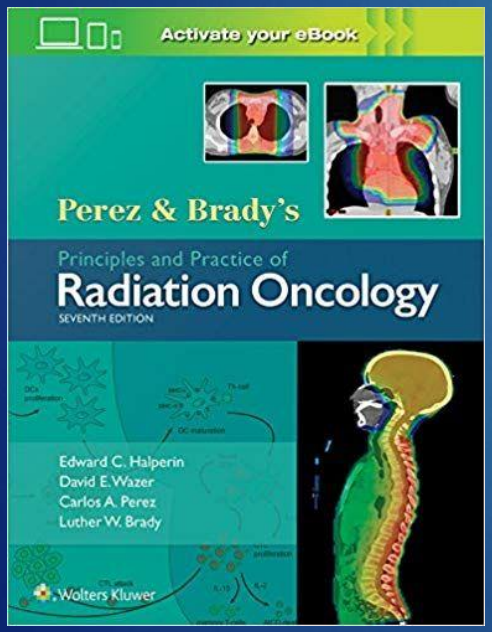
NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®)

Head and Neck Cancers

Version 2.2020 — June 9, 2020

- NCCN Guideline mentions brachytherapy in selected cases of lip and oral cavity
- No mention of brachytherapy for carcinoma oropharynx and nasopharynx



- Oropharynx: : "Brachytherapy as a technique developed in the pre-IMRT, Pre-CTRT era and is associated with significant risk of osteoradionecrosis". Logical sense in intensifying the treatment with brachytherapy to enhance loco-regional control
- Nasopharynx: "Adjuvant brachytherapy boost and in patients with recurrent/persistent disease"

GEC-ESTRO recommendations

Radiotherapy and Oncology 91 (2009) 150–156

GEC-ESTRO recommendations for brachytherapy for head and neck squamous cell carcinomas

Jean-Jacques Mazeron [a,*], Jean-Michel Ardiet [b], Christine Haie-Méder [c], György Kovács [d], Peter Levendag [e], Didier Peiffert [f], Alfredo Polo [g], Angels Rovirosa [h], Vratislav Strnad [i]

GEC-ESTRO/ACROP recommendations

Radiotherapy and Oncology 122 (2017) 248–254

GEC-ESTRO ACROP recommendations for head & neck brachytherapy in squamous cell carcinomas: 1st update – Improvement by cross sectional imaging based treatment planning and stepping source technology

György Kovács [a,*,1], Rafael Martinez-Monge [b,1], Ashwini Budrukkar [c,1], Jose Luis Guinot [d,1], Bengt Johansson [e,1], Vratislav Strnad [f,1], Janusz Skowronek [g,h,1], Angeles Rovirosa [i,1], Frank-André Siebert [j,1], on behalf of the GEC-ESTRO Head & Neck Working Group

THE AMERICAN BRACHYTHERAPY SOCIETY RECOMMENDATIONS FOR HIGH-DOSE-RATE BRACHYTHERAPY FOR HEAD-AND-NECK CARCINOMA

Int. J. Radiation Oncology Biol. Phys., Vol. 50, No. 5, pp. 1190–1198, 2001

SUBIR NAG, M.D.,* ELMER R. CANO, M.D.,† D. JEFFREY DEMANES, M.D.,‡

AJM ... AN

American Brachytherapy Society Task Group Report: Combined external beam irradiation and interstitial brachytherapy for base of tongue tumors and other head and neck sites in the era of new technologies

Brachytherapy ■ (2016) ■

Zoltán Takácsi-Nagy [1,*], Rafael Martínez-Mongue [2], Jean-Jacques Mazeron [3], Cristopher James Anker [4], Louis B. Harrison [5]

Current Management Protocol

Carcinoma Oropharynx (BOT, Tonsil, Soft palate, Pharynx)	
Stage I-II (T1-2N0)	Radiotherapy alone (IMRT) Surgery +/- Adjuvant RT/CT [p16+ve]
Stage III-IV (T3-4N0/Any TN1-3)	CTRT (70 Gray with IMRT+Cisplatin+/-Nimotuzumab) NACT->CTRT Cisplatin Ineligible patients: RT + Cetuximab Altered fractionated radiotherapy
*Assessment at 10-12 weeks for residual/persistent primary or nodal disease **Preferable to use IMRT with concurrent chemotherapy	

Current benchmark outcome with CTRT/IMRT: Oropharynx

- 5-year OS 22.4% [GORTEC], 40.3% [NCDB 2004],
- 5-year loco-regional control 47.6% [GORTEC]
- MSKCC Experience [Nancy Lee et al. IJROBP 2012
  - 442 Patients with Oropharyngeal cancers treated with CTRT
  - 73% Stage IV patients and 91% received CTRT
  - 3year local failure rate was 5.4% and OS was 84%
  - Late dysphagia and xerostomia grade =>2 was 11% and 29% respectively
  - T3/4 (HR 2.94) and N2/3 (HR 2.26) had poorer outcome

Balancing outcome and toxicity

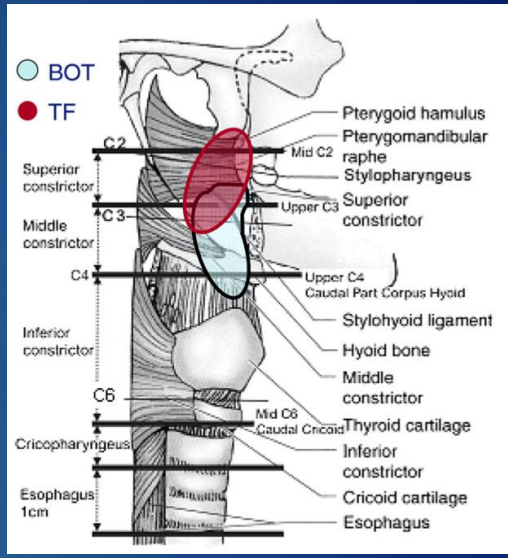
- IMRT has improved CSS in head and neck cancers (84.1% vs. 66%, p<0.001) [Beadle et al. Cancer 2014;120:702-710]
- Grade =>2 Xerostomia less common with IMRT (29% vs. 83%; p<0.001) [Nutting et al. Lancet Oncology 2011;12:127-136]
- Significant late dysphagia (Feeding tube dependency): 12-50%
- Grade ¾ late toxicity: 56% [Pooled RTOG analysis, Trotti et al JCO 2008]
- Sharp increase in risk of late dysphagia Approx. 19%/10 Gray beyond a mean dose of 55 Gray [Levendag et al. Radiother Oncol 2007; 85:64-73]
- Incidence of osteoradionecrosis in oropharyngeal cancer treated with IMRT: 5-15%
- Dose escalated IMRT (75Gray/35 fractions with CT) does not improve outcome [Tao Yungan et al. Radiother Oncol, Sep 2020]

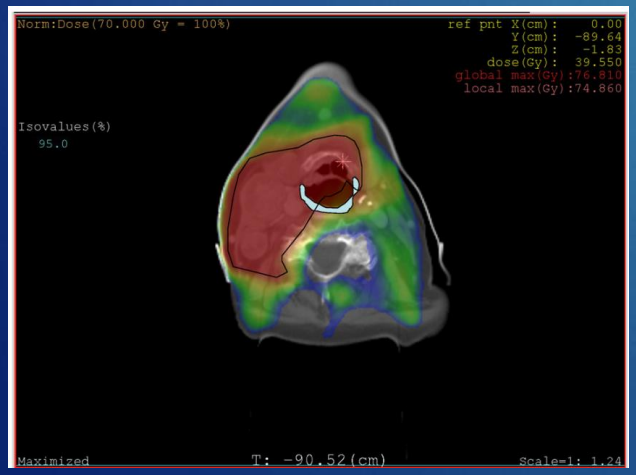
Dysphagia disorders in patients with cancer of the oropharynx are significantly affected by the radiation therapy dose to the superior and middle constrictor muscle: A dose-effect relationship

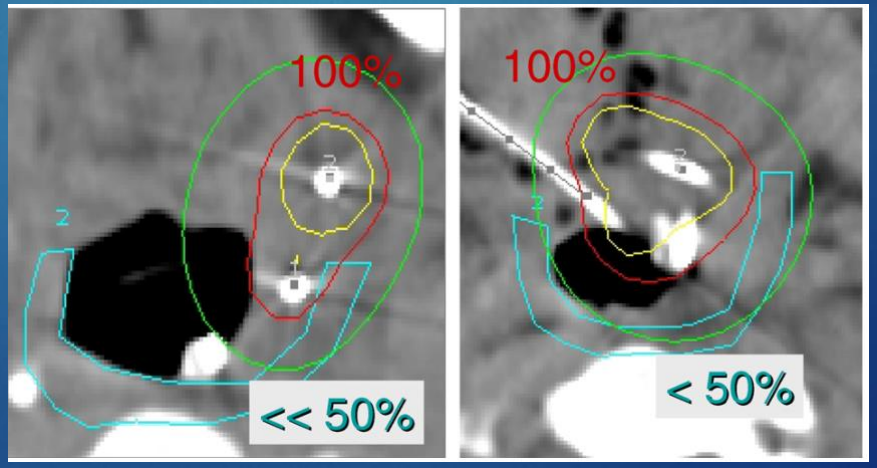
Radiotherapy and Oncology 85 (2007) 64–73
www.thegreenjournal.com

Peter C. Levendag[a,*], David N. Teguh[a], Peter Voet[a], Henri van der Est[a], Inge Noever[c], Wilhelmus J.M. de Kruijf[a], Inger-Karine Kolkman-Deurloo[a], Jean-Briac Prevost[a], Johan Poll[a], Paul I.M. Schmitz[b], Ben J. Heijmen[a]

A steep dose–effect relationship, with an increase of the probability of dysphagia of 19% with every additional 10 Gray, was established







Locoregional Failure Analysis in Head-and-Neck Cancer Patients Treated with IMRT

Gabriela Studer, Urs M. Luetolf, Christoph Glanzmann[1]

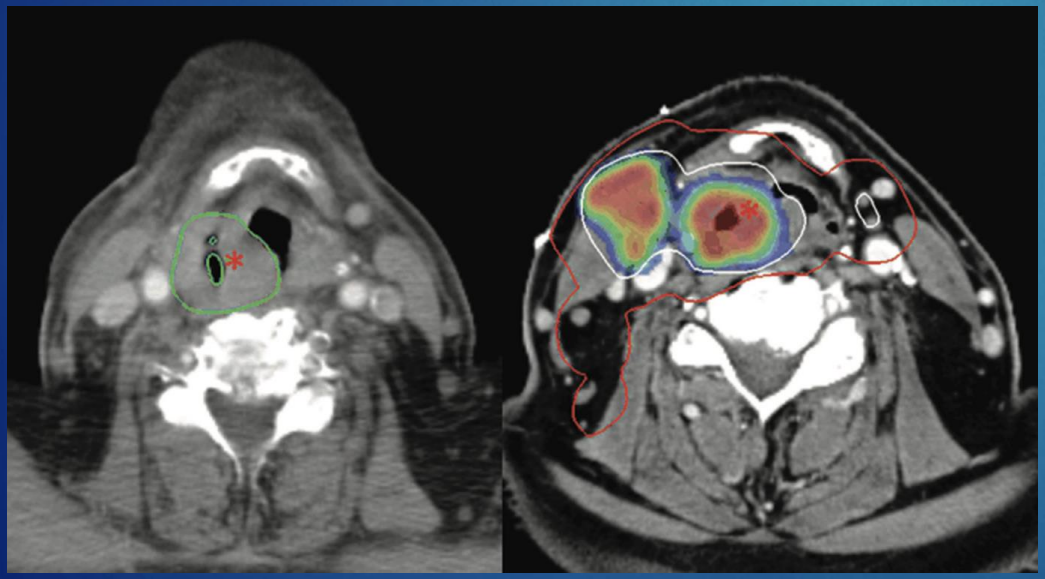
Authors [reference]	Year	Patients (n)	Failures[a] (n)	Site of locoregional failure		
				Inside PTV1 (n)	Marginal (n)	Out of field (n)
Dawson et al. [6]	2000	58	16	10	2	4
Lee et al. [17]	2003	150	10	10	0	0
Chao et al. [5]	2003	165	17	9	3[b]	5
Eisbruch et al. [8]	2004	133	21	17	4	0
Bussels et al. [3]	2004	72	20	15	5[c]	0
Yao et al. [29]	2005	151	11	10	1	0
Own series	2006	280	77	73	1	3
Patients [n (%)]		1,009	172	144 (84)	16 (9)	12 (7)

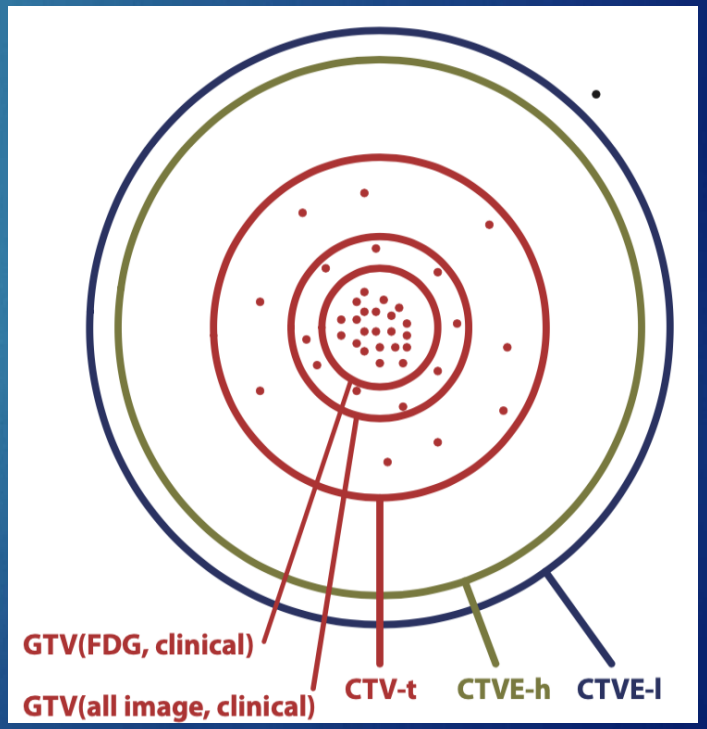
Recurrences after intensity modulated radiotherapy for head and neck squamous cell carcinoma more likely to originate from regions with high baseline [18F]-FDG uptake

Radiotherapy and Oncology xxx (2014) xxx–xxx

Anne K. Due [a], Ivan R. Vogelius [a,*], Marianne C. Aznar [a,b], Søren M. Bentzen [a,c,d], Anne K. Berthelsen [a,f], Stine S. Korreman [b,e], Annika Loft [f], Claus A. Kristensen [a], Lena Specht [a]

520 patients received radiotherapy for HNSCC from 2005 to 2009. Among 100 patients achieving complete clinical response and a later recurrence, 39 patients with 48 loco-regional failures had a recurrence CT scan before any salvage therapy





Rationale for the use of brachytherapy in Oropharynx and Nasopharynx

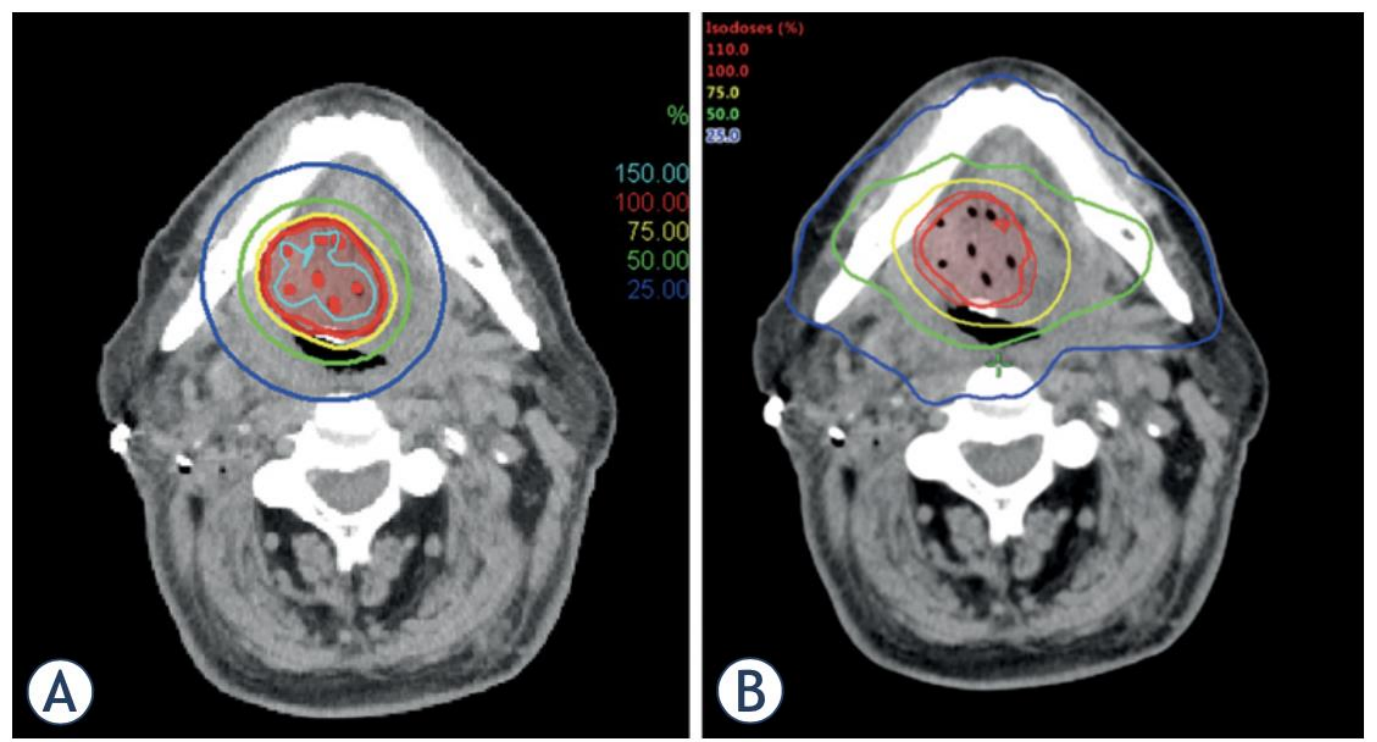
- **Loco-regional failure are predominant pattern of failure and the majority are in high dose areas**
- **Surrounded by critical structures which prohibits dose escalation with EBRT**
- **Re-irradiation is difficult with EBRT and only modest dosage can be allowed**
- **No issue of organ motion with brachytherapy combined with high intra-tumoral dosage and sharp dose fall off in the region of OARs**
- **Better sparing of Parotids, DARS structures and follows principle of ALARA**
- **Advancements: Imaging in BT target, OAR definition, stepping source technology, intensity modulation, medical and physics quality assurance (QA)**

Image guided high-dose-rate brachytherapy versus volumetric modulated arc therapy for head and neck cancer: A comparative analysis of dosimetry for target volume and organs at risk

Hironori Akiyama[1,2], Csilla Pesznyák[1], Dalma Béla[1], Örs Ferenczi[1], Tibor Major[1], Csaba Polgár[1,3], Zoltán Takácsi-Nagy[1,3]

[1] Center of Radiotherapy, National Institute of Oncology, Budapest, Hungary
[2] Department of Oral Radiology, Osaka Dental University, Osaka, Japan
[3] Department of Oncology, Semmelweis University, Budapest, Hungary

Radiol Oncol 2018; 52(4): 461-467.



Outcome of carcinoma oropharynx treated with brachytherapy

Cano *et al.* (34)	88 T1:7, T2:30, T3:22, T4:29	33	18–29.5/3–3.5/fr. (HDR) 18–29.5 (LDR) +50.4–70.2 EBI ± ChT	HDR/LDR (^{192}Ir)	NR	81% (3 y)	4.5% STN
Takácsi-Nagy *et al.* (7)	60 T1:2, T2:5, T3:17, T4:36	60	12–30 (3–4/fr.) +60 EBI ±ChT	HDR (^{192}Ir)	57% (5 y)	47% (5 y)	12% STN, 2% ORN
Johansson *et al.* (36)	83 T1:8, T2:41, T3:14, T4:20	24	35 +1.7 (bid) 40.8 EBI ±ChT	PDR (^{192}Ir)	89% (5 y)	65% (5 y)	6% STN, 7% ORN

Table 4
Results of BT for soft palate, uvula, faucial arch, and tonsil tumor

Author (localization)	*n* and T status	BT and EBI dose (Gy)	Dose rate	LC (y)	OS (y)	Toxicity
Mazeron *et al.* (65) (soft palate, uvula)	165 (64% BT + EBI) T1:58 T2:107	10–51 +45 EBI	LDR (^{192}Ir)	83% (5 y)	46% (5 y)	18% STN
Behar *et al.* (68) (tonsil, soft palate)	37 T1-2:25 T3-4:12	20–40 +40–66 EBI	LDR (^{192}Ir)	75% (5 y)	64% (5 y)	2.7%–2.7% STN and ORN
Pernot *et al.* (66) (velotonsillar area)	361 T1:90 T2:141 T3:119 T4 = 2 (Tx = 9)	20–30 +50 EBI	LDR (^{192}Ir)	80% (5 y)	53% (5 y)	NR
Levendag *et al.* (69) (tonsil, soft palate)	38 T1 = 5 T2 = 22 T3 = 10 T4 = 1	15–27 (3–5/fr.) HDR or 20–28 PDR +46–50 EBI	HDR/PDR (^{192}Ir)	87% (5 y)	60% (5 y)	5% STN
Nose *et al.* (70) (soft palate, faucial arch, base of tongue)	83 T1 = 7 T2 = 47 T3 = 24 T4 = 5	6 × 3.5 +46 EBI or 8 × 6	HDR (^{192}Ir)	84% (5 y)	64% (5 y)	29% STN

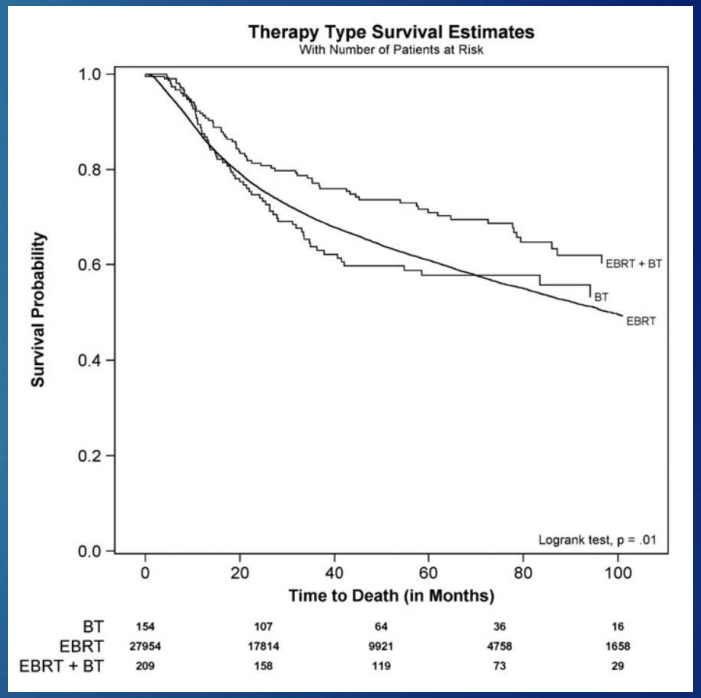
n = number of patients; T = tumor; BT = brachytherapy; EBI = external beam irradiation; LC = local control; OS = overall survival; y = years; fr. = fraction; LDR = low-dose rate; PDR = pulsed-dose rate; HDR = high-dose rate; NR = not reported; STN = soft-tissue necrosis; ORN = osteoradionecrosis.

A National Cancer Database Analysis of the effect of brachytherapy on overall survival in patients with base of tongue cancer

Scott R. Silva MD, PhD[1] | Brendan Martin PhD[2] | Mehee Choi MD[3] | Bahman Emami MD[3] | Newton J. Hurst MD, PhD[4]

Head & Neck. 2019;1–9.

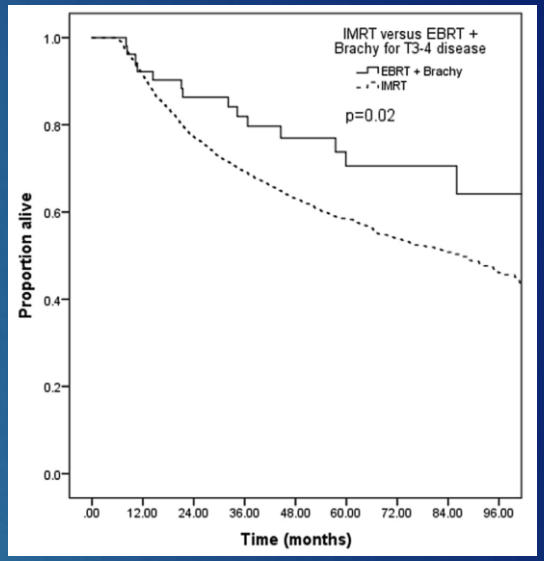
- Approx. 27,000 Patients treated with EBRT alone +/- CT versus 209 patients treated with EBRT+Brachytherapy +/- CT [2004-2013)
- More patients in the EBRT arm received CT (31.4% vs. 25.4%;p<0.001)
- More HPV +ve patient in EBRT arm (12.5% vs. 5.8%; p=0.002)
- Stage III/IV disease were 88% vs. 82% in EBRT vs. EBRT+BT
- 3-year OS was 77.1% vs. 69.6% for EBRT+BT vs. EBRT alone and median OS was 113.6 vs. 98 months

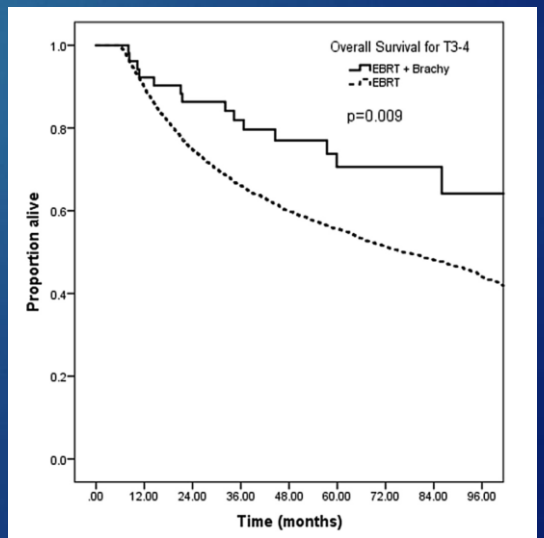


Patterns of care and impact of brachytherapy boost utilization for squamous cell carcinoma of the base of tongue in a large, national cohort

Anna Lee[1,2,*], Babak Givi[3], S. Peter Wu[4], Moses M. Tam[4], Naamit K. Gerber[4], Kenneth S. Hu[4], Peter Han[1], David Schreiber[1,2]

- Brachytherapy 2017
- NCDB analysis of 15,797 EBRT vs. 137 EBRT+BT [2004-2012]. No difference in patient demographics
- EBRT vs. EBRT+BT:
  - 5 years OS 69% vs. 78.3% (p=0.03)
  - For T3-4 tumors: 55.7% vs. 70.6% (p=0.009)
  - For T3-4 tumors: IMRT vs. BT Boost 58.3% vs. 70.6% (p=0.02)
- Brachytherapy boost utilization decreased from 2.1% [2004] to 0.2% [2013]



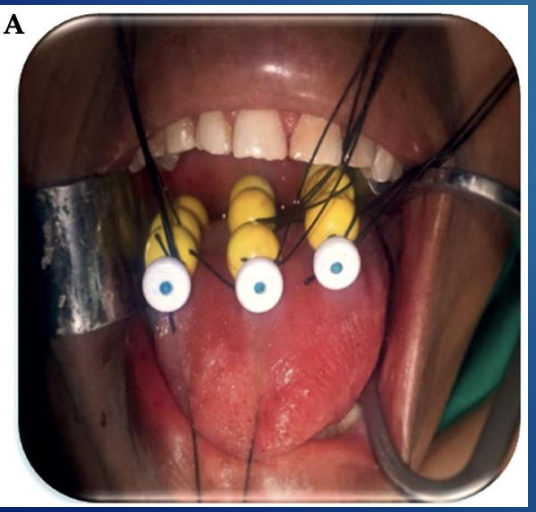


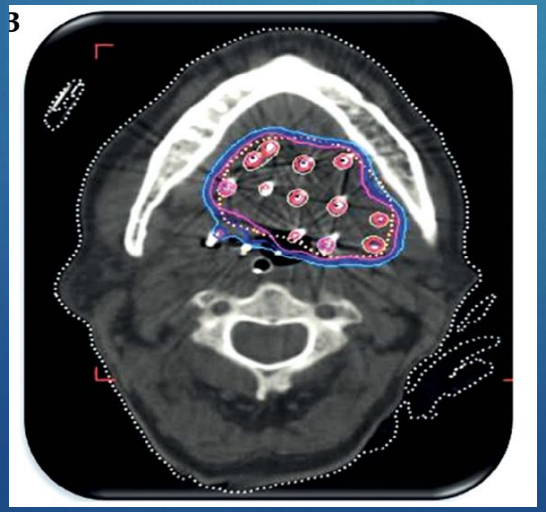
High-dose-rate interstitial brachytherapy in head and neck cancer: do we need a look back into a forgotten art – a single institute experience

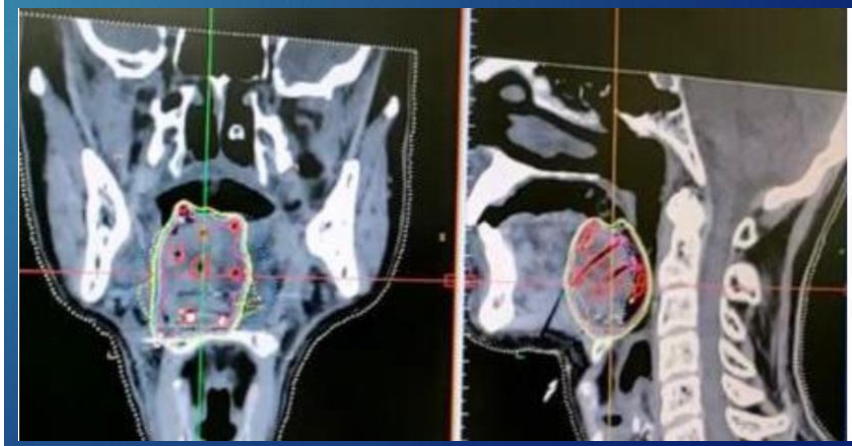
Prof. Rajendra Bhalavat, MD[1], Manish Chandra, DNB[1], Vibhay Pareek, DNB[1], Lalitha Nellore, DNB[1], Karishma George, DNB[1], Nandakumar P.[2], Pratibha Bauskar[2]

[1]Radiation Oncology Department, Jupiter Hospital, Thane (West), [2]Radiation Physics Department, Jupiter Hospital, Thane (West), India

- 58 patients; 20 Oropharynx patients
- Median follow up 25 months (2-84 months)
- DFS and OS at 1 year was 82.7% and 91.3% respectively
- Local control rate for Base of tongue tumors (n=11) was 80%







TREATMENT TECHNIQUES AND SITE CONSIDERATIONS REGARDING DYSPHAGIA-RELATED QUALITY OF LIFE IN CANCER OF THE OROPHARYNX AND NASOPHARYNX

Int. J. Radiation Oncology Biol. Phys., Vol. 72, No. 4, pp. 1119–1127, 2008

David N. Teguh, M.D.,* Peter C. Levendag, M.D., Ph.D.,* Inge Noever, R.T.T.,* Peter van Rooij, M.Sc.,* Peter Voet, R.T.T.,* Henrie van der Est, R.T.T.,* Dick Sipkema, R.T.T.,* Aniel Sewnaik, M.D., Ph.D.,† Robert Jan Baatenburg de Jong, M.D., Ph.D.,† Daniël de la Bije, R.T.T.,* and Paul I. M. Schmitz, Ph.D.‡

Table 5. Poor scores (%) of dysphagia according to the questionnaires European Organization for Research and Treatment of Cancer H&N35, Performance Status Scale (PSS), and M.D. Anderson Dysphagia Inventory (MDADI) in oropharyngeal cancer patients when grouped by boost technique

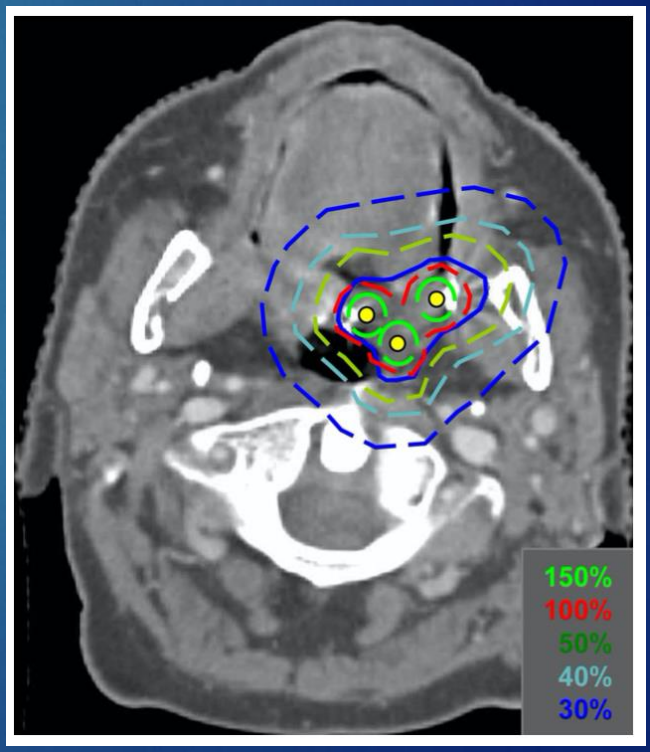
	Dysphagia-related questionnaires		
Boost technique	H&N35 (swallowing)	PSS (normalcy of diet)	MDADI (total)
Brachytherapy (n = 42)	7%	21%	14%
Cyberknife (n = 6)	17%	33%	17%
Intensity-modulated radiation therapy/three-dimensional conformal radiation therapy (n = 12)	42%	58%	58%

Intensity-modulated radiotherapy followed by a brachytherapy boost for oropharyngeal cancer

Abrahim Al-Mamgani, MD, PhD,[1]* Peter C. Levendag, MD, PhD,[1] Peter van Rooij, MSc,[2] Cees A. Meeuwis, MD, PhD,[3] Aniel Sewnaik, MD, PhD,[3] David N. Teguh, MD, PhD[1]

[1]Departments of Radiation Oncology, Erasmus Medical Center – Daniel den Hoed Cancer Center, Rotterdam, The Netherlands, [2]Department of Biostatistics, Erasmus Medical Center – Daniel den Hoed Cancer Center, Rotterdam, The Netherlands, [3]Department of Otorhinolaryngology, Erasmus Medical Center – Daniel den Hoed Cancer Center, Rotterdam, The Netherlands.

- 167 patients [2000-2011] T1-3, N0-3
- 46 Gray IMRT f/b 22 Gray Brachytherapy boost
- Chemotherapy for T3/N3 disease and neck dissection for persistent nodes+ve patients
- 5-year local control, regional control, OS was 94%, 97%, 72%
- Grade 3 late toxicity:0-3%
- QOL scores reverted to baseline within 6-12 months except Xerostomia



Current Management Protocol

Carcinoma Nasopharynx	
Stage T1N0M0	**Radiotherapy alone (66-70 Gray)**
Stage T2N0M0	**CTRT + Adjuvant Chemotherapy** **NACT (2 Cycles) + CTRT** **CTRT**
Stage T3-4N0-3	**NACT (2 Cycles) + CTRT** **CTRT + Adjuvant Chemotherapy**
***Assessment at 10-12 weeks for residual/persistent primary or nodal disease**	

Current clinical outcomes: Nasopharynx

	5year local control rates	5year survival rate	Complications Grade 3 or higher
Conventional RT	T1/2: 70-90% T3/4: 40-80% N2/N3: 70-80%	40-60%	15-30% Grade =>4 at 5, 10 ,20 years: 15, 20, 30% [MDACC]
IMRT	83% [MSKCC] 89% [Wu et al, China] 97% [UCSF]	73% [Wu et al, China] 74% [MSKCC] 88% [UCSF]	Limited data Better salivary functions TLN:10% Symptomatic endocrine dysfunction: 5% [Incidence 60%)
Brachytherapy boost	90-98% [Various series]	-	-

Brachytherapy boost: Nasopharyngeal Carcinoma

TABLE 44.13 ADJUVANT BRACHYTHERAPY BOOST FOR PRIMARY TREATMENT OF NASOPHARYNGEAL CARCINOMA

			Brachytherapy				Local Control	
Author	**T Category[a]**	**External RT Dose (Gy)**	**Modality**	**Dose (Gy)**	**Fraction**	**Day**	**Year**	**Rate (%)**
Chang et al.[207]	T1	65–68	HDR-ICB	5–11	1–2	1–8	5	94
		65–68	HDR-ICB	15–16.5	3	15		80 vs. 74
		68–72	Control	—				(P = .01)
Lee et al.[198]	T1-3	54–72	HDR-ICB or LDR-ICB	5–7 10–54	2	1	5	89
Levendag et al.[194]	T1-2a	60	HDR-ICB	15	5	3	5	92
	T2b	70	HDR-ICB	11	2			
Lu et al.[208]	T1-2	66	HDR-ICB	10	2	8	2	94
Ng et al.[209]	T1-4	43–70	HDR-ICB	6–15	2–5	2–5	5	96
Ozyar et al.[210]	T1-4	59–71	HDR-ICB	12	3	3	5	86 vs. 94
		59–74	Control	—				(P = .23)
Ren et al.[211]	T2b	60	HDR-ICB	12–20	1	1	5	98 vs. 80
		68	Control	—				(P = .012)
Syed et al.[205]	T1-4	50–60	ICB + interstitial	33–37	1	3	5	93
Teo et al.[212]	T1-2a	60–71	HDR-ICB	18–24	3	15	5	95 vs. 90
		60–71	Control	—				(P = .17)
Vikram[213]	T1-4	60–66	Interstitial	160 in 1 yr			5	96
Wang[196]	T1-2	60–64	LDR-ICB	7–10	1	1	5	91 vs. 60
		65–70	Control	—				(P < .01)

Brachytherapy boost in loco-regionally advanced nasopharyngeal carcinoma: a prospective randomized trial of the International Atomic Energy Agency

Rosenblatt *et al. Radiation Oncology* 2014, **9**:67

- 274 patients randomized to either CTRT (70 Gray EBRT with Cisplatin) or same with LDR 11 Gray or HDR 3 Grayx3 boost
- Medina follow up 29 months
- 3Year LRFS was 60.5% vs. 54.4% (p=0.647)
- 3year distant metastasis rate was 59.7% vs. 54.3%(p=0.37)
- Grade ¾ toxicity rates were 21.6% vs. 24.4% (p=0.687)
- Poorer outcome in the control arm as compared to published contemporary literature
- Authors themselves accepted this in discussion but failed to give any explanation

Local control in advanced cancer of the nasopharynx: Is a boost dose by endocavitary brachytherapy of prognostic significance?

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- Pooled analysis of 411 advanced NPC treated by Vienna, Rotterdam and Amsterdam series
- For T1/2N+ tumors, the local relapse rate was significantly smaller if brachytherapy boost was given (0% vs. 14%; p=0.023)
- For T3/T4 tumors, the LRR was not statistically different (10% vs. 15%; p=0.463)

Salvage brachytherapy for locally persistent/recurrent NPC

TABLE 44.15 RESULTS OF LOCALLY PERSISTENT/RECURRENT NASOPHARYNGEAL CARCINOMA TREATED WITH BRACHYTHERAPY

			Brachytherapy			Local Control	
Author	T Category	Modality	Dose (Gy)	Fraction	Day	Time (y)	Rate (%)
Part A. Local persistence							
Kwong et al.[258]	T1	Interstitial gold grain	60			5	87
Law et al.[273]	T1–2a	Iridium mold	40			5	90
Leung et al.[274]	T1–2	HDR-ICB	22.5–24	3	15	5	95
Leung et al.[275]	T2b	HDR-ICB	22.5–24	3	15	5	97
Zheng et al.[276]	T1	HDR-ICB	15–30	5–6	15–18	5	100
	T2	HDR-ICB	15–30	5–6	15–18		90
Part B. Local recurrence							
Kwong et al.[258]	rT1	Interstitial gold grain	60			5	63
Law et al.[273]	rT1–2a	Iridium mold	50–55[a]			5	89
Leung et al.[277]	rT1–2	EBRT + HDR-ICB	50 + 14.8[a]	3	15	3	72

						rT4: 4		
Zheng et al.[285]	2005	86	All 3-D	5	rT1: 92 rT2: 81 rT3: 68 rT4: 41	rT1: 70 rT2: 52 rT3: 32 rT4: 10	49	16
Lu et al.[286]	2004	49	IMRT	3/4	100	NR	NR	NR
Chua et al.[287]	2005	31	IMRT	1	rT1-3: 10% rT4: 35	63	19	7
Koutcher et al.[288]	2010	29	83 % IMRT, 4% 2-D, 13% 3-D	5	52	60	31	17
Ozyigit et al.[289]	2011	51	47% SBRT, 53% 3-D	2	rT1-2: 75 rT3-4: 54	rT1-2: 85 rT3-4: 46	3-D: 48 SBRT: 21	3-D: 19 SBRT: 4
Qiu et al.[290]	2011	70	IMRT	2	66	67	36	NR

Patient selection

- **Oropharynx:**
  - <5cm (BOT, Soft palate, Tonsillar fossa and the vallecula)c/d: Bone invasion, extension to nasopharynx, larynx, hypopharynx, and RMT (GEC-ESTRO 2009)
  - Brachytherapy alone for exophytic tumors <1cm in diameters and for recurrent tumors
  - Combined external irradiation and brachytherapy is recommended as the reference treatment if brachytherapy is indicated in oropharyngeal tumors
  - Intact T1-2 tumors in patients ineligible for surgery as described before but with a substantial risk of lymph node involvement
  - Advanced T3-4 and/or N + tumors that would require surgical resections with functional or cosmetic impact (i.e. cheek, base of tongue, etc.)
  - Tumors of different locations eligible for primary radiotherapy in whom a brachytherapy boost outweighs the discomfort of an interventional procedure (i.e., soft palate, tonsil, etc.)
  - Locally recurrent tumors at primary or nodes

Patient selection: Nasopharynx

- Depth of the target volume <10mm
- Superficial tumors/tumors after EBRT not involving bone or not deeply involving ITF
- Well circumscribed superficial local recurrences
- Brachytherapy boost for T1-2N+ve cases
- Endoscopic guided interstitial and intracavitary brachytherapy for advanced cases possible
- Locally persistent/recurrent tumors

Pre-treatment evaluation

- Detailed examination of head and neck region
- EUA with pan-endoscopy to rule out synchronous lesion
- Pan-endoscopy: Bronchial and esophageal examination
- CT/MRI (medullary space of mandible and inferior alveolar nerve)
- Bone abutment and bone invasion is a contraindication
- Oral hygiene and dental prophylaxis
  - Dental extractions: avoid dental necrosis
- Placement of radio-opaque markers or tattoos if EBRT or NACT is used

General principles

- No concurrent chemotherapy with brachytherapy
- Limit total duration of radiation therapy to <8 weeks
- Gap between EBRT and Brachytherapy <2 weeks
- Adequate mouth opening under nasotracheal intubation
- Small residual lesions after EBRT that can be safely encompassed within the prescription isodose
- Airway protection with temporary tracheostomy, however, it should be discussed case by case depending on the risk assessment of severe dyspnoea
- Wider loops or non-looping techniques if stepping sources are used.
- Have too many catheters rather than too few beyond CTV
- USG or fluoroscopy guidance may be used for placement of catheters
- ABS Guideline 2001:
  - Prophylactic antibiotics to limit secondary infections
  - Corticosteroids to reduce post-operative swelling
  - Preferably sequence brachytherapy after EBRT

Implant technique

- Operating room with anesthesia facility
- Adequate lightening and suction facility
- Catheters spaced 1-1.5 cm; parallel and equidistant
- Looping techniques may be replaced by parallel tubes and dose distribution optimized by increasing dwell times at the blind end [HDR]
- Tracheostomy tube: If vallecular region invaded by large tumor and in recurrent/irradiated patient
- Optimization not a substitute for poor quality implant
- Report doses as per ICRU 58
- CT based planning is recommended

Implant technique: Oropharynx

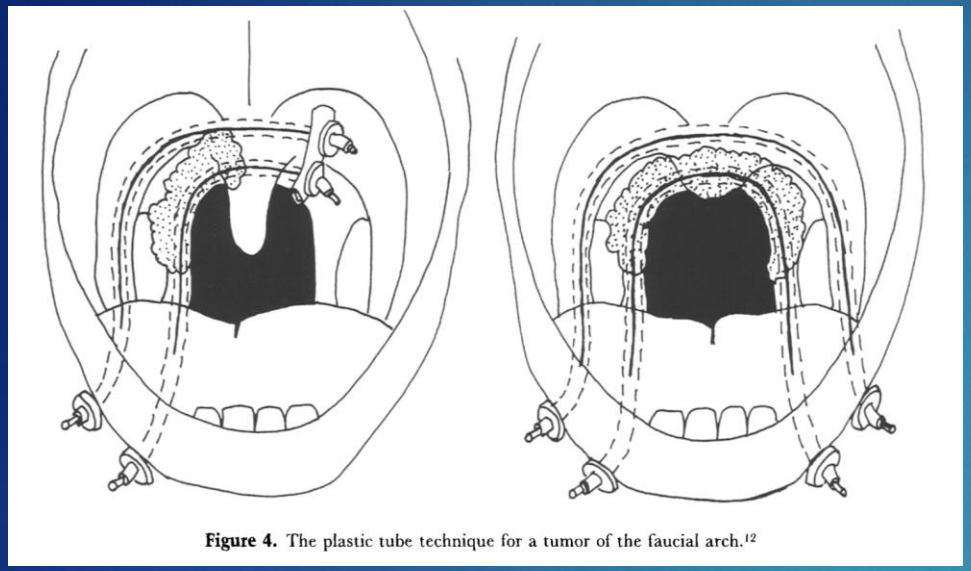
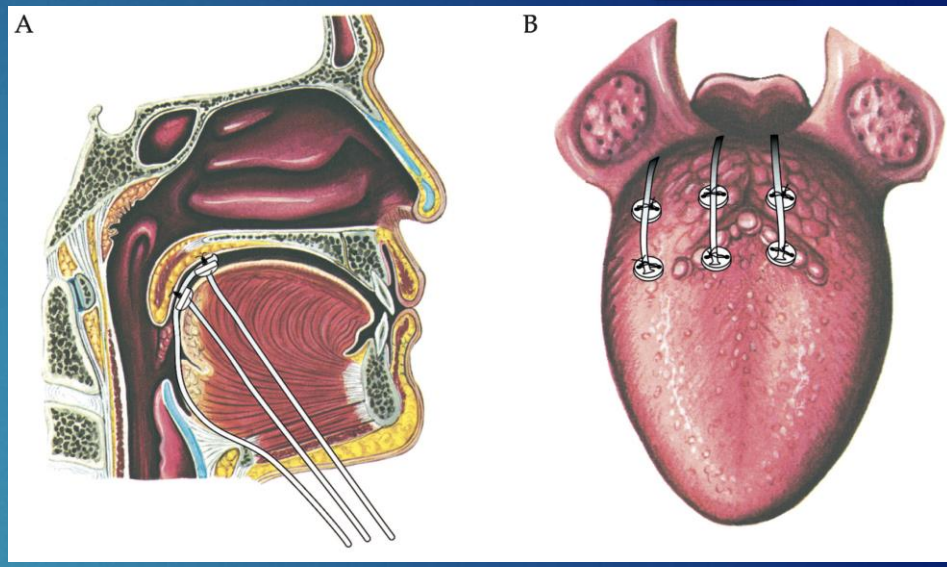
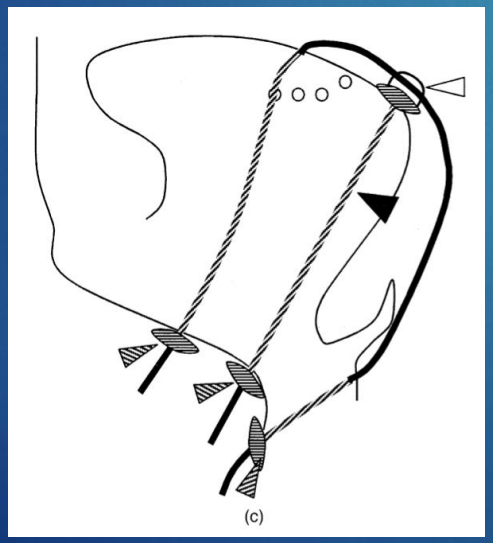
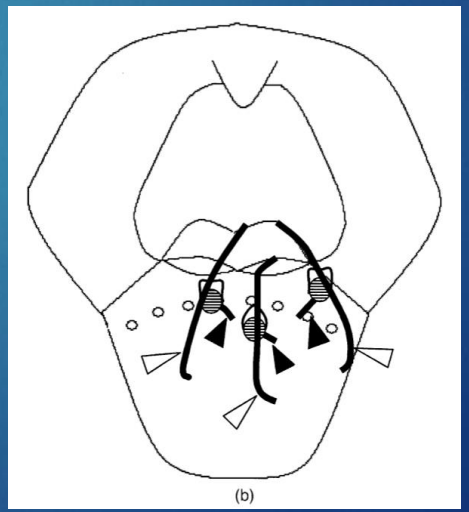


Figure 4. The plastic tube technique for a tumor of the faucial arch.[12]

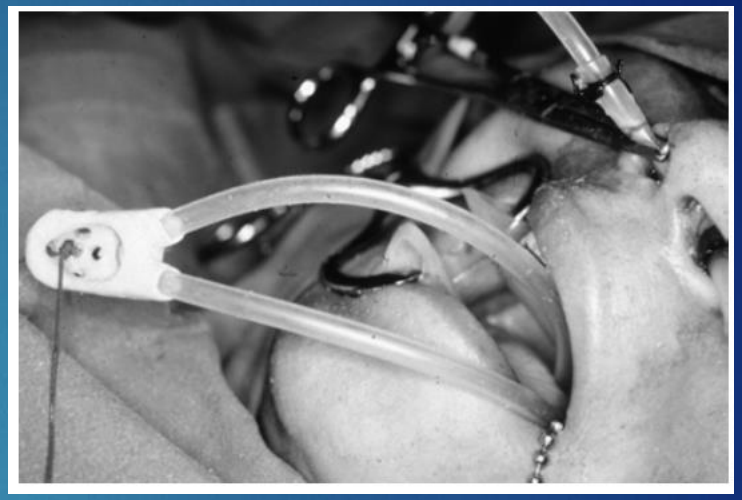


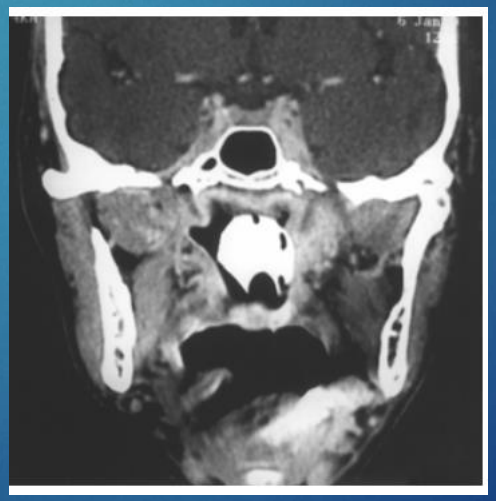


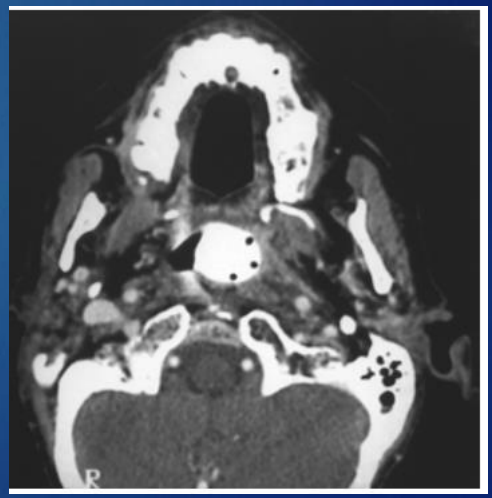


Brachytherapy techniques: Nasopharynx

- Mould Technique
- Rotterdam Nasopharyngeal Applicator
- Massachusetts General Hospital technique: Using two pediatric endotracheal tube
- Trans nasal permanent interstitial implant

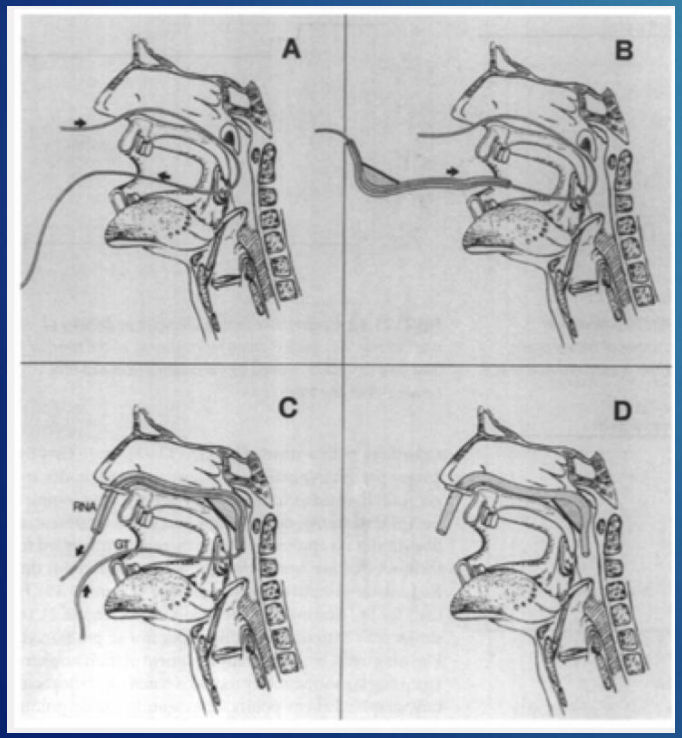


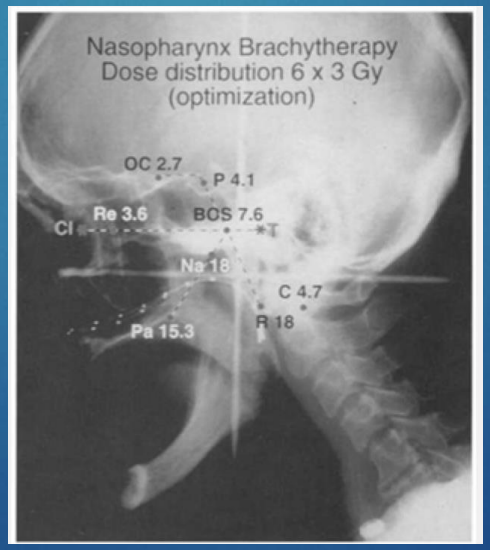


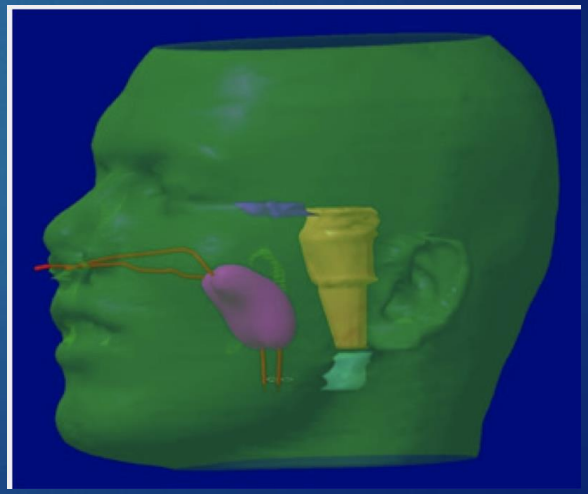


The Rotterdam nasopharyngeal applicator

1. Silicone tubes with outer diameter of 15 French and inner diameter of 9 French
2. Local anesthesia of oropharynx and nasal cavities with 2% Xylocaine spray
3. Flexible guide wire inserted in to one nasal cavity and then taken outside the mouth
4. The applicator is advanced over the guide wires and fixed with clamps







CUSTOMIZED CONFORMAL HIGH-DOSE-RATE BRACHYTHERAPY BOOST FOR LIMITED-VOLUME NASOPHARYNGEAL CANCER

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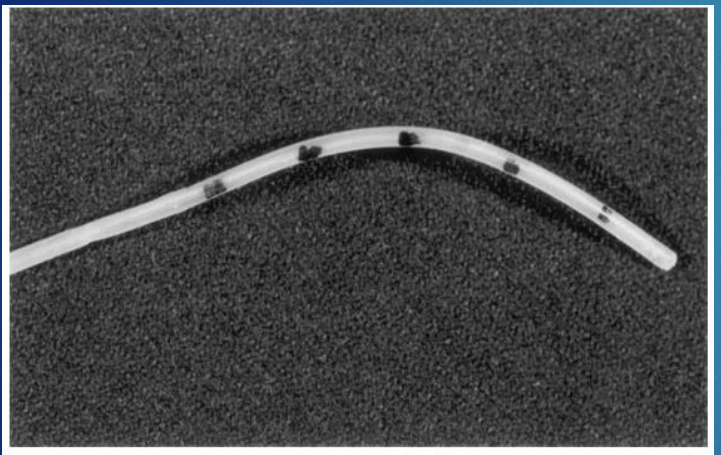
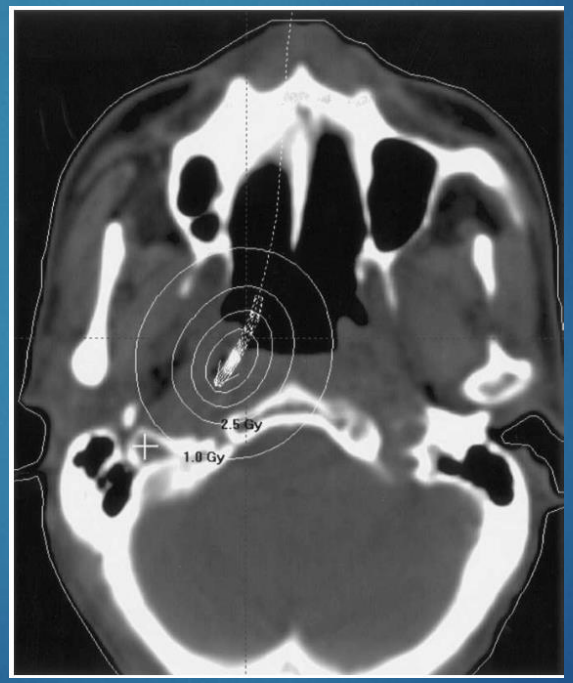
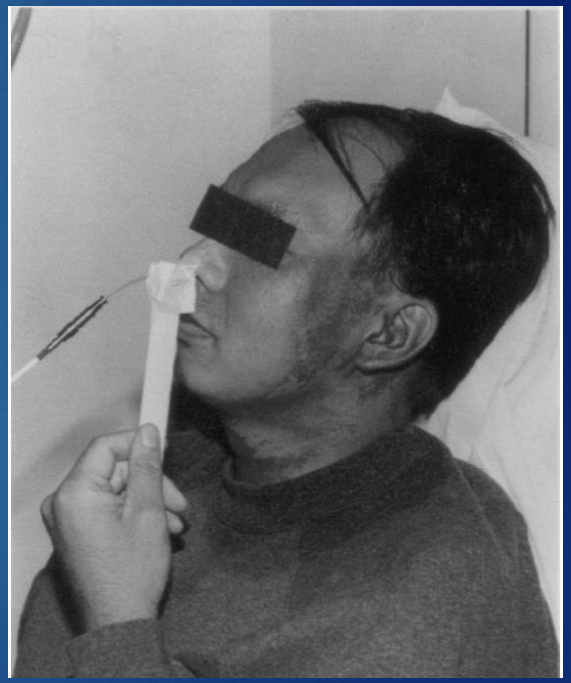
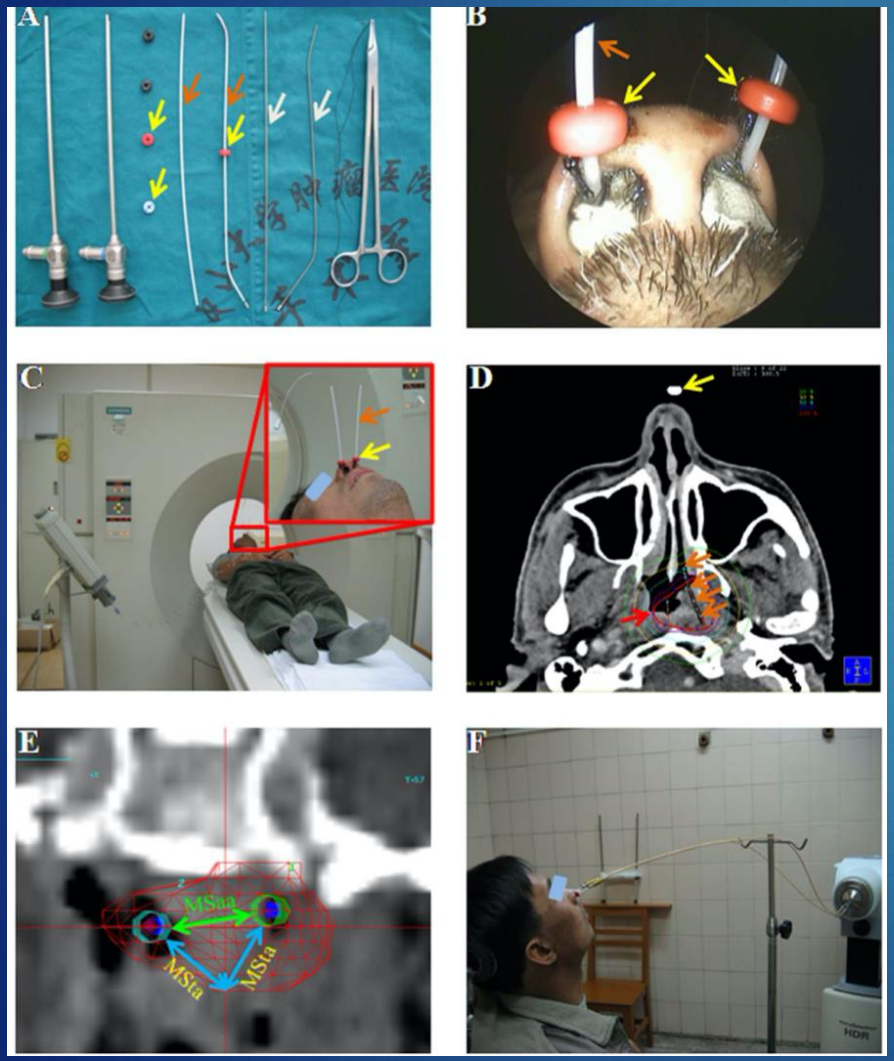


Fig. 1. Customized brachytherapy catheter illustrating typical shape and dwell point markings.





Other applicators/techniques



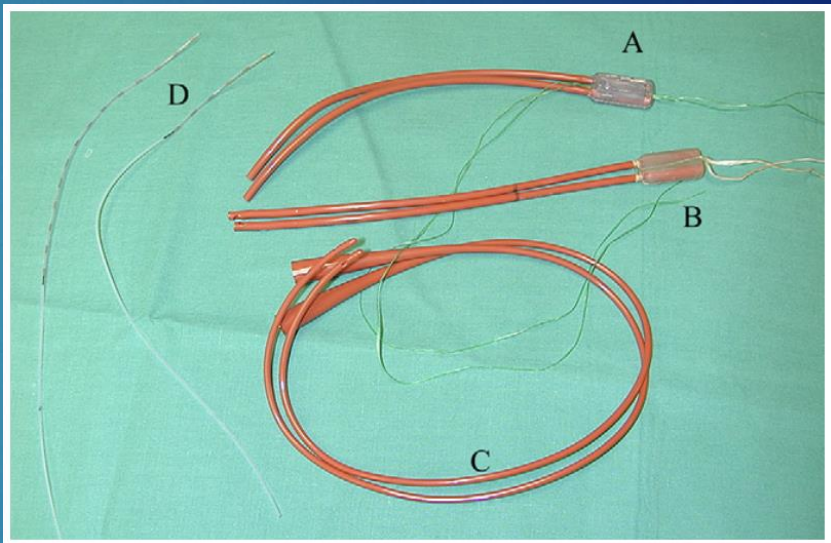


Fig. 1. Nasopharynx applicator set (Mick Radionuclear Instruments, Mount Vernon, NY) consisting of (A) two catheters and a lead shield embedded in a rectangular silastic mold, (B) applicator without lead shield for simulation, (C) insertion catheters, and (D) dummy ribbons used for simulation and localization.

Target Definition

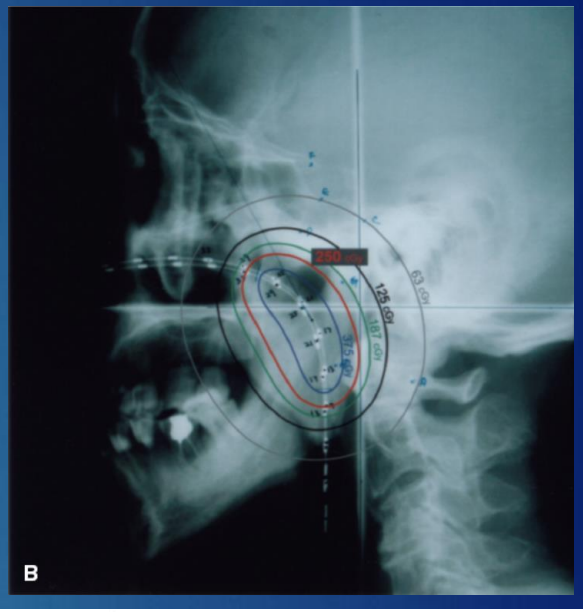
- GTV
- CTV=GTV+ 0.5-1 cm (larger safety margin for base of tongue tumors)
- CTV nasopharynx: Endoscopy, CT scan and MRI
- CTV=PTV
- Minimize skin dose as much as possible and exclude it from CTV [markers placed on the skin surface or CT/MRI planning

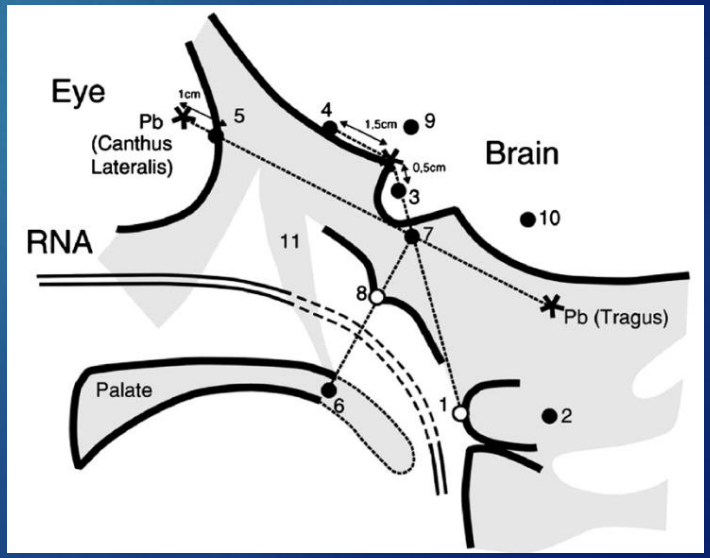
Dose prescription

- **Nasopharynx**
  - **T1: 60 Gray EBRT f/b 18 Gray/6fractions [ABS guideline]**
  - **T2-T4: 70 Gray EBRT f/b 12 Gray/4 fractions**
  - **For recurrent tumors: 60 Gray with brachytherapy alone (LDR-PDR)**
- **Dose Oropharynx:**
  - **21-30 Gray/3 Gray or 21-24 Gray/4 Gray f/b boost 45-50 Gray EBRT**
- **Dose per fraction <3-4 Gray (GEC-ESTRO) or <=6 Gray (ABS Guideline)**
- **Minimum time between fractions=6 hours**

Dose prescription nasopharynx

- Dosimetry is based on two orthogonal films or CT scan slices.
- If CT scan slices are available, the dose is usually prescribed to an isodose covering the surface of the underlying bone, which is situated at 5–10 mm from the mucosal surface.
- Anatomical points related to the target and critical organs that are easy to be identified on lateral and AP X-ray films.
- The dose is prescribed at a reference point situated on the midline of the bony surface of the nasopharyngeal roof





Treatment monitoring and catheter removal

- Adequate analgesic and anti-inflammatory coverage
- Oral hygiene with mouth washes
- Nutritional support through nasogastric tube or gastrostomy
- Patient educated about inflammatory reactions: Starts 7 days after and increases until third week and then stabilizes for one week to decrease by sixth week
- Proper skin care to avoid secondary infections
- Implant removed in OT with preparedness for hemorrhage and airway protection
- Secure IV access and use bimanual compression for 10 minutes for stopping arterial bleeding
- To prevent nasal synechiae after removal of the nasopharyngeal applicator, paraffin-impregnated gauze may be introduced into the nasal cavity and left in place for about 1 week

Plan evaluation and quality indices

- An appropriate implant geometry to the CTV is essential to provide an adequate target coverage and a favourable dose non-uniformity ratio (V100: V150 = DNR). The optimal spacing between applicators is <15 mm
- The prescription dose is usually the minimum dose received by the CTV or a CTV surrogate (i.e., the D90 > 100, V100 > 90%)
- A cautionary measure is to keep the hyperdose sleeves (200% isodose volumes) as thin as possible and not confluent with other applicator sleeves
- DNR should be equal or lower than 0.36 and in IMBT (intensity modulated Brachytherapy) 0.42
- For small GTVs (few cm3 and applicator spacing of less than 10 mm) the DNR may be as high as 0.50–0.52

General quality assurance

- Check manually the clearance of the catheter paths using a dummy wire. Too narrow catheter diameters or kinks can be detected in this way
- Enhance the visibility of plastic catheters thin metal wires may help when inserted into the catheters before scanning the patient
- A CT slice thickness of 0.2–0.3 cm (in small tumours 0.1 cm) should be adequate to accurately reconstruct each individual catheter
- When a patient is disconnected after a treatment fraction, the implant tubes should be closed with mandarins. This is to prevent kinking of the catheters and to keep the inner part of the catheters clean

Take home message

- Brachytherapy in oropharynx and nasopharynx cancer yields superior therapeutic ratio in selected cases
- The role of brachytherapy exists as boost to EBRT for nasopharynx and selected cases of oropharynx
- Brachytherapy is indispensable for recurrent cases of nasopharynx and in selected cases of oropharynx
- Techniques of implantation are easy once the skill is acquired and needs a team approach for successful outcome
- Brachytherapy may yield better organ preservation and lesser late toxicities when employed as part of the treatment in selected cases