Brachytherapy in Soft Tissue Sarcomas: When and Where

Dr. D.N. Sharma

Professor,

Department of Radiation Oncology,

All India Institute of Medical Sciences, New Delhi

STS Brachytherapy

- STS brachytherapy is very simple & easy treatment
- No vital organ in the implant area
- Since implant area is located peripheraly, accessibility is very good.
- Surgical resources are used
- Single plane implant, no learning curve
- Brachytherapy is a proven therapy in improving the local control

Soft tissue sarcomas

- Median age of diagnosis - 56 years
- Male : Female – 3.7 : 2.6 per 100,000
- 1% of all new solid tumors in adults
- 4% in childhood

Soft tissue sarcomas

- Around 50 subtypes – WHO
- SEER Database
  - Leiomyosarcoma - 23.7 %
  - MFH - 17.1 %
  - Liposarcoma - 11.5 %
  - Dermatofibrosarcoma - 10.5 %
  - Rhabdomyosarcoma - 4.6 %

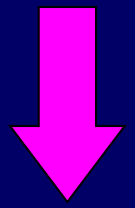
Prognostic Factors

- Positive Margins
- Histological grade
  - Histological type, cellularity, pleomorphism, cellularity, necrosis
- Tumor Size
- Necrosis
- Vascular Invasion
- Tumor Depth
- Location
- Local recurrence

Paradigm shift

- **Changing trends- Extremity sarcomas**

Amputation



Limb Preservation

- NCI trial- Rosenberg et al – Amputation = Limb salvage: (**Comparable Survival**)
- Limb salvage rates: 60% - 1970 = 90% -1990

Localized STS: Clinical categories

- Resectable : Organ preservation
- Borderline resectable: Amputation vs Organ preservation
- Unresectable: RT+CT
- Recurrent: Individualised

R - Classification

R0	The surgical margins are macroscopically and microscopically negative for tumor cells
R1	A surgical margin is microscopically contaminated with tumor cells or the tumor was marginally resected along its pseudocapsule
R2	An intralesional tumor resection was performed

Radiotherapy

Indications For Adjuvant Radiotherapy

Yes	No
• High grade	Superficial
• Size > 5cms	Low Grade
• Recurrent Tumor	Size < 5 cm
• Revision surgery (30-60%)	
• Deep/ Truncal /Neurovascular	

Adjuvant treatment

- Amputation vs. Limb sparing Surgery
  + post operative RT (300pts): Advantage of post op RT

Lindbrg et.al.Cancer:2391,1981.

- Brachytherapy vs.No Brachy.Boost dose
  Improves Local control.

Brennan et.al.ArchSurg 122:1289,1987

-

PORT : Techniques and doses

- Clinical Target Volume: gross tumor area + margin (Surgical, MRI / CT findings, Scars, Drain sites)
- Brachytherapy alone (45-50 Gy)
- EBRT alone (60 Gy)
- EBRT + Brachy (50 Gy + 16 Gy)

Total Dose = 60-66 Gy

Brachytherapy

– **Brachytherapy alone (as Monotherapy)**
  - Completely resected
  - High grade
  - Size < 10 cm
  - Even surface of Tumor Bed

– **BRT + EBRT** (All pts not suitable for brachy alone)

Table 2
Outcomes of EBRT with a brachytherapy boost

Series	Reference	Year	*N*	Modality	BT dose (Gy) × fractions	EBRT dose (Gy)	FU (mo)	LC (%)	Complications (Grade >2)
Alekhteyar	(39)	1996	18	LDR BT + EBRT	15–20	45–50	22	90	27
Chaudhary	(40)	1998	118	LDR BT + EBRT	To keep total dose 70 Gy	45 (12–70)	40	71	<1%
Delannes	(46)	2000	58	LDR BT + EBRT	20 (12–25)	45–50	54	89	17
Chun	(47)	2001	17	HDR BT + EBRT	2–3 × 6	36–60	31	100	12
Andrews	(37)	2004	25	LDR BT + EBRT	16 (10–20)	50	69	90	8
Lazzaro	(42)	2005	24	PDR BT + EBRT	15 (10–29)	50 (40–66)	34	92	16
Martinez-Monge	(48)	2005	35	HDR BT + EBRT	4 × 4–8	45	23	100	28
Aronowitz	(49)	2006	12	HDR BT + EBRT	3–5.5 × 3–4	45–50	34	83	6
Llacer	(50)	2006	73	LDR/PDR BT + EBRT	20	46 (45–50)	58	90	44
Mierzwa	(44)	2007	19	LDR BT + EBRT	25	45	39	100	21
Laskar	(43)	2007	100	LDR/HDR BT + EBRT	23.9	46 (20–50)	45	83	30
Pohar	(51)	2007	37	LDR/HDR BT + EBRT	LDR 15–20.5, HDR 3–5 × 3–4	45–50	24	94	19
Beltrami	(52)	2008	112	LDR BT + EBRT	35 (15–46)	44 (25–70)	75	87	12.5
Muhic	(53)	2008	39	PDR BT + EBRT	20	46	41	83	21
Petera	(36)	2010	34	HDR BT + EBRT	3 × 8	45–50	38	85	NR
San Miguel	(54)	2011	60	HDR BT + EBRT	4 × 4–6	45	49	77	30
Emory	(16)	2012	12	HDR BT + EBRT	3.4 × 4	54.8	11	83	NR
Sharma	(55)	2015	52	HDR BT + EBRT	4 × 4	50	46	100	17

ELSEVIER

CrossMark

BRACHYTHERAPY

Brachytherapy 14 (2015) 571–577

Perioperative high-dose-rate interstitial brachytherapy combined with external beam radiation therapy for soft tissue sarcoma

Daya Nand Sharma[1,*], S.V. Suryanarayana Deo[2], Goura Kisor Rath[1], Nootan Kumar Shukla[2], Sameer Bakhshi[3], Ajeet Kumar Gandhi[1], Pramod Kumar Julka[1]

[1]*Department of Radiation Oncology, All India Institute of Medical Sciences, New Delhi, India*
[2]*Department of Surgical Oncology, All India Institute of Medical Sciences, New Delhi, India*
[3]*Department of Medical Oncology, All India Institute of Medical Sciences, New Delhi, India*

AIIMS Protocol

Day 0: Surgery + Intra-operative Brachytherapy Implantation

↓

Day 2: CT Scan Based Brachytherapy Planning

↓

Day 3-5: Brachytherapy Treatment (16 Gy/4F/2days)

↓

Day 28 onwards: External Beam RT (50 Gy/25F/5 wks)

Table 2
Outcomes of EBRT with a brachytherapy boost

Series	Reference	Year	*N*	Modality	BT dose (Gy) × fractions	EBRT dose (Gy)	FU (mo)	LC (%)	Complications (Grade >2)
Alekhteyar	(39)	1996	18	LDR BT + EBRT	15–20	45–50	22	90	27
Chaudhary	(40)	1998	118	LDR BT + EBRT	To keep total dose 70 Gy	45 (12–70)	40	71	<1%
Delannes	(46)	2000	58	LDR BT + EBRT	20 (12–25)	45–50	54	89	17
Chun	(47)	2001	17	HDR BT + EBRT	2–3 × 6	36–60	31	100	12
Andrews	(37)	2004	25	LDR BT + EBRT	16 (10–20)	50	69	90	8
Lazzaro	(42)	2005	24	PDR BT + EBRT	15 (10–29)	50 (40–66)	34	92	16
Martinez-Monge	(48)	2005	35	HDR BT + EBRT	4 × 4–8	45	23	100	28
Aronowitz	(49)	2006	12	HDR BT + EBRT	3–5.5 × 3–4	45–50	34	83	6
Llacer	(50)	2006	73	LDR/PDR BT + EBRT	20	46 (45–50)	58	90	44
Mierzwa	(44)	2007	19	LDR BT + EBRT	25	45	39	100	21
Laskar	(43)	2007	100	LDR/HDR BT + EBRT	23.9	46 (20–50)	45	83	30
Pohar	(51)	2007	37	LDR/HDR BT + EBRT	LDR 15–20.5, HDR 3–5 × 3–4	45–50	24	94	19
Beltrami	(52)	2008	112	LDR BT + EBRT	35 (15–46)	44 (25–70)	75	87	12.5
Muhic	(53)	2008	39	PDR BT + EBRT	20	46	41	83	21
Petera	(36)	2010	34	HDR BT + EBRT	3 × 8	45–50	38	85	NR
San Miguel	(54)	2011	60	HDR BT + EBRT	4 × 4–6	45	49	77	30
Emory	(16)	2012	12	HDR BT + EBRT	3.4 × 4	54.8	11	83	NR
Sharma	(55)	2015	52	HDR BT + EBRT	4 × 4	50	46	100	17

ELSEVIER

BRACHYTHERAPY

Brachytherapy ■ (2017) ■

American Brachytherapy Society consensus statement for soft tissue sarcoma brachytherapy

A.O. Naghavi[1], D.C. Fernandez[1], N. Mesko[2], A. Juloori[3], A. Martinez[4], J.G. Scott[3,5], C. Shah[3,*,5], L.B. Harrison[1,5]

[1]*Radiation Oncology, H. Lee Moffitt Cancer Center and Research Institute, Tampa, FL*
[2]*Department of Orthopedics, Cleveland Clinic, Cleveland, OH*
[3]*Department of Radiation Oncology, Taussig Cancer Institute, Cleveland Clinic, Cleveland, OH*
[4]*21st Century Oncology/Michigan Health Care Professionals, Farmington Hills, MI*

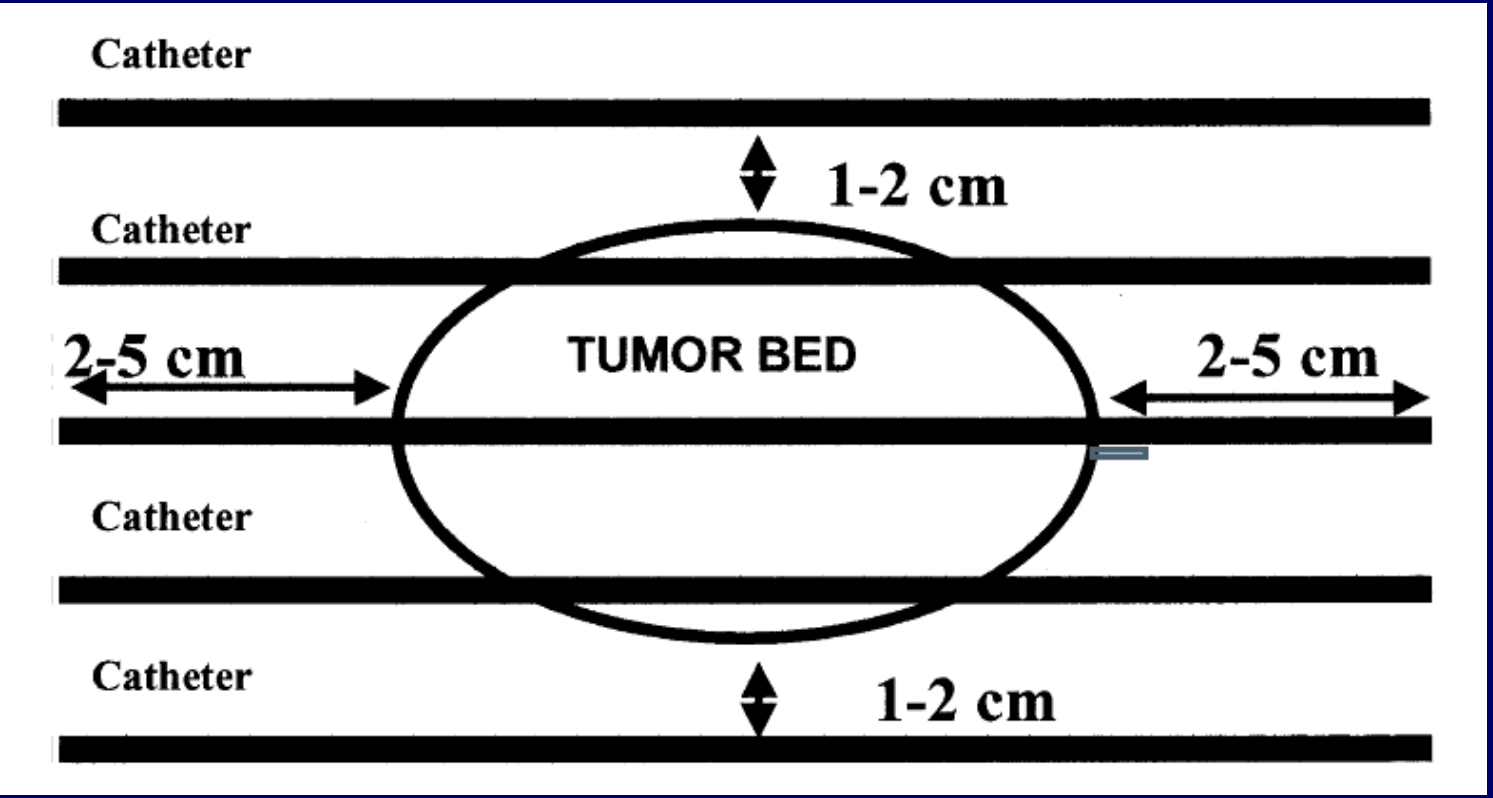
ABS Guidelines : General

- Assess patients in a multidisciplinary setting
- Determine CTV by radiographic, surgical, and pathologic findings
- Place catheters to encompass CTV
- Identify and demarcate OAR
- Place catheters at least 1 cm from the incision
- Place catheters in parallel arrays at intervals of 1.0 to1.5 cm
- Start treatment no sooner than 5th PO day when used as adjuvant monotherapy
- Plan CT-based dosimetry

Brachytherapy

Catheter Insertion

- Single-plane implant

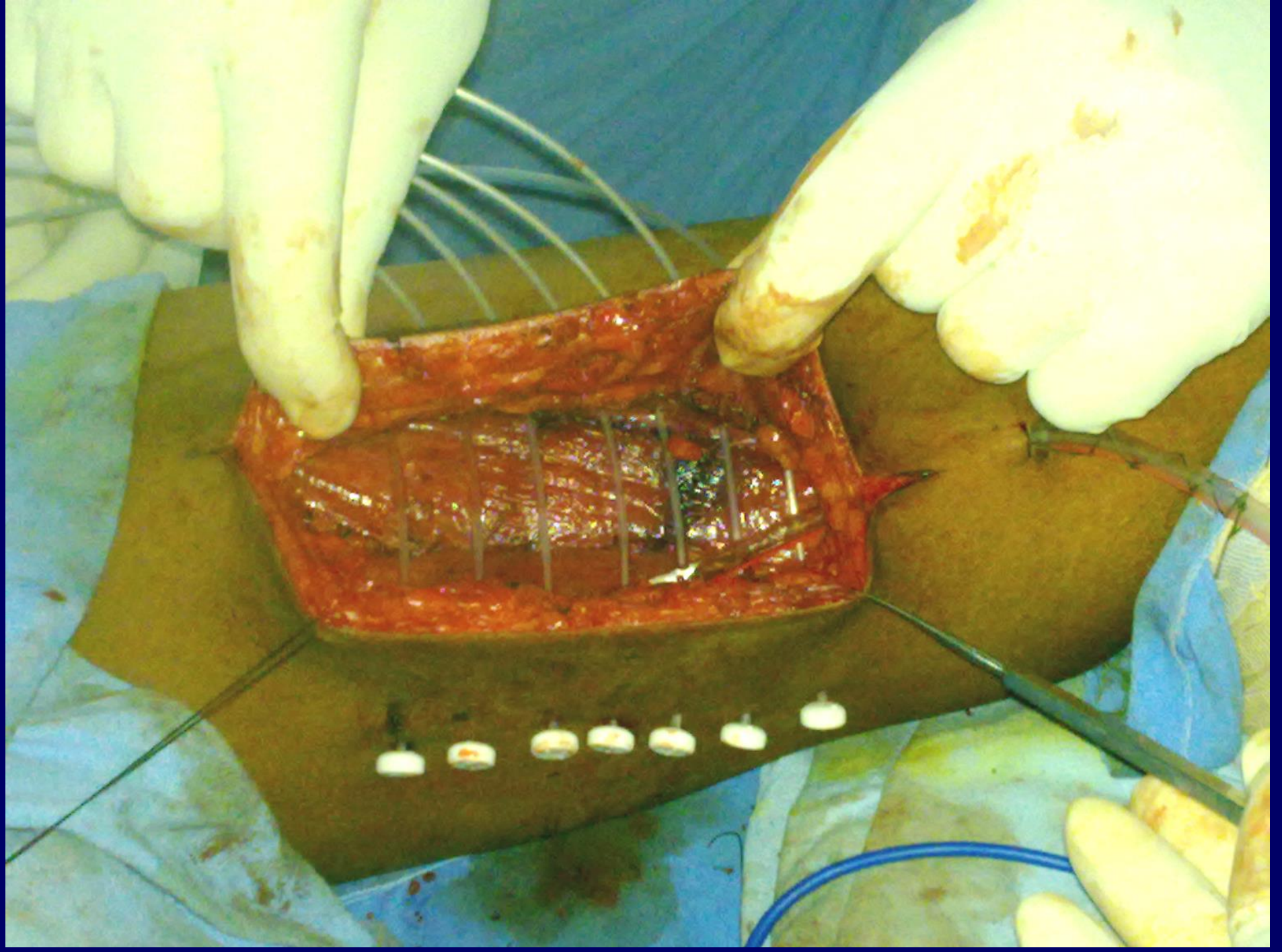


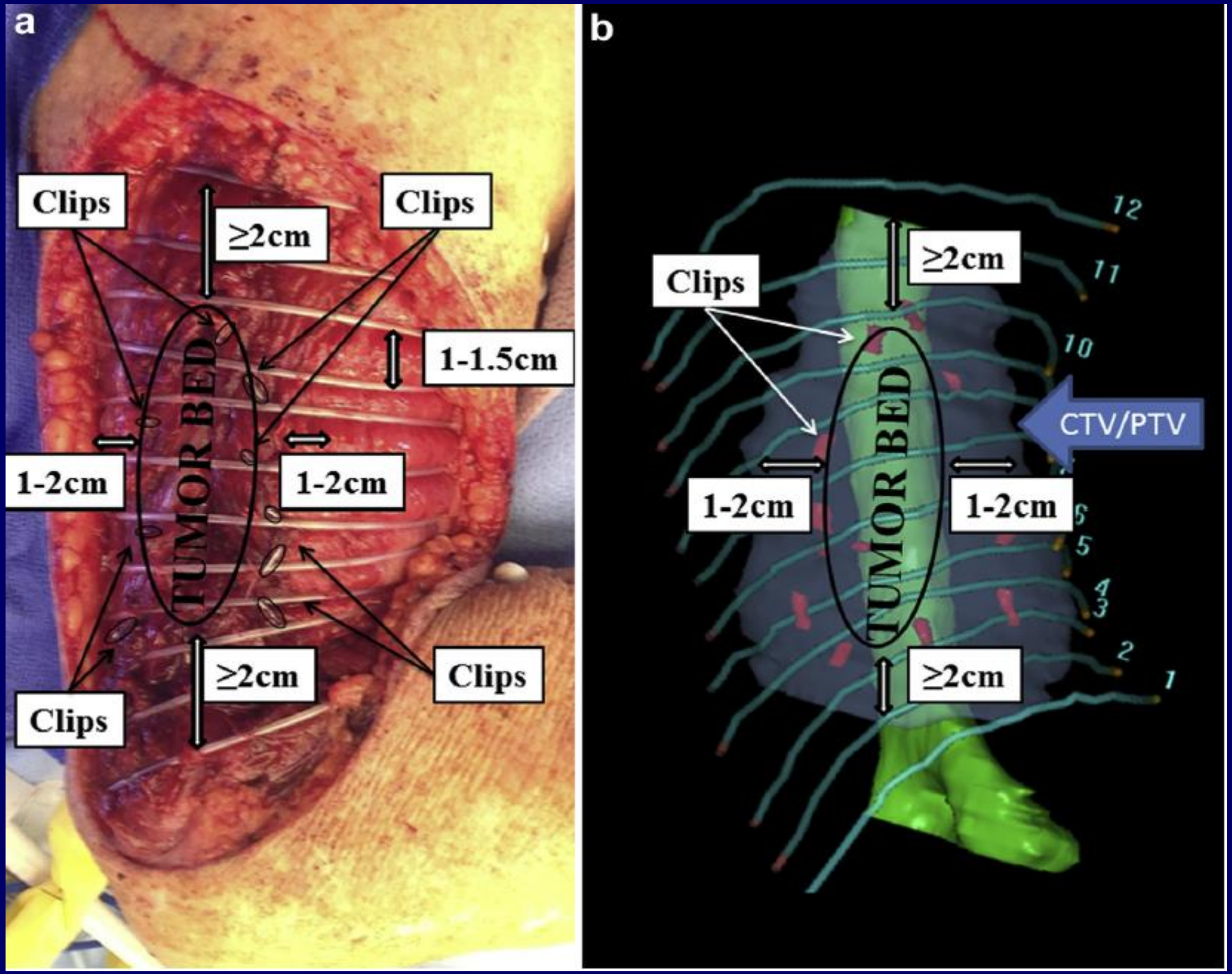
Recommended BT prescription dose and constraints for primary STS

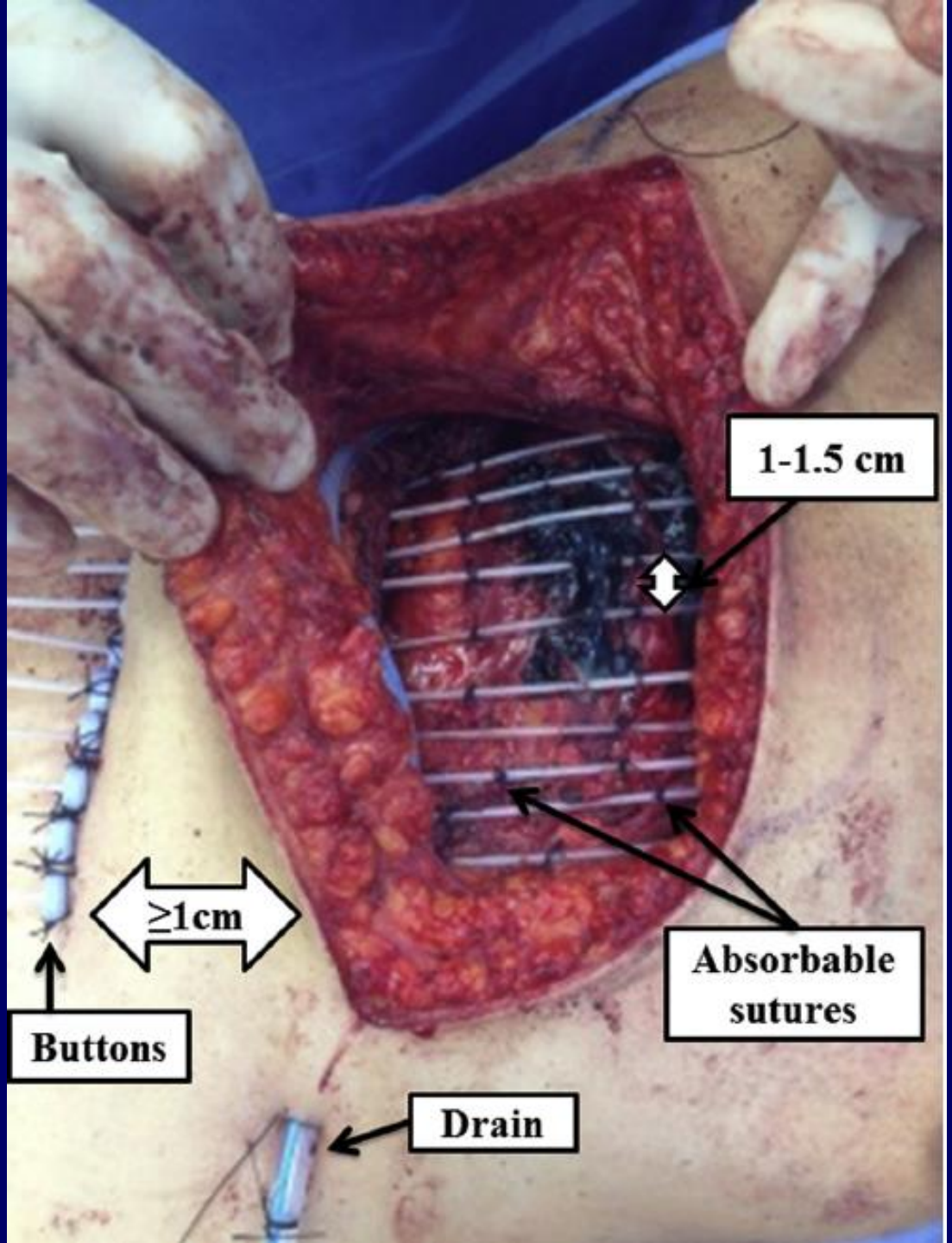
BT type	Modality	EBRT (Gy)	BT (Gy)	BT duration (d)	Dosing
LDR/PDR	BT		45–50	4–6	0.45–0.5 Gy/h
	BT + EBRT	45–50	15–25	2–4	0.45–0.5 Gy/h
HDR	BT		30–50	4–7	2–4 Gy bid
	BT + EBRT	45–50	12–20	2–3	2–4 Gy bid
IORT	IORT + EBRT	45–50	10–20	Intraoperative	1 fraction

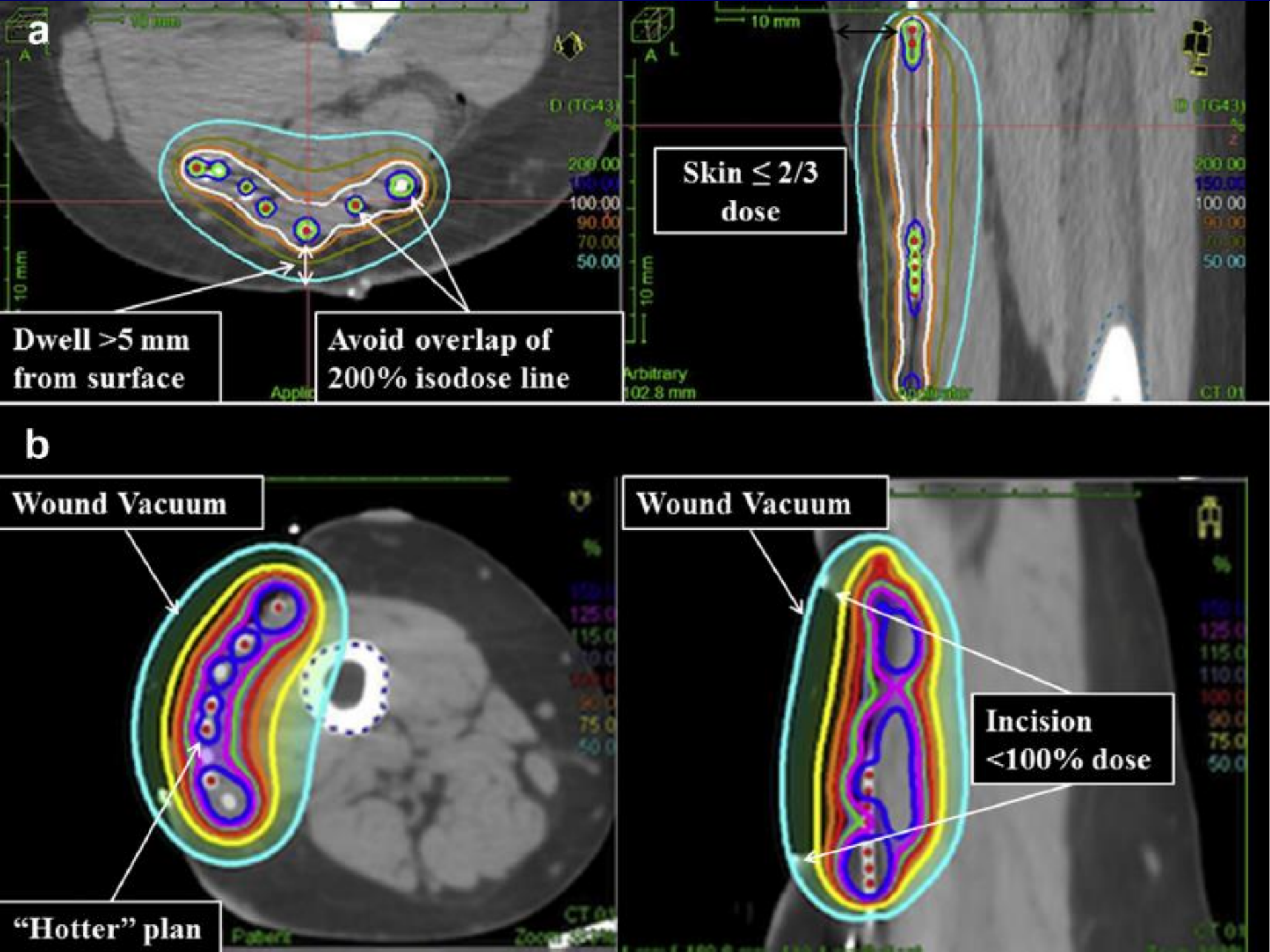
Volume	Constraints	Common	Ideal
CTV	V_{100}	≥90%	≥95%
	V_{150}	≤50%	≤40%
	D_{90}	≥90%[a]	≥100%[a]
	DHI	≥0.6	≥0.8

OAR	Constraints	IORT (Gy)	Postoperative BT (Gy)	SBRT end point (adapted OAR)	Comments
Skin	$D_{0.1cc}$	20	40	Ulceration	≤2/3 the prescribed dose
	D_{2cc}	18	37	(Skin)	
Nerve	$D_{0.1cc}$	16	32	Neuropathy	Full dose if involved
	D_{2cc}	14	30	(Cauda equina/sacral plexus)	(Max BT ~50 Gy)
Vascular	$D_{0.1cc}$	20	53	Aneurysm	Full dose if involved
	D_{2cc}	18	47	(Great vessels)	
Bone	$D_{0.1cc}$	20	43	Fracture	Caution with periosteal stripping,
	D_{1cc}	18	35	(Ribs)	avoid acral bone BT
Stomach/Duodenum	$D_{0.1cc}$	12	32	Ulceration/fistula	IORT <15 Gy, avoid postoperative
	D_{1cc}	11	18	(stomach/duodenum)	BT in upper abdomen




a
Clips
Clips
≥2cm
1-1.5cm
TUMOR BED
1-2cm
1-2cm
Clips
≥2cm
Clips
b
Clips
≥2cm
CTV/PTV
TUMOR BED
1-2cm
1-2cm
≥2cm
12
11
10
5
4
3
2
1


1-1.5 cm
≥1cm
Absorbable sutures
Buttons
Drain


a
Dwell >5 mm from surface
Avoid overlap of 200% isodose line
Skin ≤ 2/3 dose
b
Wound Vacuum
"Hotter" plan
Wound Vacuum
Incision <100% dose

STS Brachytherapy: Conclusion

- STS brachytherapy is very simple & easy treatment
- No vital organ in the implant area
- Since implant area is located peripheraly, accessibility is very good.
- Surgical resources are used
- Single plane implant, no learning curve
- Brachytherapy is a proven therapy in improving the local control