

## Head & Neck Brachytherapy: Primary or Salvage — When, Why, Who?

Vratislav Strnad, MD, PhD, Prof.

University Hospital Erlangen  
University of Erlangen-Nürnberg  
Erlangen, Germany

## Disclosure

- Consulting Fees: Elekta Company



## Brachytherapy in Head & Neck Cancer

### Indications

- ✓ Brachytherapy as monotherapy
  - ✓ Brachytherapy only
  - ✓ Brachytherapy as boost

Factor at risk

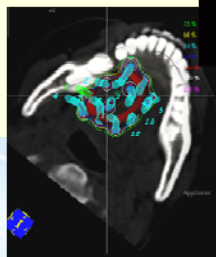
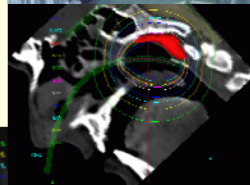
Tumor size

- ✓ Postoperative brachytherapy
  - ✓ Brachytherapy only
  - ✓ Brachytherapy as boost

## Brachytherapy in Head & Neck Cancer

### Techniques, Imaging

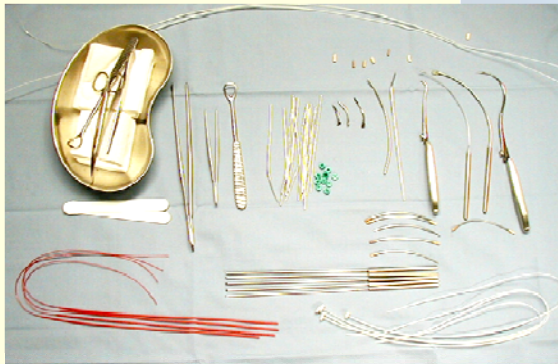
- ✓ Techniques – interstitial, intracavitary
- ✓ Imaging
  - ✓ Clinical feeling (finger, eyes...)
  - ✓ X-ray imaging
  - ✓ CT
  - ✓ MRI
  - ✓ PET-CT





## Technique – Instruments

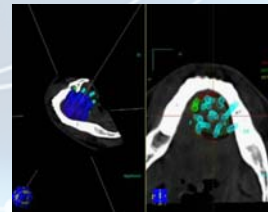
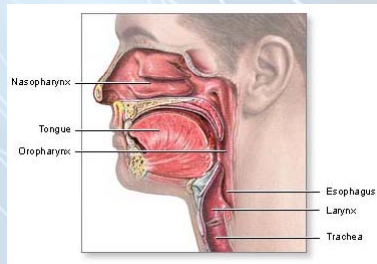
- ✓ Single-leader catheters
- ✓ Double-leader catheters
- ✓ Blind-end tubes
- ✓ Marker pen
- ✓ Forceps
- ✓ Rieman spatula
- ✓ Scissors
- ✓ Needle holder
- ✓ Suture material with needles
- ✓ Various clamps
- ✓ Small and large Reverdin needles



## H&N Brachytherapy – Techniques and Imaging

Cancer of the

- 1 ✓ Lip, buccal mucosa, nasopharynx
- 2 ✓ Oropharynx
- ✓ Oral tongue and floor of mouth





## Lip Cancer and Buccal Mucosa Cancer

### Indications, patient selection

1. Small tumors (<4 cm)
2. Postoperatively if there are the following risk factors:
  - a) Close resection margins
  - b) R1 status
  - c) G3 differentiation
  - d) L1 lymphovascular invasion
  - e) V1 hematogenous invasion

### Contraindication:

1. Significant bone infiltration
2. Fistula

## Cancer of the Nasopharynx

### Indications, patient selection

1. As boost for superficially growing tumors <1 cm
2. Brachytherapy alone is only indicated in a recurrence situation in patients who have previously had radiotherapy

### Contraindication:

1. Tumors >1 cm, bone infiltration
2. Tumors growing outside the nasopharynx



## Technique

✓ Clinical sense

Corner of one's mouth

10 mm

10 mm

## Technique

✓ Clinical sense

**Lip and buccal mucosa**

- ✓ **Brachytherapy only:**
  - PDR: 60-66 Gy/0.5 Gy/h/24 h.
  - HDR: 9x 4.5-5.0 Gy (40.5-45 Gy)
  -
- ✓ **Boost:**
  - PDR: 8-24 Gy/0.5 Gy/h/24 h.

70.9

70 %

80 %

90 %

100 %

120 %

150 %

Appliances

Movie 7



## Technique

### Nasopharynx

- ✓ Boost:
  - HDR: 4-6 x 4.0 Gy
- ✓ Salvage brachytherapy
  - PDR: 60 Gy/0.4-0.5 Gy/h /24 h



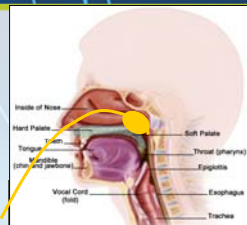
Rotterdam Applicator



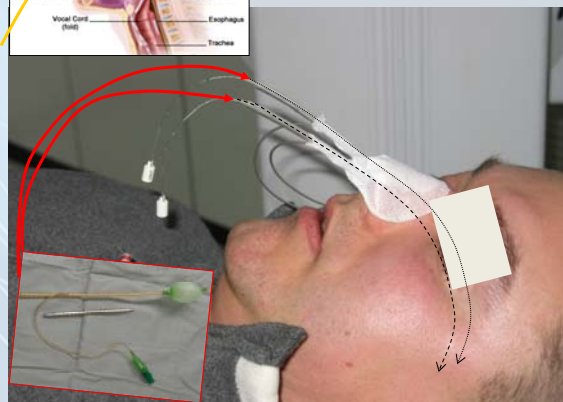
Balloon Applicator



## Technique

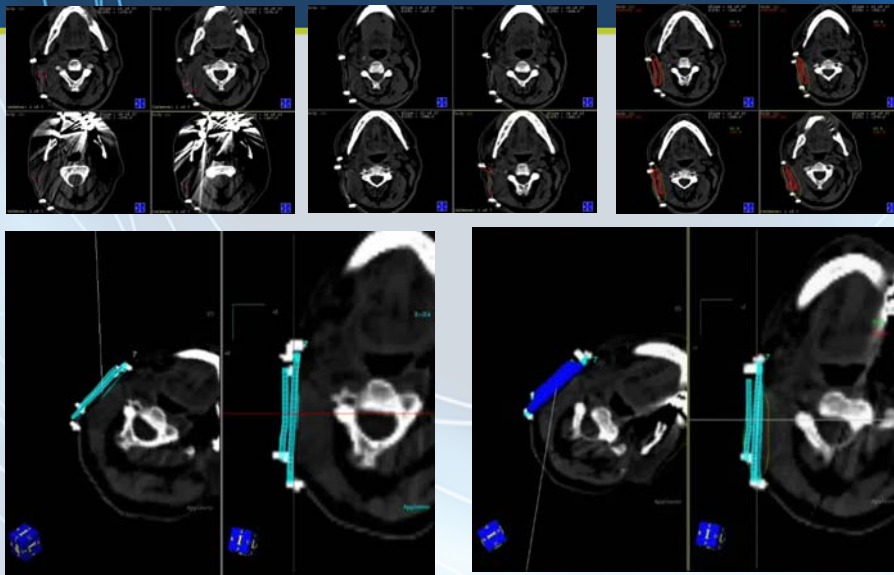


- ➔ Clinical sense X-ray
- ➔ imaging
  - CT
  - MRI

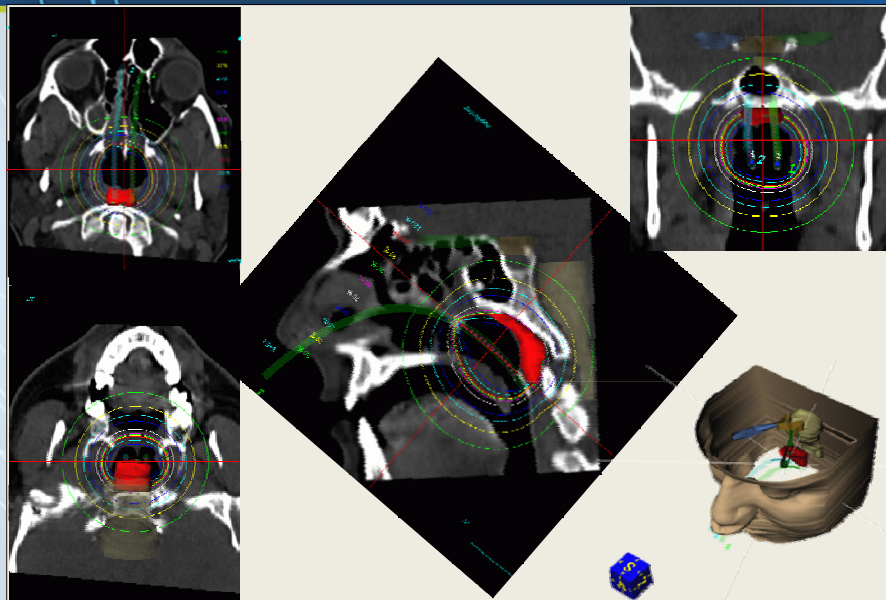




## Target Delineation

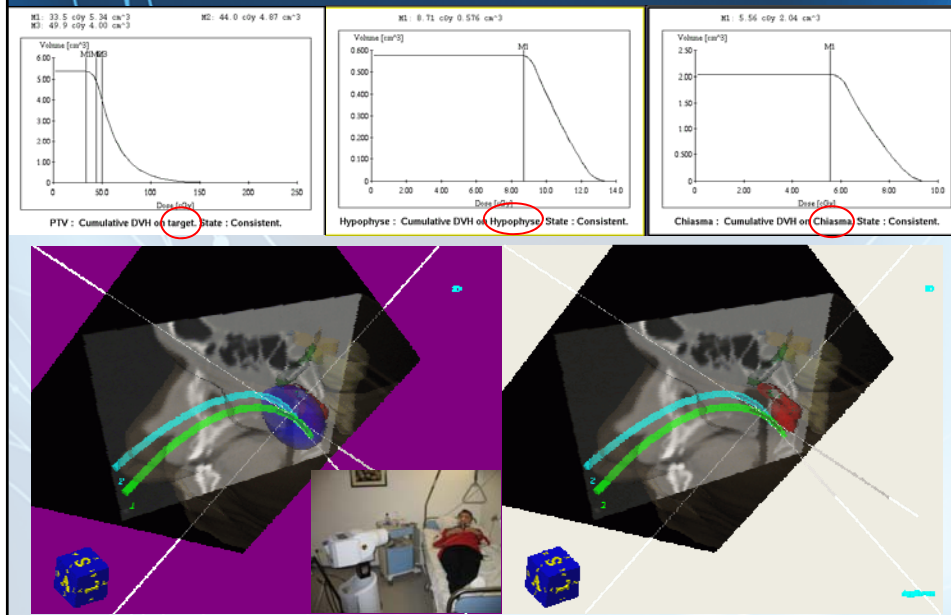


## Target Delineation





## Target Delineation



## Recommendation for Target Delineation

- 1 ✓ Lip cancer, cancer of buccal mucosa
- ✓ Cancer of the nasopharynx

1. CT-imaging = „Gold Standard“
2. Clinical knowledge about tumor size and localization are crucial
3. Value MR- and PET-CT-imaging is not defined



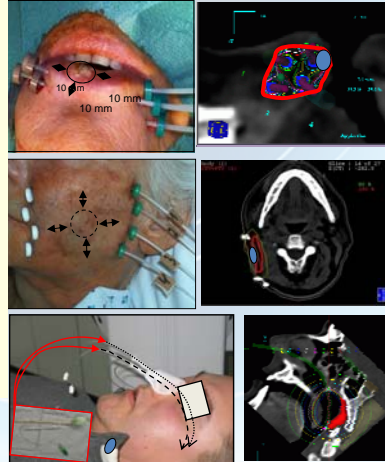


## Recommendations for Target Delineation

1

- ✓ Lip cancer, cancer of buccal mucosa
- ✓ Cancer of the nasopharynx

1. Contouring of **only the CTV** (= PTV) is adequate
2. Preferably encompass the **entire thickness** of the lip, buccal mucosa, mucosa of the nasopharynx
3. **Safety margin** in the lateral and caudal (cranial direction): **PTV/CTV=GTV + 10 mm** in all directions – respecting natural anatomical boundaries!



## Cancer of the Oropharynx, Mobile Tongue and of Floor of the Mouth

### Indications, patient selection

1. Small tumors: <3 (-4) cm
2. Postoperatively alone or as boost after EBRT if following risk factors exist:
  - a) Close resection margins or R1 status
  - b) Depth of tumor infiltration >5 mm
  - c) G3 differentiation
  - d) L1 lymphovascular invasion
  - e) V1 hematogenous invasion

### Contraindication:

1. Significant bone infiltration
2. Fistula



## Technique

Cancer of the

2 ✓

Oropharynx

✓ Oral tongue and of the floor of the mound

### Dose, Dose rate

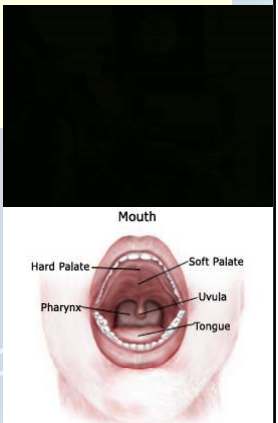
✓ Brachytherapy as monotherapy:

✓ LDR/PDR: **60-70 Gy** (0.3-0.55 Gy/h)

✓ Boost:

✓ LDR/PDR: **14-24 Gy** (0.3-0.55 Gy/h)

✓ HDR: **12-15 Gy** (à 3-4 Gy)

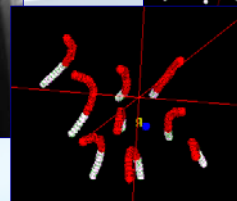
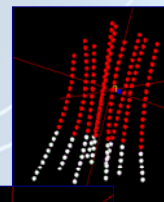
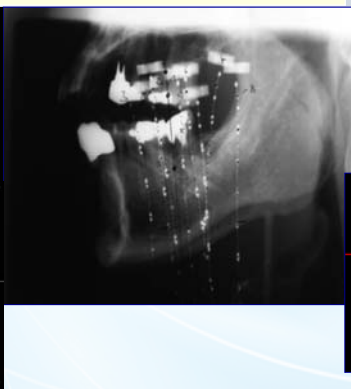
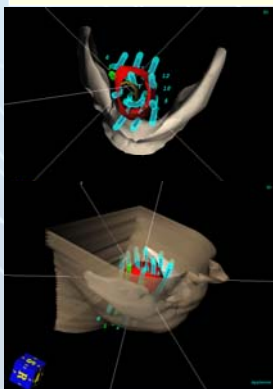


## Technique

✓ **Parallel, equidistant** arrangement of plastic tubes

✓ This makes possible **prediction of dose distribution** already during insertion of catheters

✓ **Distance** of plastic tubes is an important parameter (9-14 mm, max. 17 mm)

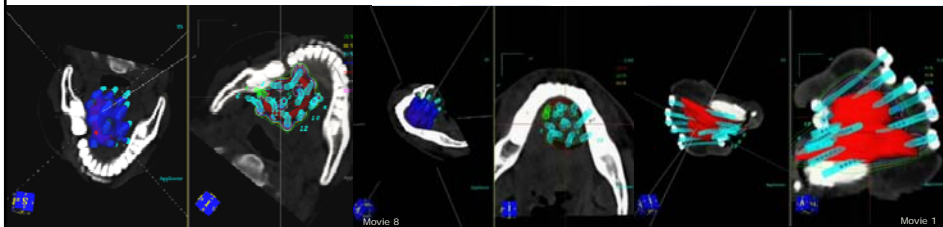




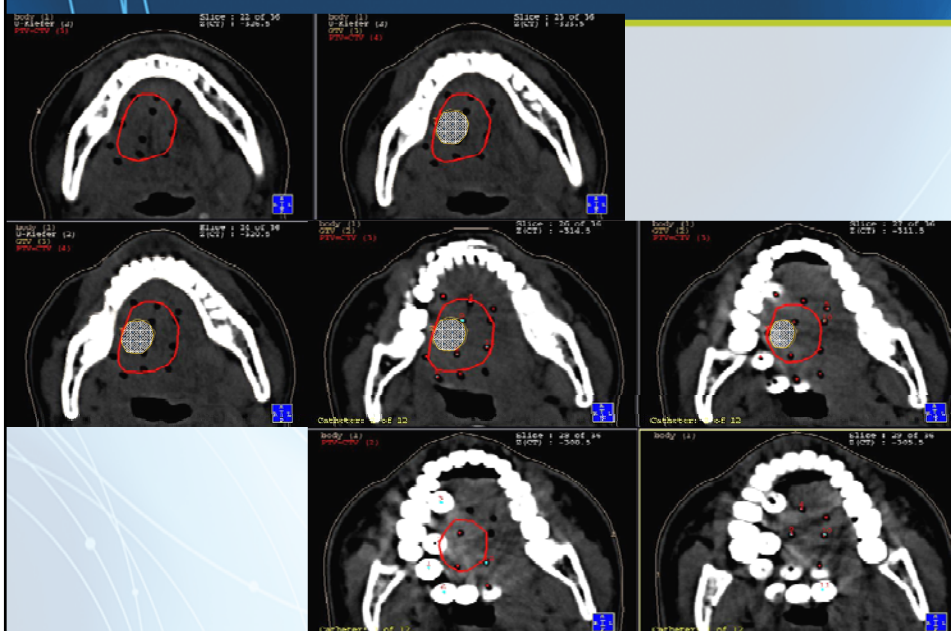
## Technique – Floor of Mouth



IMPLANTATION = INSPECTION, PALPATION!!



## Technique – Mobile Tongue





## Technique – Base of Tongue

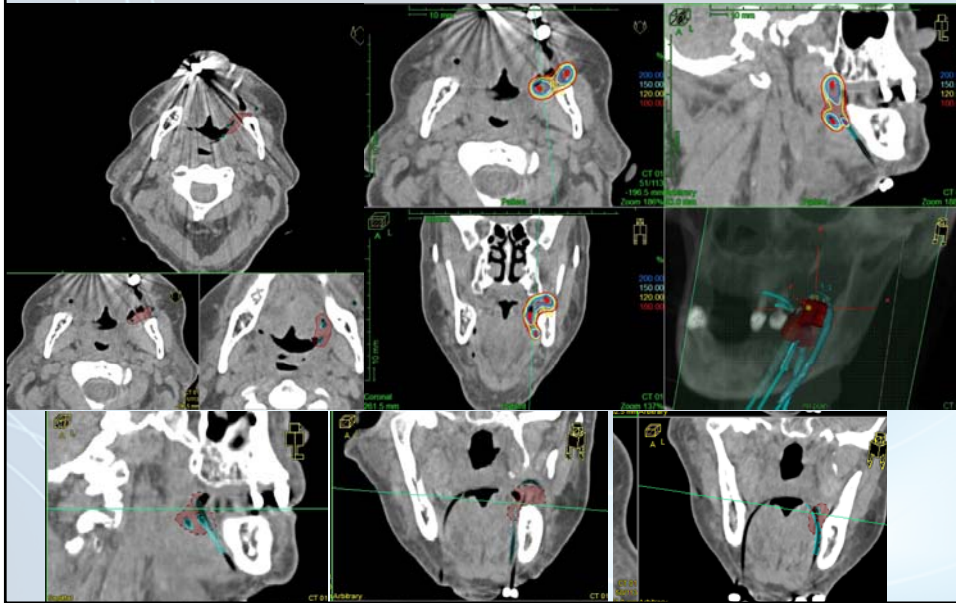
Structure	Mean D (Gy)	Mean D (Gy)	Volume (%)	Volume (cc)
PTX	100.00	20.00	95.00	14.00
PTX	61.04	22.00	100.00	10.20
PTX	100.00	52.00	25.20	3.75
PTX	176.47	65.00	17.00	2.50
PTX	100.00	38.00	97.00	15.70
PTX	100.00	38.00	100.00	14.70
PTX	60.20	30.00	100.00	15.00
PTX	100.00	20.00	100.00	1.00
PTX	100.00	20.00	100.00	1.00
PTX	100.00	52.00	60.17	1.70
PTX	176.47	65.00	13.00	0.60
PTX	100.00	20.00	100.00	1.00
PTX	100.00	20.00	100.00	1.00

## Technique – Soft Palate

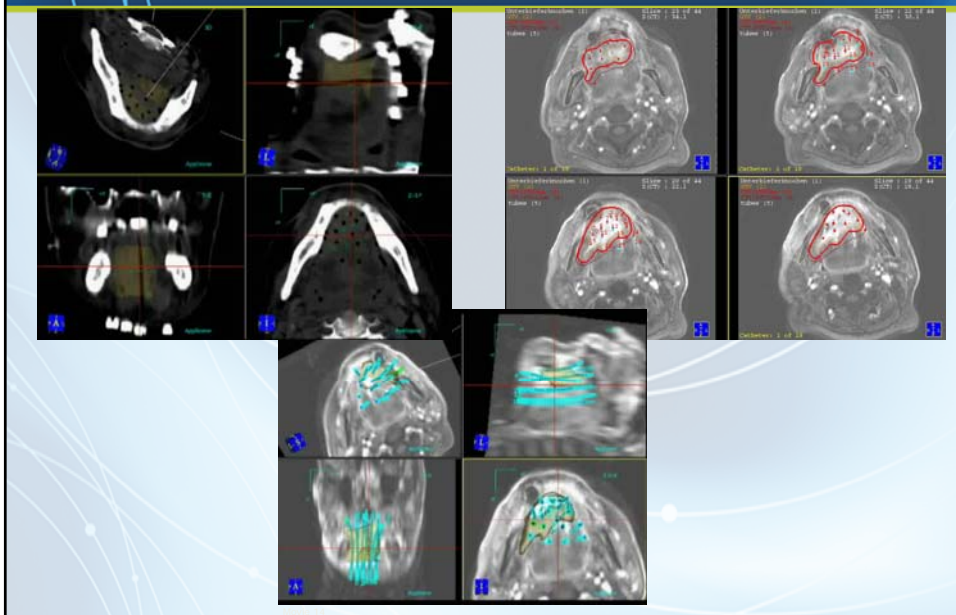


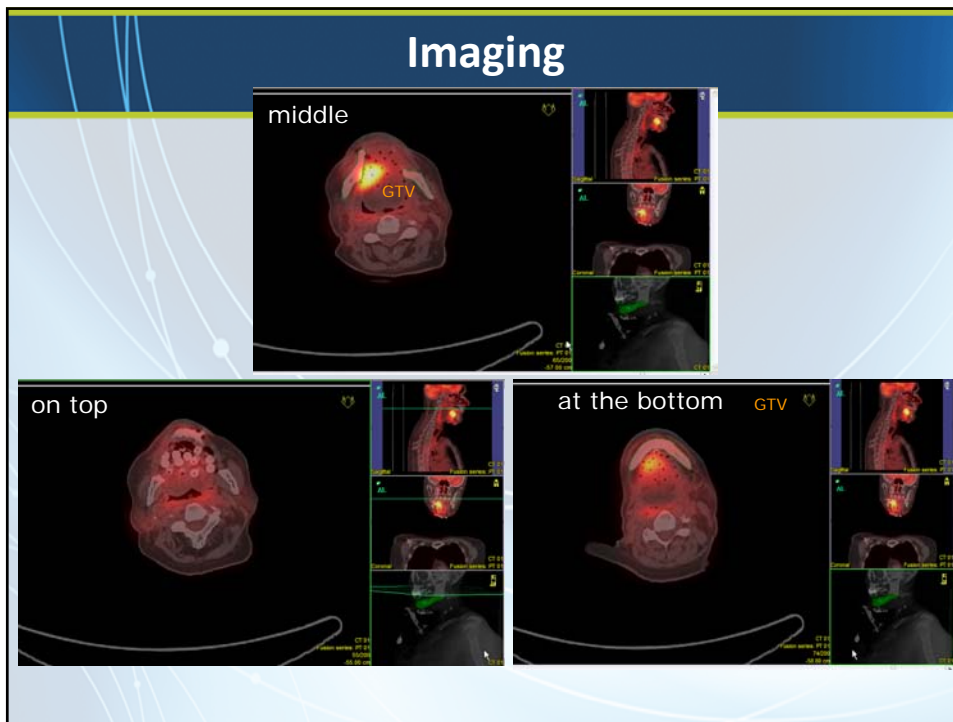
## Technique – Tonsillar Fossa and Regio Retromolare

„Pernot bridge“



## Imaging





## Recommendation for Target Delineation

- ✓ Cancer of the oropharynx
- ✓ Cancer of mobile tongue, floor of mouth

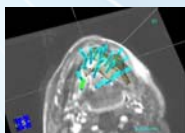
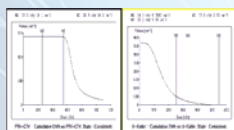
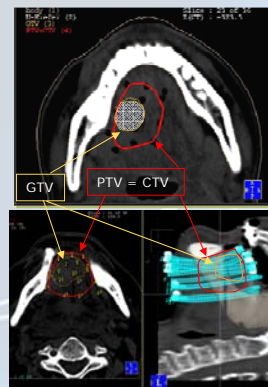
1. **CT imaging** = „Gold Standard“
2. **Clinical knowledge** about tumor size and localization are crucial
3. Value MR- and PET-CT-imaging is not defined



## Recommendation for Target Delineation

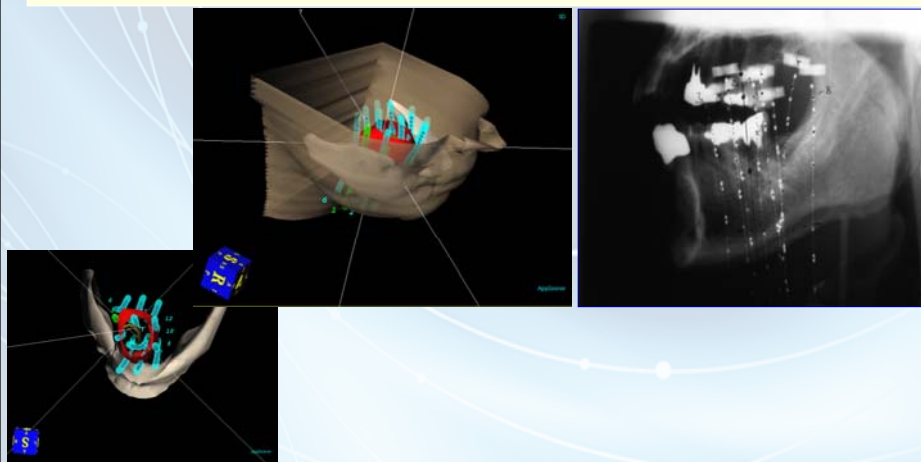
### HOW TO DELINEATE?

- 1. Delineate GTV according clinical sense and CT.** Use of MRI and PET-CT is currently not a standard, but can be useful
- 2. Delineate PTV = CTV lateral 5 mm** in all direction – please respect natural anatomic boundaries (mandible, side of tongue...)
- 3. Delineate PTV = CTV in the depth 10-15 mm**– also here please respect natural anatomic boundaries (skin, mandible)



## Quality Assurance

- ✓ **Parallel, equidistant** arrangement of plastic tubes.
- ✓ **Distancing** of plastic tubes is a important parameter (9-14 mm, max. 17 mm)





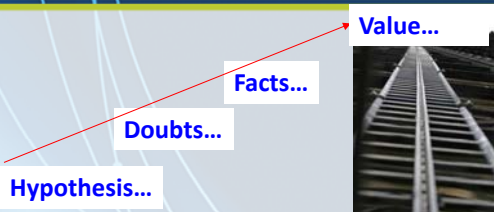
## Quality Assurance

Table 3  
Overview of all analyzed parameters for quality of interstitial HDR-brachytherapy with thresholds (medians) and significances in the  $\chi^2$ -square test ( $\chi^2$ ) and binary logistic regression (BLR)

	Thresholds for low and high category (median)	Range	Soft tissue necrosis		Significance		Incidence of osteoradio necrosis		Significance		Local failure rate		Significance	
			$\chi^2$	BLR	$\chi^2$	BLR	$\chi^2$	BLR	$\chi^2$	BLR				
V85	>26.8 ml >26.8 ml	1.9-72.7	15/176 8.5%	0.253	8/34 23.5%	0.010	5/34 14.7%	6.25%	0.089	0.253	15/176 7.3%	0.253	0.129	
V120	>7.1 ml	0.9-35.5	11/130 8.5%	0.516	12/80 15.0%	0.141	7/130 5.7%	5.7%	0.120	0.260	8/130 6.2%	0.478	0.311	
V150	>4.4 ml	0.7-11.6	22/206 10.7%	0.647	22/206 10.7%	0.364	16/206 7.8%	7.8%	0.652	0.360	15/206 7.3%	0.575	0.495	
Low dose	>4.4 ml >55.8 cGy	22.3-68.8	1/4 33.3%	0.596	8/105 7.6%	0.122	5/105 4.8%	4.8%	0.119	0.789	0/4 0.0%	0.180	0.466	
Peak dose	>64.2 cGy >64.2 cGy	25.2-77.8	15/105 14.3%	0.992	11/108 11.0%	0.714	12/102 11.8%	11.8%	0.028	0.811	5/105 4.8%	0.358	0.069	
High dose	>80.3 cGy >80.3 cGy	54.9-113.0	14/105 13.3%	0.607	9/105 8.6%	0.269	4/105 3.8%	3.8%	0.037	0.176	6/105 5.7%	0.421	0.238	
Uniformity index	<1.91 >1.91	0.86-2.73	7/77 9.1%	0.788	16/133 12.3%	0.511	5/77 6.5%	6.5%	0.640	0.347	3/77 3.9%	0.165	0.148	
Homogeneity index	<0.83 >0.83	0.62-0.89	1/18 5.5%	0.443	22/192 11.5%	0.154	2/18 11.1%	11.1%	0.559	0.648	1/18 5.5%	0.784	0.265	
Quality index	<1.72 >1.72	1.0-2.3	10/103 9.7%	0.571	12/98 12.3%	0.048	7/103 6.6%	6.6%	0.659	0.674	3/103 2.9%	0.020	0.610	
Volume gradient ratio	<1.23 >1.23	0.47-11.1	13/103 12.2%	0.349	12/98 12.3%	0.575	9/98 9.2%	9.2%	0.424	0.190	12/107 11.2%	0.032	0.687	
Dose non-uniformity ratio	<3.6 >3.6	0.1-0.4	16/136 11.8%	0.610	11/112 9.8%	0.609	7/112 6.3%	6.3%	0.458	0.461	12/112 10.7%	0.065	0.084	
Minimal distance	<6.7 mm >6.7 mm	1.0-3.5	7/74 9.5%	0.504	15/101 14.9%	0.082	9/101 8.9%	8.9%	0.497	0.117	2/74 2.7%	0.135	0.484	
Maximal distance	<16.9 mm >16.9 mm	5.1-29.6	8/109 7.3%	0.079	9/103 8.7%	0.313	7/109 6.4%	6.4%	0.336	0.930	5/109 4.6%	0.157	0.847	
Median distance	<13.6 mm >13.6 mm	4.0-15.6	14/107 13.1%	0.291	14/107 13.1%	0.069	6/103 5.8%	5.8%	0.336	0.930	10/103 9.7%	0.157	0.847	
Mean distance	<11.8 mm >11.8 mm	4.5-16.5	9/104 8.7%	0.104	14/106 13.2%	0.806	11/106 10.4%	10.4%	0.307	0.430	5/107 4.7%	0.400	0.608	
			12/104 11.5%	0.104	11/106 10.4%	0.806	6/104 5.7%	5.7%	0.307	0.430	12/104 11.5%	0.015	0.881	
			11/106 10.4%				10/106 9.4%	9.4%			3/106 2.8%			

Significant values ( $p < 0.05$ ) are marked.

## 3D Image-Guided Brachytherapy



**IF YOU ARE GOING TO DOUBT SOMETHING, DOUBT YOUR LIMITS.**  
(DON WARD)



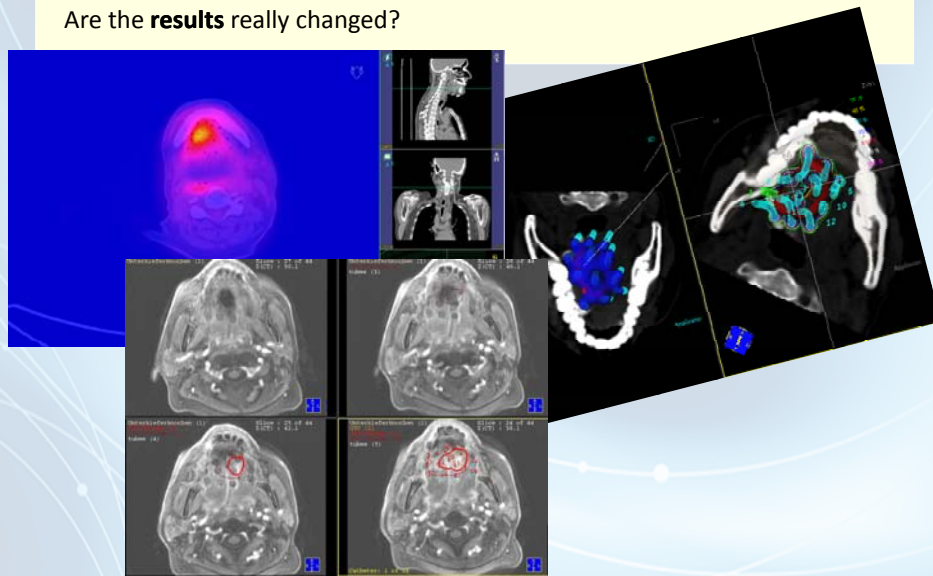




## Value of Image-Guided Brachytherapy...

Is there any **clinical important difference**?

Are the **results** really changed?



## Results

Author, year	Tumor site	n	Dose	Recurrence rate	Serious late side effects
Mazeron 1984	Lip	1267	60-75 Gy	1,6-10 %	3-9 %
Finestres-Zubeldia 2006	Lip	28	60-80 Gy (HDR)	3,5%	10,7%
Conill 2007	Lip	54	60-65 Gy	2%	0%
Guinot 2013	Lip	104	45-50 Gy (HDR)	5%	0%
		99	60 Gy	5%	15%
Pernot 1994	Mobile tongue	448	20-80 Gy*)	T1 7 % T2 35 % T3 51 %	3-6 %
Mazeron 1991	Mobile tongue	166	60-70 Gy	8-11 %	19-36 %
Mazeron 1990	Floor of mouth	117	60-75 Gy	6-35 %	6-24 %
Pernot 1995	Floor of mouth	207	20-40 Gy*)	T1 3 % T2 28 % T3 49 %	6-17 %
Strnad 2013	Mobile tongue / Floor of mouth / Oropharynx	385	24-60 Gy*)	14 %	0,9-3,8 %
Chen 2007	Oropharynx	90	20-24 Gy*)	T1 83% T2/3 79%	14,4%
Lusinchi 1989	Base of tongue	108	22-84 Gy*)	17-49 %	27 %
Karakoyun-Celik 2005	Base of tongue	122	9,6-24 Gy*)	22%	5,7%
Mazeron 1993	Tonsillar fossa	165	31-64 Gy*)	27 %	12,7 %
Gerbaulet 2002	Buccal mucosa	266	65-70 Gy	19 %	15-20 %
Takacs-Nagy 2013	Base of tongue	60	12-30 Gy*) (HDR)	43%	2-12 %
Wang 1997	Nasopharynx	112	7-12 Gy*) (HDR)	18-36 %	ns
Ng 2005	Nasopharynx	38	8-15 Gy*) (HDR)	4%	3%
Thiagarajan 2006	Nasopharynx	33	10 Gy*) (HDR)	6%	0% (Grad 3/4)

\*) = EBRT

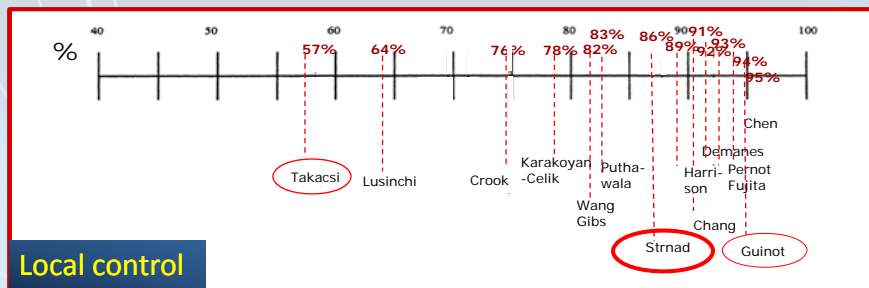


## Results – Last 5 Years

Author_year	Tumor site	n	Dose	Recurrence rate	Serious late side effects
Mazeron 1984	Lip	1267	60-75 Gy	1,6-10 %	3-9 %
Finestres-Zubeldia 2006	Lip	28	60-80 Gy (HDR)	3,5%	10,7%
Conill 2007	Lip	54	60-65 Gy	2%	0%
<b>Guinot 2013</b>	<b>Lip</b>	<b>104</b>	<b>45-50 Gy (HDR)</b>	<b>5%</b>	<b>0%</b>
		<b>99</b>	<b>60 Gy (LDR)</b>	<b>5%</b>	<b>15%</b>
Pernot 1994	Mobile tongue	448	20-80 Gy*	T1 7 % T2 35 % T3 51 %	3-6 %
Mazeron 1991	Mobile tongue	166	60-70 Gy	8-11 %	19-36 %
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Chen 2007	Oropharynx	90	20-24 Gy*	T1 83% T2/3 79%	14,4%
Lusinchi 1989	Base of tongue	108	22-84 Gy*	17-49 %	27 %
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<b>Takacsi-Nagy 2013</b>	<b>Base of tongue</b>	<b>60</b>	<b>12-30 Gy* (HDR)</b>	<b>43%</b>	<b>2-12 %</b>
Wang 1997	Nasopharynx	112	7-12 Gy* (HDR)	18-36 %	ns
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\*) =EBRT

## 3D Image-Guided Brachytherapy Results



Interstitial image-guided brachytherapy provides similar very good local control rates as LDR brachytherapy for patients with head and neck tumors.

Here no benefit of modern brachytherapy detectable.



## 3D Image-Guided PDR Brachytherapy Results

### Grade 3 late side effects (\*)

Surgical treatment necessary

Soft-tissue necrosis 13/39 [13/385, 3.4%]

Bone necrosis 13/18 [13/385, 3.4%]

(\*)

### Centre Alexis Vautrin Classification:

- Grade 1, limited mucosal necrosis or bone exposure
- Grade 2, necrosis > 1 cm or requiring hyperbaric oxygen therapy
- Grade 3, complication requiring surgery or necrosis with sequelae
- Grade 4, lethal complication



Brachytherapy 12 (2013) 101–107



Interstitial pulsed-dose-rate brachytherapy for head and neck cancer—Single-institution long-term results of 385 patients  
Vrtnislav Strnad<sup>a</sup>, Michael Lotter, Stephan Kreppner, Rainer Fietkau  
<sup>a</sup>Division of Interinstitutional Radiation Oncology, Department of Radiation Oncology, University Hospital Erlangen, Erlangen, Germany

## 3D Image-Guided PDR Brachytherapy Results

Author	Year	Pts. (n)	Osteonecrosis	Soft tissue necrosis
Pernot	1996	1334	~4.2% (Grade 3*)	
Lapyere	2004	82	9.8% (Grade 3*)	
Chen	2006	90	3.3%	5.6%
Strnad	2013	385	3.4% (Grade 3*)	3.4% (Grade 3*)
Takácsi-Nagy	2013	60	2% (Grade 3)	12% (Grade 3)
Guinot	2013	90	0	0

(\*)

### Centre Alexis Vautrin Classification:

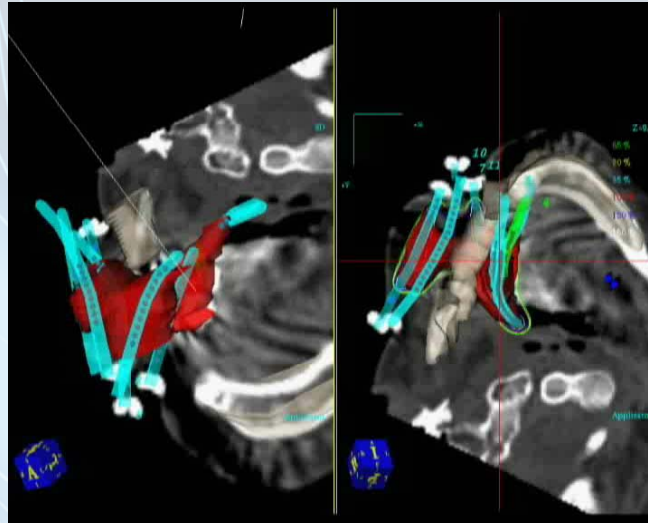
- Grade 1, limited mucosal necrosis or bone exposure;  
Grade 2, necrosis > 1 cm or requiring hyperbaric oxygen therapy;  
Grade 3, complication requiring surgery or necrosis with sequelae;  
Grade 4, lethal complication).

The morbidity associated with image-guided PDR/HDR brachytherapy is in experienced hands low – significant lower than using “classical” LDR brachytherapy

Here the benefit of image-guided brachytherapy seems be present!



## Re-irradiation Using Interstitial Brachytherapy in Patient With Recurrent Head and Neck Cancer



Author, year	Number of pts.	Tumor site	Therapy	Local control	OS	Serious late side effects
Mazeron JJ, et al. 1987 (56)	70	Oropharynx	Ir-192 LDR-BT	72% / 5y.	14%/5y.	27% Grade 3
Levendag PC, et al. 1992 (17)	55	Oral cavity, oropharynx	EBRT EBRT+Ir-192 LDR-BT	29%/5y. 50%/5y.	20%/5y. 20%/5 y.	28% Grade 3
Stevens KR, et al. 1994 (7)	85	Miscellaneous head & neck regions	EBRT Ir-192 LDR-BT	27% / 5y.	17%/5 y.	8.2% Grade 3 and 4
Peiffert D, et al. 1994 (55)	73	Oropharynx	Ir-192 LDR-BT	80-67%/5y.	30%	0% Grade 3/4
Cornes PG, et al. 1996 (1)	39	Neck nodes	Ir-192 LDR-BT	63%/1 y.	na	12% Grade 3
Friedrich RE, et al. 1997 (4)	38	Oral cavity, oropharynx	Ir-192 HDR-BT	59%/1 y.	49%/1 y.	na
Krull A, et al. 1999 (43)	19	Miscellaneous head & neck regions	Ir-192 HDR-BT	34%/2 y.	35%/2 y.	na
Leung TW, et al. 2000 (22)	91	Nasopharynx	EBRT, Ir-192 HDR-BT	38%/5 y	30%/5 y.	73% Grade 3/4
Puthawala A, et al. 2001 (45)	220	Miscellaneous head & neck regions	Ir-192 LDR-BT	51%/5 y.	20%/5 y.	27% Grade 3-4
Fischer M, et al. 2002 (16)	13	Nasopharynx	Ir-192 HDR-BT	na	46%/5 y.	na
Skowronek J, et al. 2004 (28)	47	Miscellaneous head & neck regions	Ir-192 HDR-BT and PDR-BT	15%/0.5y.	na	75% Grade 3
Hepel JT, et al. 2005 (71)	30	Miscellaneous head & neck regions	Ir-192 HDR-BT	69%/1 y.	37%/2 y.	16% Grade 3/4
Martinez-Monge R, et al. 2006 (25)	25	Miscellaneous head & neck regions	Surgery & Ir-192 HDR-BT	86%/4 y.	46%/4 y.	40% Grade 3/ 4
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Tsellei N, et al. 2011 (53)	74	Neck nodes	Ir-192 HDR-BT	67%/3 y.	6%/3 y.	13% Grade 3/4
Jiang P, et al. 2012 (52)	29	Miscellaneous head & neck regions	I-125 LDR-BT	17%/3 y.	27%/3 y.	14% Grade 3
Meng N, et al. 2012 (50)	17	Miscellaneous head & neck regions	I-125 LDR-BT	50%/2 y.	38%/2 y.	na
Bartochowska A, et al. 2012 (3)	156	Miscellaneous head & neck regions	Ir-192 HDR-BT and PDR-BT	19.6%/0.5 y.	17%/2 y.	15% Grade 3
Strnad, V, et al. 2013	104	Oral cavity, oropharynx	Ir-192 PDR-BT ± sim. Chemo	59%/5 y. (all pts.) 48%/5 y. (- sim. Chemo) 76%/5 y. (+ sim. Chemo)	21%/5 y.	3-17% Grade 3/4 (only by 3% surgical treatment necessary)

# BrachyNext

Working Together to Shape the Future of  
Brachytherapy



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last 10 years



## Salvage-Brachytherapy

N = 220

Table 1. Sites of recurrent head-and-neck cancers

Sites	Number of patients
Lip	2
Buccal mucosa	2
Floor of mouth	11
Anterior tongue	9
Hard palate	2
Soft palate	19
Retromolar trigone	2
Tonsillar region	20
Base of tongue	45
Nasopharynx	22
Larynx/pharynx	13
Hypopharynx	8
Neck only	65*
Total	220



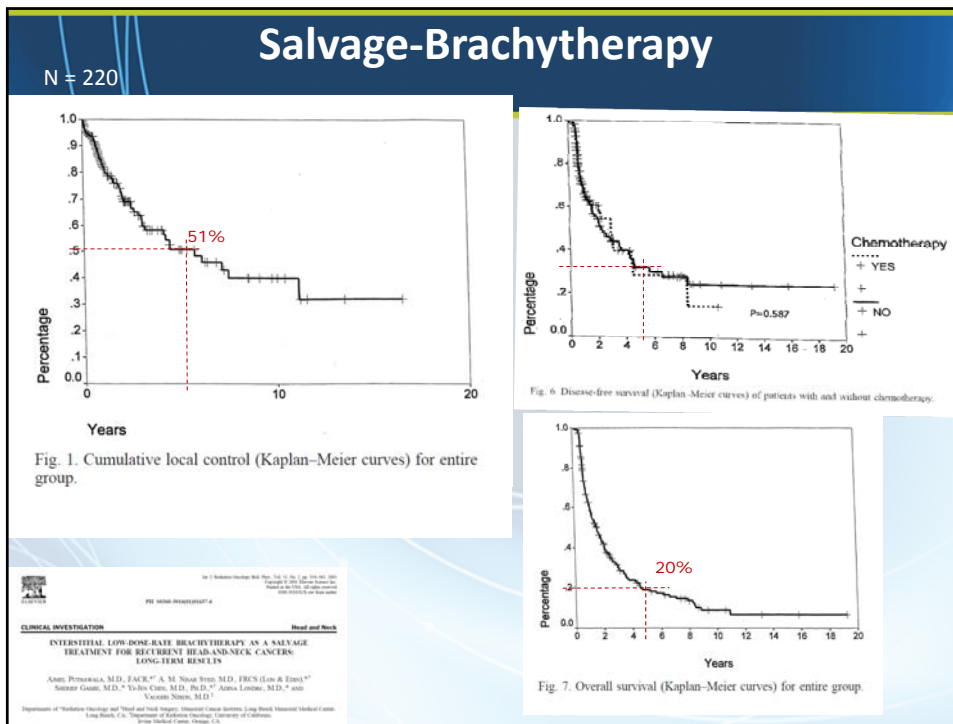
## Salvage-Brachytherapy

N = 220

Table 2. Patient characteristics

Median age	56 years (range 16–88)
Sex	
Male	136
Female	84
Median time interval between prior treatment and recurrence	2.3 years (range 2 months–14 years)
Prior surgery	114 (52%)
Prior radiation	
External only	180 (82%)
External and brachytherapy	40 (18%)
Median dose	5717 cGy (range 39–74 Gy)
LDR brachytherapy reirradiation dose (median)	53 Gy (range 46–60 Gy)
Concurrent chemotherapy	88 (40%)
Interstitial hyperthermia	133 (60%)





## Salvage-Brachytherapy

N = 220

Table 4. Type of late complications

Type	Number of patients
Soft tissue necrosis	28
Osteoradionecrosis	17
Orocutaneous fistulae	3
“Woody” fibrosis	7
Carotid “blowout”	4
Tongue atrophy	6
Dysphagia	8
Severe trismus	4
Hemorrhage	3
<b>Total</b>	<b>80*/220 (36%)</b>

} 22%

\* Twenty patients experienced more than one complication.

**CLINICAL INVESTIGATION** **Head and Neck**

**INTERSTITIAL LOW-DOSE-RATE BRACHYTHERAPY AS A SALVAGE TREATMENT FOR RECURRENT HEAD-AND-NECK CANCERS: LONG-TERM RESULTS**

Amit, P. Prasad, M.D., F.A.C.R.,<sup>1</sup> A. M. Nisar, M.D., F.R.C.S. (Gen & Ears),<sup>2</sup> Srinivas Ganti, M.D.,<sup>3</sup> Yuhua Chen, M.D., Ph.D.,<sup>4</sup> Anita Lomax, M.D.,<sup>5</sup> and V. Srinivas, M.D.<sup>6</sup>

<sup>1</sup>Department of Radiation Oncology and <sup>2</sup>Head and Neck Surgery, Memorial Sloan-Kettering Cancer Center, Long Beach, Memorial Sloan-Kettering Cancer Center, Long Beach, C.A., <sup>3</sup>Department of Radiation Oncology, University of California, Los Angeles, Los Angeles, California, <sup>4</sup>Department of Radiation Oncology, University of California, Los Angeles, Los Angeles, California, <sup>5</sup>Department of Radiation Oncology, University of California, Los Angeles, Los Angeles, California, <sup>6</sup>Department of Radiation Oncology, University of California, Los Angeles, Los Angeles, California



## Salvage-Brachytherapy

N = 104

Table 1: Patients characteristics	
Characteristic	Number of patients, n (%)
Age	58.9 year (range 21-81 y)
Gender	
Male	81 (78.8%)
Female	23 (21.2%)
Primary tumor localization	
Tongue - mobile tongue	99 (97.5%)
Tongue - base of tongue	29 (27.9%)
Floor of mouth	22 (21.2%)
Tonsil/palate	5 (4.8%)
Buccal mucosa	4 (3.8%)
Lip	3 (2.9%)
Nasopharynx	2 (1.9%)
Orbit	1 (1.0%)
Histopathology	
Squamous cell carcinoma	98 (94.2%)
Sarcoma	4 (3.8%)
Other	2 (1.9%)
Grading	
G1	10 (9.6%)
G2	58 (55.8%)
G3	28 (26.9%)
Unknown	8 (7.7%)
Lymphangiosis	
L0	27 (26%)
L1	22 (21.2%)
Unknown	55 (52.9%)
Stage	
rT1	21 (20.2%)
rT2	47 (45.2%)
rT3	12 (11.5%)
rT4	13 (12.5%)
rTx	11 (10.6%)
rN0	24 (23.1%)
rN+	23 (22.2%)
rNx	7 (6.8%)

## Salvage-Brachytherapy

N = 104

**(1) Interstitial PDR-brachytherapy boost**

**23/104 (22%)**

Pulsed IBT: 0.4-0.7 Gy/h/24 h **D<sub>90-95</sub> = 21.6 Gy (Median)**

External beam radiation **53.0 Gy (Median)**

**(2) Interstitial PDR-brachytherapy alone**

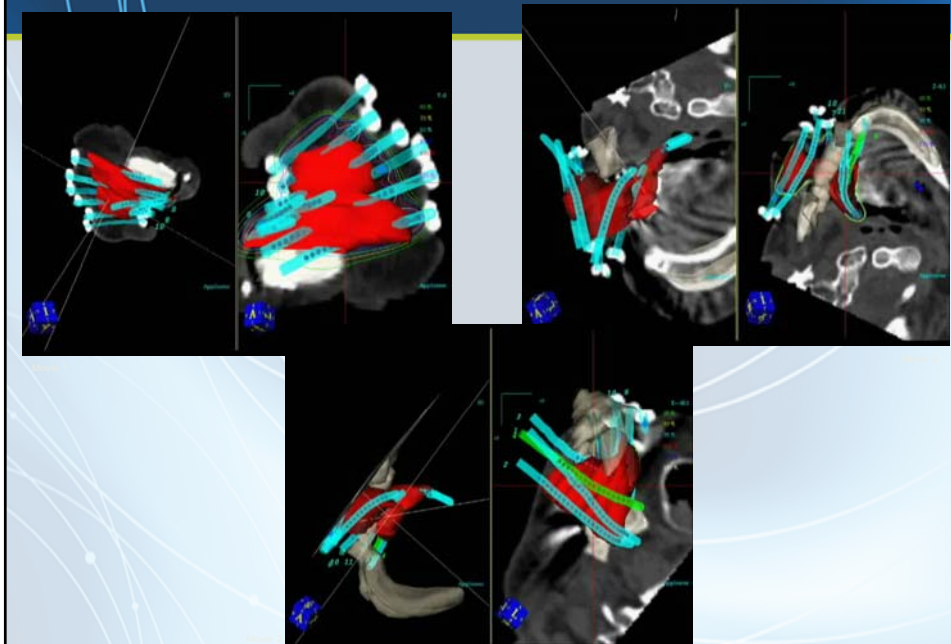
**81/104 (78%)**

Pulsed IBT: 0.5-0.7 Gy/h/24 h **D<sub>90-95</sub> = 56.7 Gy (Median)**





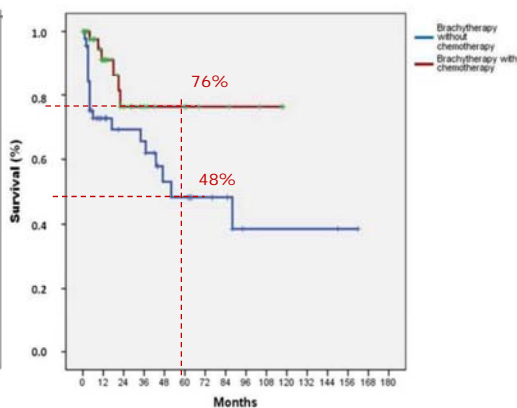
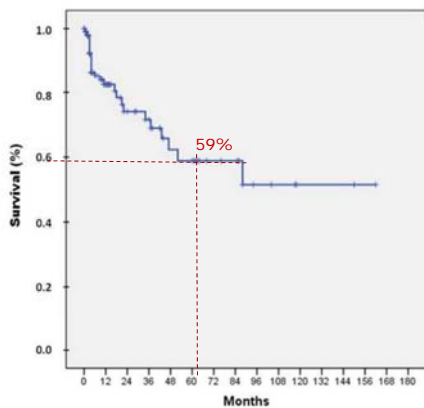
## Re-irradiation – Example



## Salvage-Brachytherapy

N = 104

Local control





## Salvage-Brachytherapy

N = 104

(3)	Soft tissue necrosis	18/104	17.3%
		<i>surgery necessary: 3/104 2.9%</i>	
(4)	Osteoradionecrosis	11/104	9.6%
		<i>surgery necessary: 3/104 2.9%</i>	

## Salvage-Brachytherapy

Re-irradiation using interstitial PDR brachytherapy  
in patient with recurrent head and neck cancer

### Conclusion

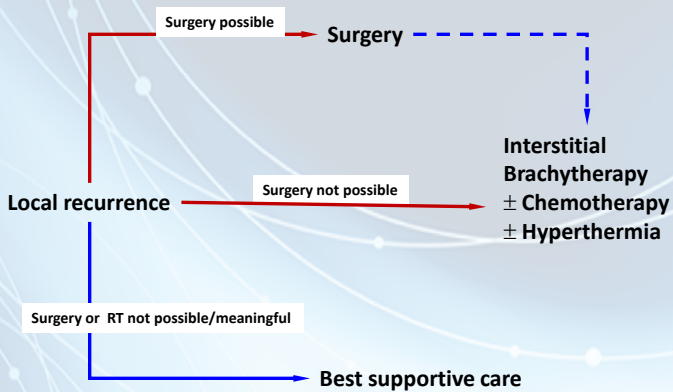
- |    |                                  |        |
|----|----------------------------------|--------|
| 1. | High local control rate          | ≈ 70%  |
| 2. | Low metastases rate              | ≈ 10%  |
| 3. | Acceptable overall survival      | ≈ 50%  |
| 4. | Late toxicity                    | ≈ 10%  |
|    | (soft tissue/osteoradionecrosis) | ≈ 1-3% |

Interstitial PDR brachytherapy is  
**a highly effective and safe treatment option**  
for selected patients with recurrent H&N cancers.



## Take-Home Message

1. Salvage brachytherapy for H&N recurrence is a meaningful treatment option
2. Treat these patients in dedicated centers!



## ...and SUMMARY of all these FACTS??





## Benefit of 3D Image-Guided Brachytherapy

### SUMMARY OF CLINICAL RESULTS

#### 1. LOCAL CONTROL RATES

PDR- (HDR-) brachytherapy is at least **equivalent to LDR brachytherapy** if the pulses were given for 3–7 days once per hour with pulse doses (dp) between 0.4 and 0.7 Gy

#### 2. LATE SIDE EFFECTS

PDR- (HDR-) brachytherapy seems **superior to LDR brachytherapy** – due to the possibility of optimization of the source times – better individualization of dose distribution

## Benefit of 3D Image-Guided Brachytherapy

### SUMMARY OF CLINICAL RESULTS

#### 3. VALUE OF IMAGING

The implantation should be done based particularly on **inspection, palpation** and histology report. **CT, FDG- PET or MRI are useful**, but have crucial limitations

#### 4. RE-IRRADIATION

Interstitial PDR brachytherapy is a **very effective treatment option** for carefully selected patients, those requiring re-irradiation or with disease involving only one site



## Benefit of 3D Image-Guided Brachytherapy

### SUMMARY OF CLINICAL RESULTS

#### 5. QUALITY ASSURANCE – don't forget!

- Dose rate/pulse dose < .57 Gy/h
- Vref < 27 CC (soft tissue necrosis)
- Peak dose < 64 Gy (osteonecrosis)
- High dose < 80 Gy (osteonecrosis)
- QI > 1.72 (LR, soft tissue necrosis)
- Mean distance of tubes ~ 12 mm (soft tissue necrosis)
- Volume gradient ratio > 1.23 (LR)

## ...have fun with brachytherapy!!

The efficacy of PDR-(HDR-)brachytherapy is high, the morbidity in experienced hands low and acceptable, but can be significant and, therefore, **should be performed at centers with adequate experience in planning and implementing these treatments.**

