28eme congrès de
Radiothérapie Tunisien

Sousse 2025

Stéréotaxie os et oligométastase

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Quant.IF - AIMS

Liens d'intérêt

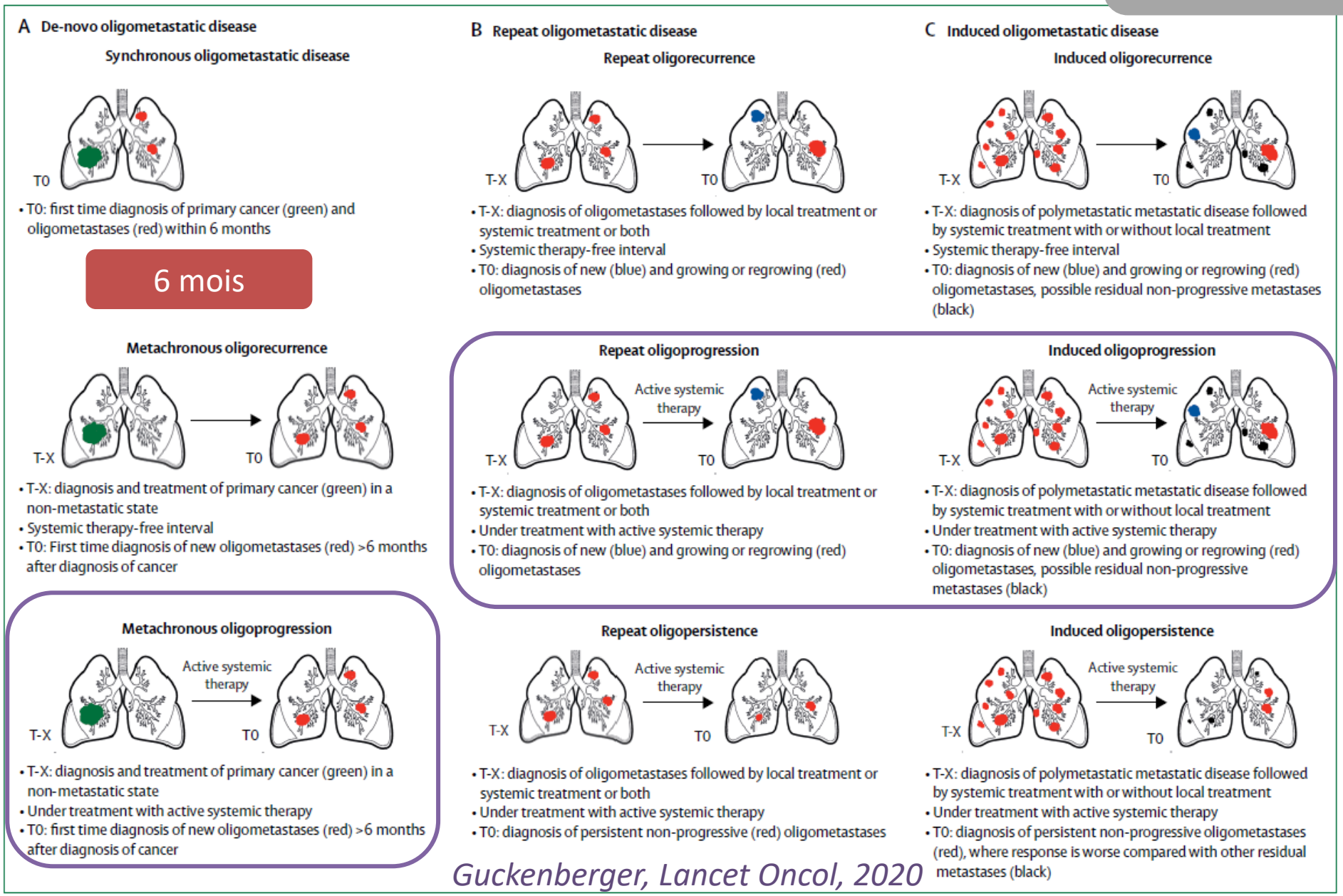
- **Congrès: Merck**
- **Réunions scientifiques: AMGEN, BMS, MSD, Lilly, ASTRA ZENECA, MERCK**
- **Boards scientifiques: ASTRA ZENECA**
- **Projets scientifiques: Brainlab, Varian**

Définition

Recommandations ESMO ESTRO

Oligoprogression = traitement

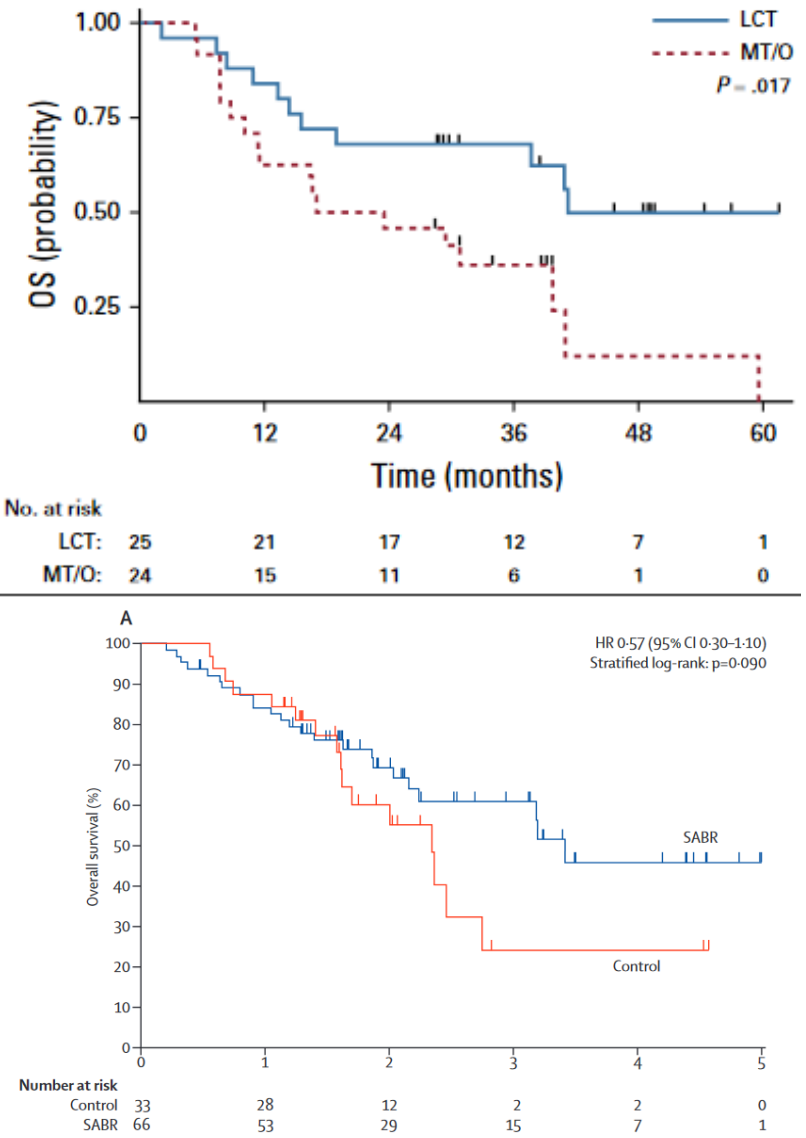
Oligorécurrence = absence de traitement



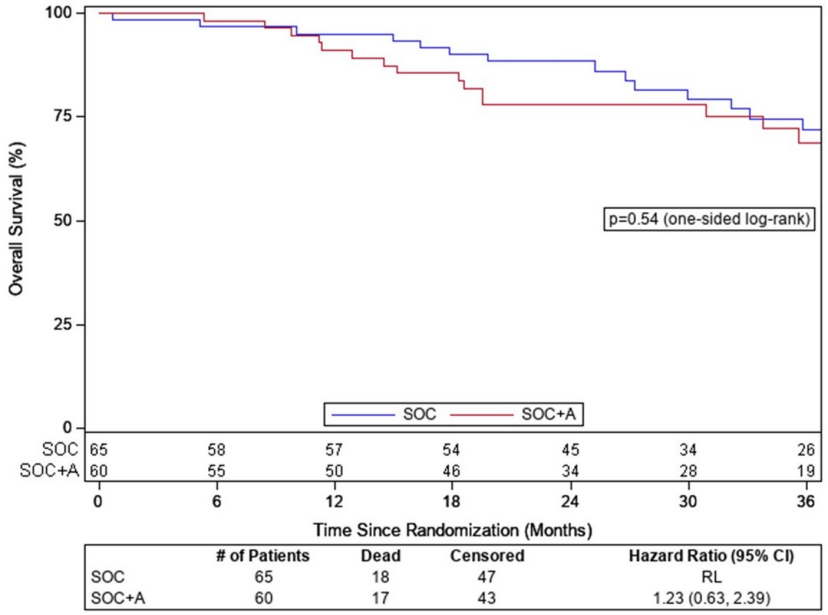
Guckenberger, Lancet Oncol, 2020

Etat des lieux

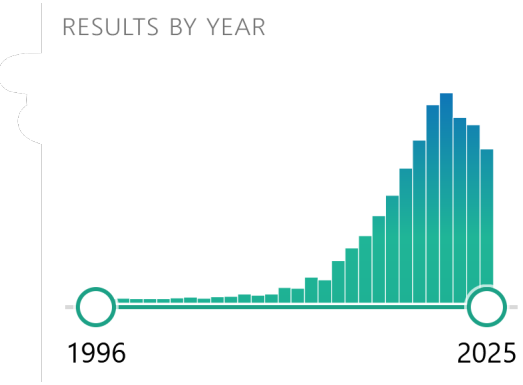
Phase II



Phase III



Oligometastatic radiotherapy
2600 articles



Clinical trial
154

Randomized Controlled Trial
48

Palma, JCO, 2020 ; Gomez, JCO, 2019; Schmura, ASCO, 2022

Méta-analyse

Prostate

Résultats

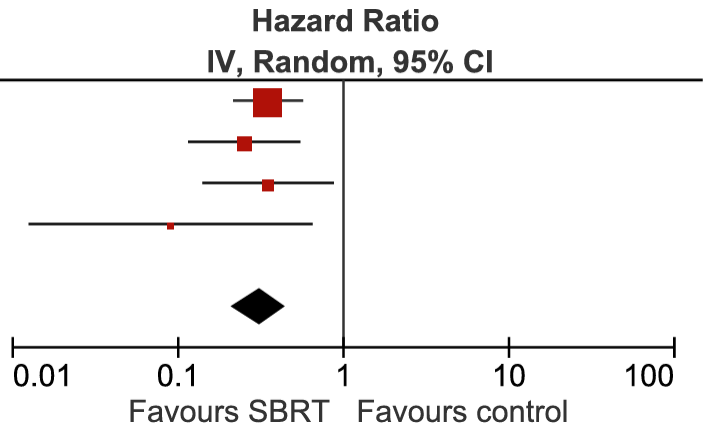
- ✓ SABR-COMET
  - ✓ 99 patients
- ✓ EXTEND
  - ✓ 87 patients
- ✓ ORIOLE
  - ✓ 54 patients
- ✓ ARTO
  - ✓ 157 patients

PFS

Study or Subgroup	log[Hazard Ratio]	SE	Weight	Hazard Ratio IV, Random, 95% CI
ARTO	-1.0498	0.2488	57.7%	0.35 [0.21, 0.57]
EXTEND	-1.3823	0.3982	22.5%	0.25 [0.12, 0.55]
ORIOLE	-1.0498	0.4675	16.3%	0.35 [0.14, 0.88]
SABR-COMET	-2.4079	1.0088	3.5%	0.09 [0.01, 0.65]
Total (95% CI)			**100.0%**	**0.31 [0.21, 0.45]**

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.09$, df = 3 ($P = 0.55$); $I^2 = 0\%$

Test for overall effect: $Z = 6.21$ ($P < 0.00001$)

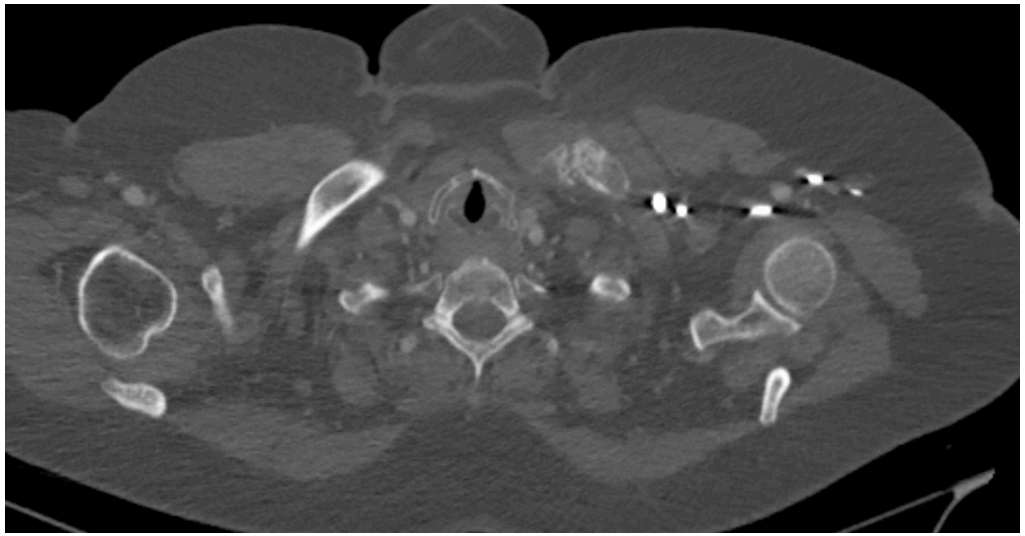


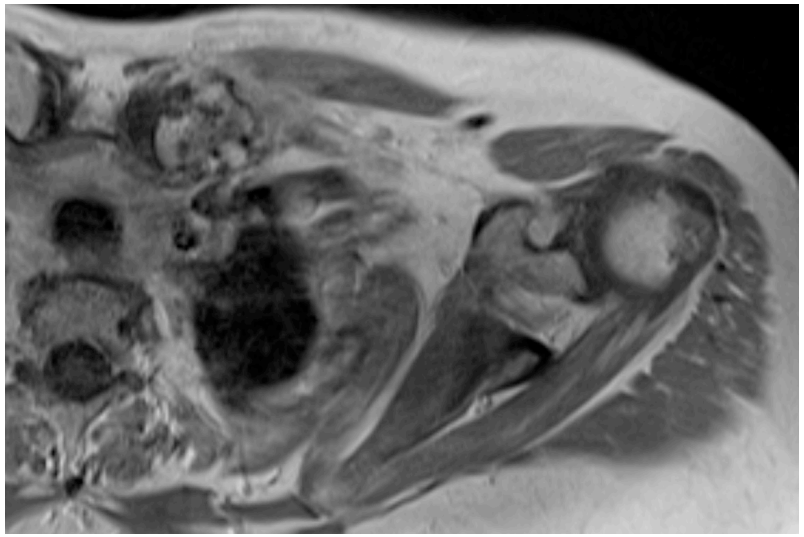
Persson, Radiation Oncology, 2024

Cas clinique

Mme B, 68 ans, OMS 0, absence de comorbidités
En 2018
- CCI de 15 mm N- de grade 2 RH+ Her2- Ki 67 à 15%
- Tumorectomie, Radiothérapie et Anti-aromatase

En 2025
- Douleurs de l'épaule Gauche
- Bilan par TDM injectée et Scintigraphie Osseuse
- Lésion de la clavicule Gauche et de la voute crânienne
- Traitement par FASLODEX – PALBOCICLIB
- Adressée par Oncologue Médical pour radiothérapie stéréotaxique





Que faites vous?

1. Stéréotaxie des deux lésions osseuses

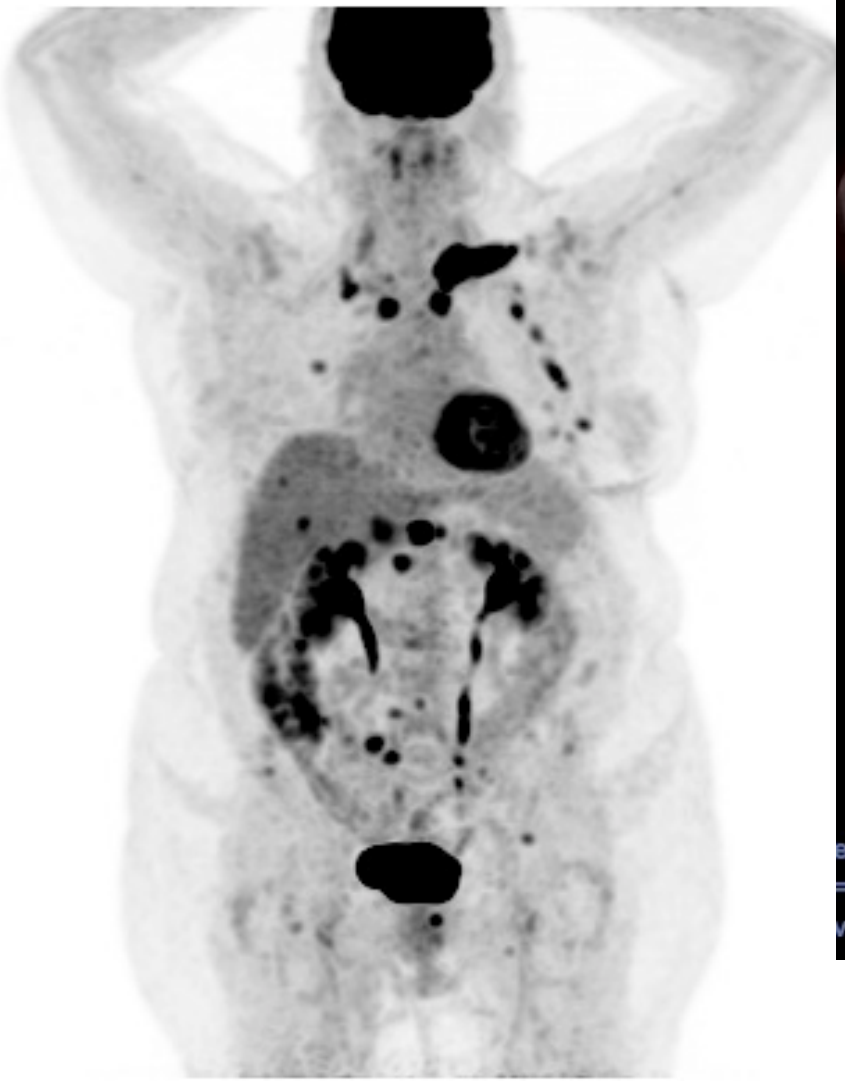
2. Traitement antalgique par 30Gy/10

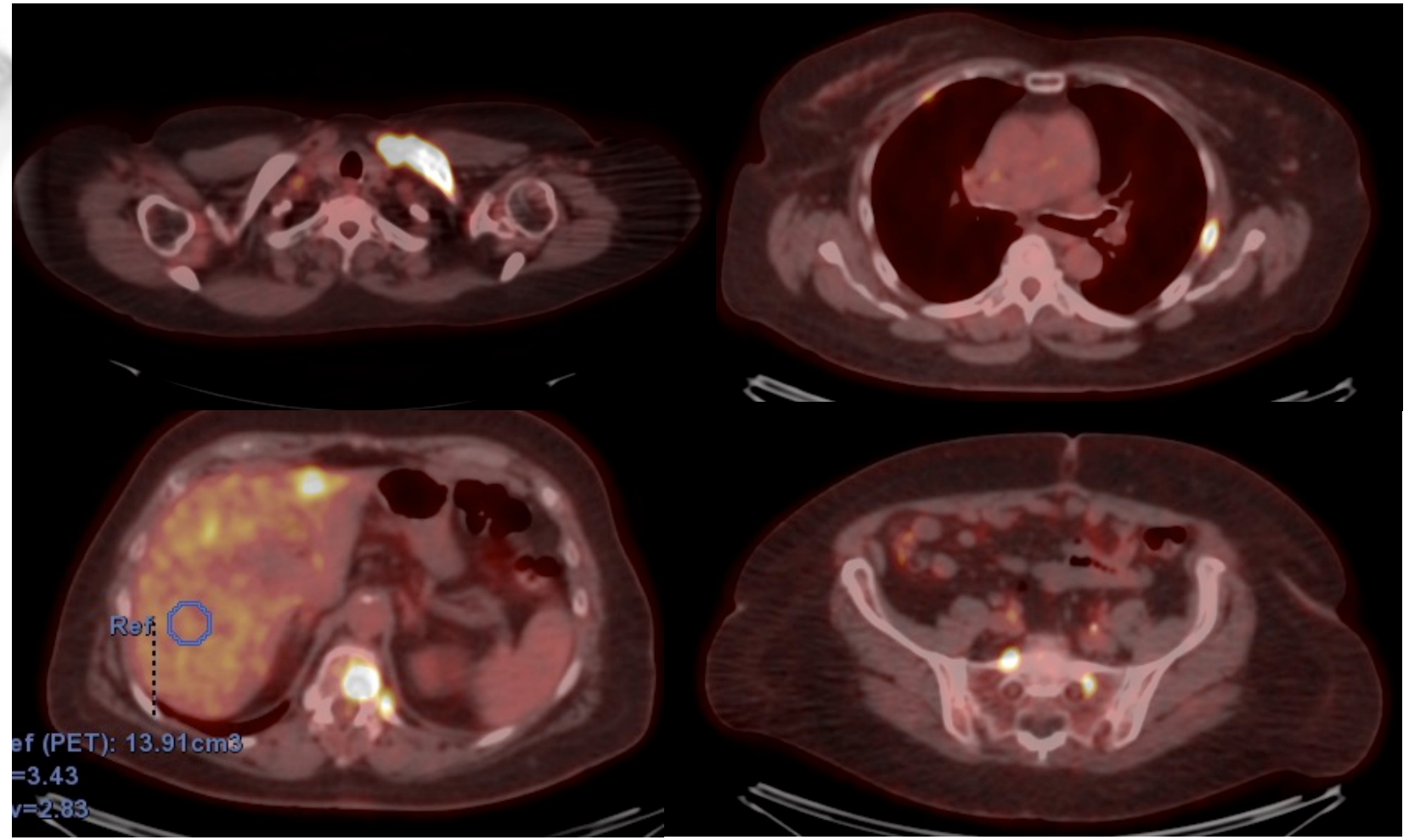
3. Traitement antalgique par 8Gy/1

4. Absence de traitement par RTH car terrain irradié

5. Traitement médical seul

6. Autre





Rao, Medecine, 2016

EORTC-ESTRO E2 RADIatE OligoCare study

Traitements réalisés

Cohorte prospective

Pan-tumeur

4 cancers primitifs

Breast
Prostate
Lung
Colorectal

1,597 patients enregistrés

1468 patients évalués

Severe adverse event by concomitant systemic therapy.

System Organ Class + Preferred term	Comcomitant systemic treatment							
	(SBRT pop: N=941) no				(SBRT pop: N=527) yes			
	Grade 3 N (%)	Grade 4 N (%)	Grade 5 N (%)	Grade ≥3 N (%)	Grade 3 N (%)	Grade 4 N (%)	Grade 5 N (%)	Grade ≥3 N (%)
PATIENTS' WORST GRADE	3 (0.3)		1 (0.1)	4 (0.4)	3 (0.6)		1 (0.2)	4 (0.8)
INFECTIONS AND INFESTATIONS								
Empyema	1 (0.1)			1 (0.1)				
Pneumonia					1 (0.2)			1 (0.2)
INJURY, POISONING AND PROCEDURAL COMPLICATIONS								
Radiation Pneumonitis					1 (0.2)			1 (0.2)
Radiation Skin Injury	1 (0.1)			1 (0.1)				
METABOLISM AND NUTRITION DISORDERS								
Decreased Appetite	1 (0.1)			1 (0.1)				
MUSCULOSKELETAL AND CONNECTIVE TISSUE DISORDERS								
Bone Pain					1 (0.2)			1 (0.2)
NERVOUS SYSTEM DISORDERS								
Brain Oedema	1 (0.1)			1 (0.1)				
Cerebral Haemorrhage	1 (0.1)			1 (0.1)				
RESPIRATORY, THORACIC AND MEDIASTINAL DISORDERS								
Pneumonitis					1 (0.2)			1 (0.2)

Alongi, Radiother Oncol, 2024

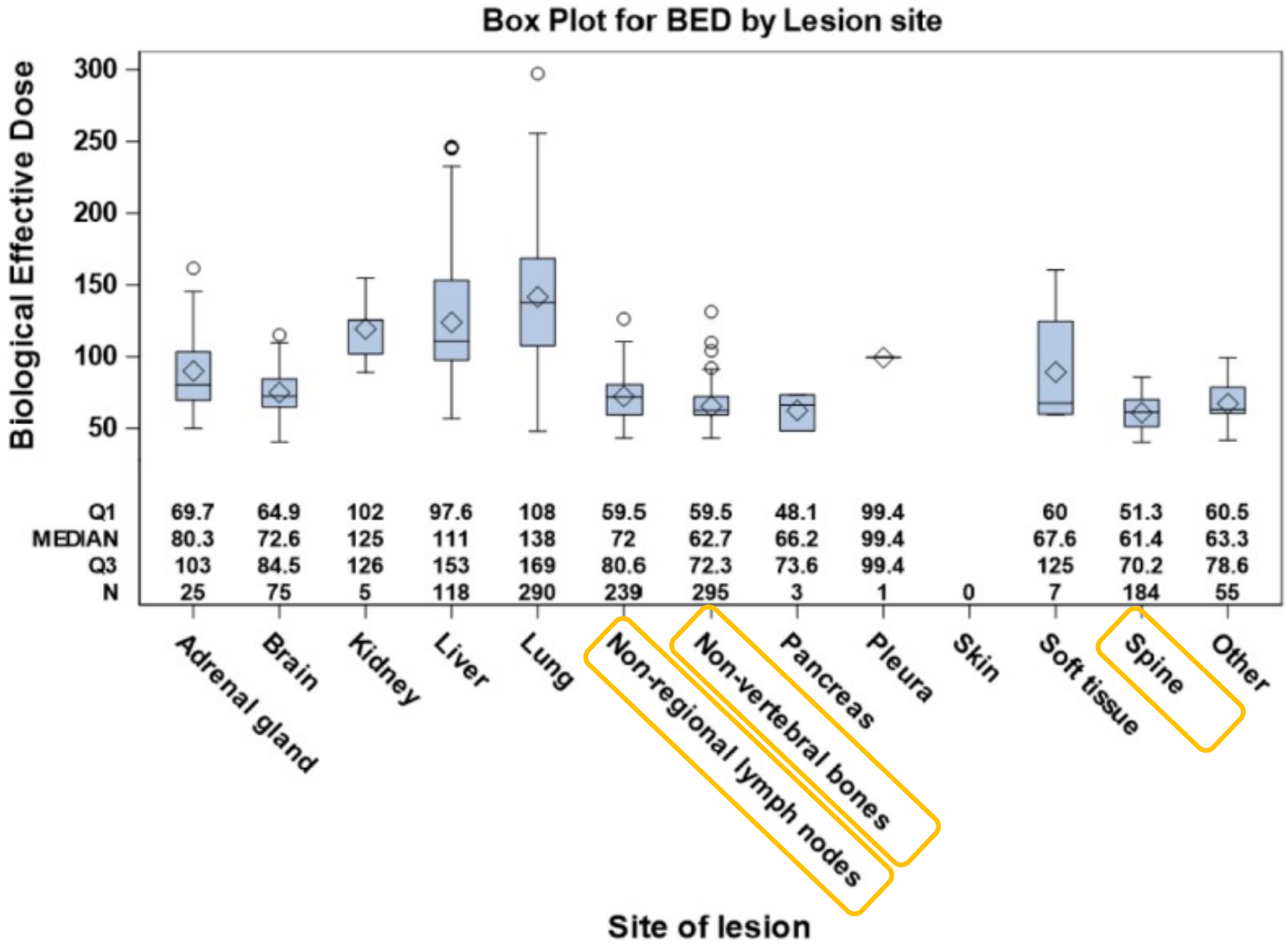
EORTC-ESTRO E2
RADIatE
OligoCare study

Traitements réalisés

Cohorte prospective

Pan-tumeur

- ✓ α/B à 10 pour lung cancer et CRC
- ✓ α/B à 2.5 pour breast cancer
- ✓ α/B à 1.5 pour prostate cancer
- ✓ 1004 patients inclus



Christ, Radiother Oncol, 2024

Indications

Node

Author	Study design	N	N with A-P LN	Primary tumor	Median FU (months)	Median total dose (range)	Median number of fractions (range)	Median d/f (range)	Toxicity classification	QA score
Alsuhaibani, 2019 [19]	Retrospective	21	11	GI	17	n.a. (30–60)	n.a. (3–5)	n.a. (n.a.)	CTCAE V4.0	3
Barney, 2012 [20]	Retrospective	47	13	Various	12	45 (20–60)	5 (1–5)	10 (n.a.)	CTCAE V3.0	4
Bignardi, 2011 [21]	Retrospective	19	19	Various	12	45 (36–45)	6 (6)	n.a. (6–7.5)	CTCAE V3.0	3
Bouman, 2017 [22]	Retrospective	43	34	Prostate	31	n.a. (30–35)	n.a. (3–5)	n.a. (7–10)	n.a.	3
Burkon, 2020 [12]	Retrospective	90	57	Various	35	n.a. (27–45)	n.a. (3–8)	n.a. (5–15)	CTCAE (version n.a.)	3
Caivano, 2023 [23]	Retrospective	174	82	Various	NA	36 (14–76)	n.a. (1–8)	n.a. (4–23)	CTCAE V4.4	3
Corvò, 2013 [24]	Retrospective	36	36	Various	28	35 (12–50)	5 (2–10)	n.a. (4–9)	CTCAE V4.0	3
Cozzi, 2022 [25]	Retrospective	74	74	Prostate	31	40 (33–40)	5 (3–5)	8 (8–11)	CTCAE V4.0	3
Cuccia, 2023 [26]	Retrospective	69	66	Prostate	16	35 (30–40)	5 (3–6)	n.a. (n.a.)	CTCAE V4.0	3
Detti, 2015 [27]	Retrospective	30	30	Prostate	12	n.a. (24–36)	n.a. (1–5)	n.a. (6–24)	CTCAE V4.0	3
Franzese, 2017 [28]	Retrospective	26	26	Prostate	29	40 (25–45)	6 (4–6)	n.a. (n.a.)	CTCAE V4.0	3
Franzese, 2017 [29]	Retrospective	35	35	CRC	15	n.a. (30–45)	n.a. (6–13)	n.a. (3–7.5)	CTCAE V3.0	3
Franzese, 2016 [30]	Retrospective	71	71	Various	18	45 (45)	6 (6)	7.5 (7.5)	CTCAE V4.0	3
Franzese, 2020 [31]	Prospective	52	52	Various	24	48 (48)	4 (4)	12 (12)	CTCAE V4.0 & RTOG/EORTC	5
Gawish, 2023 [32]	Retrospective	17	17*	Prostate	16.6	48 (30–60)	12 (5–20)	4 (3–8)	n.a.	3
Ingrosso, 2017 [33]	Retrospective	40	39	Prostate	24	n.a. (12–50)	n.a. (1–5)	n.a. (5–12)	RTOG/EORTC criteria	4
Kang, 2010 [34]	Retrospective	59	30	CRC	32	42 (35–51)	3 (3)	n.a. (12–17)	CTCAE V2.0	4
Kneebone, 2018 [35]	Prospective	57	39	Prostate	16	n.a. (30–50)	n.a. (1–5)	10 (10)	CTCAE V4.0	5
Kutuk, 2022 [36]	Retrospective	96	52	Various	10	48.5 (30–60)	5 (3–15)	n.a. (n.a.)	CTCAE V4.0	2
Lepinoy, 2019 [37]	Retrospective	62	35	Prostate	42	36 (30–66)	n.a. (n.a.)	7.5 (2–15)	CTCAE V4.0	4
Loi, 2018 [38]	Retrospective	23	23	Prostate	22	24 (24)	1 (1)	24 (24)	CTCAE V4.0	3
Loi, 2018 [39]	Retrospective	91	89	Various	23	n.a. (40–48)	n.a. (5–6)	n.a. (7–9)	CTCAE V4.0	3
Matoba, 2020 [40]	Retrospective	15	15	HCC	18	n.a. (45–49.5)	n.a. (6–9)	n.a. (5.5–7.5)	CTCAE V4.0	4
Nicosia, 2022 [41]	Prospective	63	63	Prostate	17	35 (14–40)	n.a. (n.a.)	n.a. (5–21)	CTCAE V5.0	6
Ost, 2016 [42]	Retrospective	72	72	Prostate	36	n.a. (24–50)	n.a. (3–10)	n.a. (5–10)	CTCAE V4.0	3
Park, 2015 [43]	Retrospective	85	83	Cervix	20	39 (27–51)	n.a. (3–10)	13 (n.a.)	CTCAE V4.0	4
Pasqualetti, 2016 [44]	Prospective	29	17	Prostate	12	n.a. (24–27)	n.a. (1–3)	n.a. (9–24)	CTCAE V4.0	5
Pezzulla, 2021 [45]	Prospective	38	38	Prostate	27	n.a. (20–50)	n.a. (1–5)	n.a. (9–24)	CTCAE V4.0	6
Regnery, 2022 [46]	Prospective	26	26	Various	10	n.a. (25–40)	n.a. (3–7)	n.a. (5–9)	CTCAE V5.0	5
Shahi, 2020 [11]	Retrospective	51	48	Various	22	35 (25–40)	5 (5)	7 (5–8)	CTCAE V4.0	4
Siva, 2018 [47]	Prospective	33	13	Prostate	NA	20 (20)	1 (1)	20 (20)	CTCAE V4.0	6
Wang, 2016 [48]	Retrospective	22	22	Various	33	39 (21–51)	5 (3–8)	8 (5–13)	CTCAE V4.0	4
Werensteijn, 2021 [49]	Prospective/ retrospective	90	90	Prostate	21	n.a. (30–35)	n.a. (3–6)	n.a. (6–10)	RTOG/EORTC criteria	5
Yang, 2022 [50]	Prospective/ retrospective	101	101	Various	11	40 (25–50)	5 (n.a.)	8 (5–10)	CTCAE V5.0	5
Yeung, 2017 [51]	Retrospective	18	11	Various	34	n.a. (30–60)	n.a. (4–8)	n.a. (5–8)	CTCAE V4.0	3
Median:		**47**	**37**		**21**					3

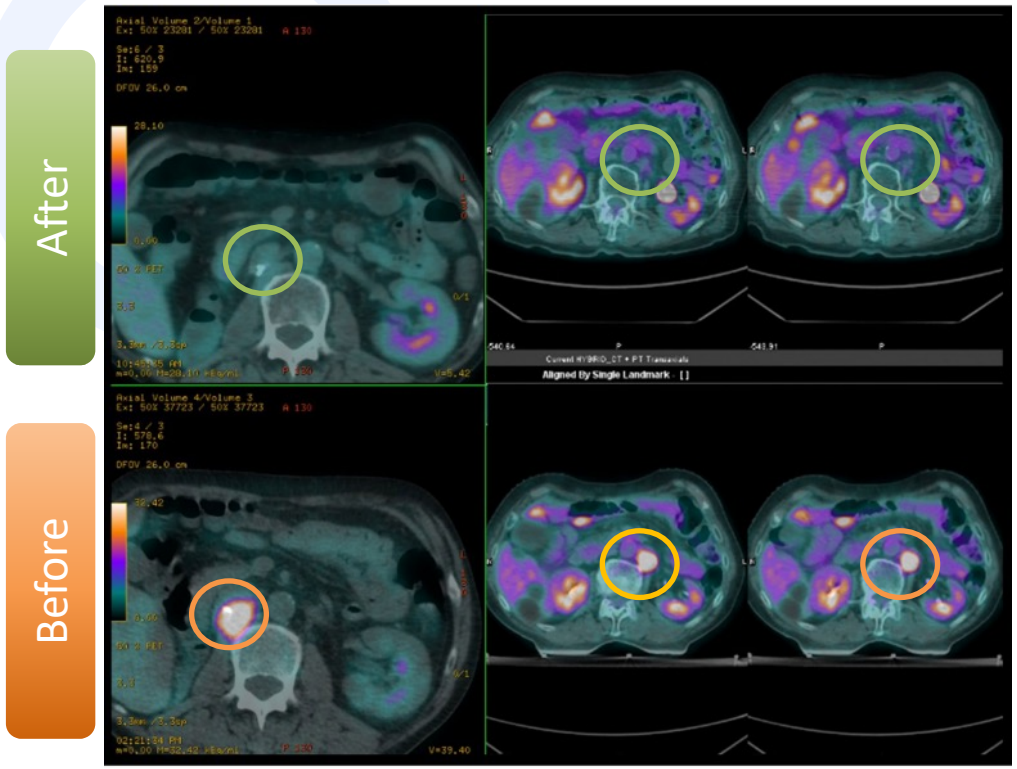
Study	N pts A-P LN	Acute toxicity in grade:				Late toxicity in grade:			
		1	2	3	4	1	2	3	4
Alsuhaibani (2019) [19]	11	n.a.	2	0	0	n.a.	0	0	0
Barney (2012) [20]	13	n.a.	n.a.	0	0	n.a.	n.a.	0	0
Bignardi (2011) [21]	19	4	0	0	0	1	0	1	0
Bouman (2017) [22]	34	1	2	0	0	0	0	0	0
Burkon (2020) [12]	57	n.a.	n.a.	0	0	0	0	0	0
Caivano, (2023) [23]	82	n.a.	n.a.	0	0	0	0	0	0
Corvò (2013) [24]	36	23	0	0	0	0	0	0	0
Cozzi (2022) [25]	74	0	0	0	0	0	0	0	0
Cuccia (2023) [26]	66	n.a.	n.a.	0	0	n.a.	n.a.	0	0
Detti (2015) [27]	30	0	1	0	0	1	0	0	0
Franzese (2017) [29]	35	2	3	0	0	n.a.	n.a.	n.a.	n.a.
Franzese (2017) [28]	26	5	0	0	0	0	0	0	0
Franzese (2016) [30]	71	10	2	0	0	0	0	0	0
Franzese (2020) [31]	52	4	0	0	0	0	0	0	0
Gawish (2023) [32]	17	n.a.	n.a.	0	0	n.a.	n.a.	0	0
Ingrosso (2017) [33]	39	n.a.	1	0	0	n.a.	0	1	0
Kang (2010) [34]	30	n.a.	n.a.	0	2	n.a.	n.a.	n.a.	n.a.
Kneebone (2018) [35]	39	n.a.	n.a.	0	0	n.a.	n.a.	0	0
Kutuk (2022) [36]	52	n.a.	n.a.	0	0	n.a.	n.a.	0	0
Lepinoy (2019) [37]	35	0	2	1	0	2	12	2	0
Loi (2018) [38]	23	2	0	0	0	0	0	0	0
Loi (2018) [39]	89	26	13	0	0	5	5	0	0
Matoba (2020) [40]	15	8	1	0	0	0	0	0	0
Nicosia (2022) [41]	63	0	0	0	0	0	0	0	0
Ost (2016) [42]	72	n.a.	n.a.	n.a.	n.a.	12	3	0	0
Park (2015) [43]	83	n.a.	n.a.	1	0	0	9	2	2
Pasqualetti (2016) [44]	17	n.a.	0	0	0	n.a.	0	0	0
Pezzulla (2021) [45]	38	n.a.	n.a.	0	0	n.a.	n.a.	0	0
Regnery (2022) [46]	26	9	2	0	0	n.a.	n.a.	n.a.	n.a.
Shahi (2018) [11]	48	n.a.	n.a.	1	0	1	0	0	0
Siva (2018) [47]	13	n.a.	n.a.	0	0	n.a.	n.a.	0	0
Wang (2016) [48]	22	n.a.	n.a.	0	0	0	0	0	0
Werensteijn (2021) [49]	90	48	3	0	0	18	8	0	0
Yang (2022) [50]	101	n.a.	n.a.	n.a.	n.a.	53	4	3	0
Yeung (2017) [51]	11	n.a.	3	0	0	n.a.	0	0	0
Total toxicity		**142**	**35**	**3**	**2**	**93**	**41**	**9**	**2**
Reported in studies (*n*)*		16	20	33	33	21	25	32	32
Total patients in studies		718	796	1356	1356	1122	1200	1438	1438
% patients with toxicity		**19.8**	**4.4**	**0.2**	**0.1**	**8.3**	**3.4**	**0.6**	**0.1**

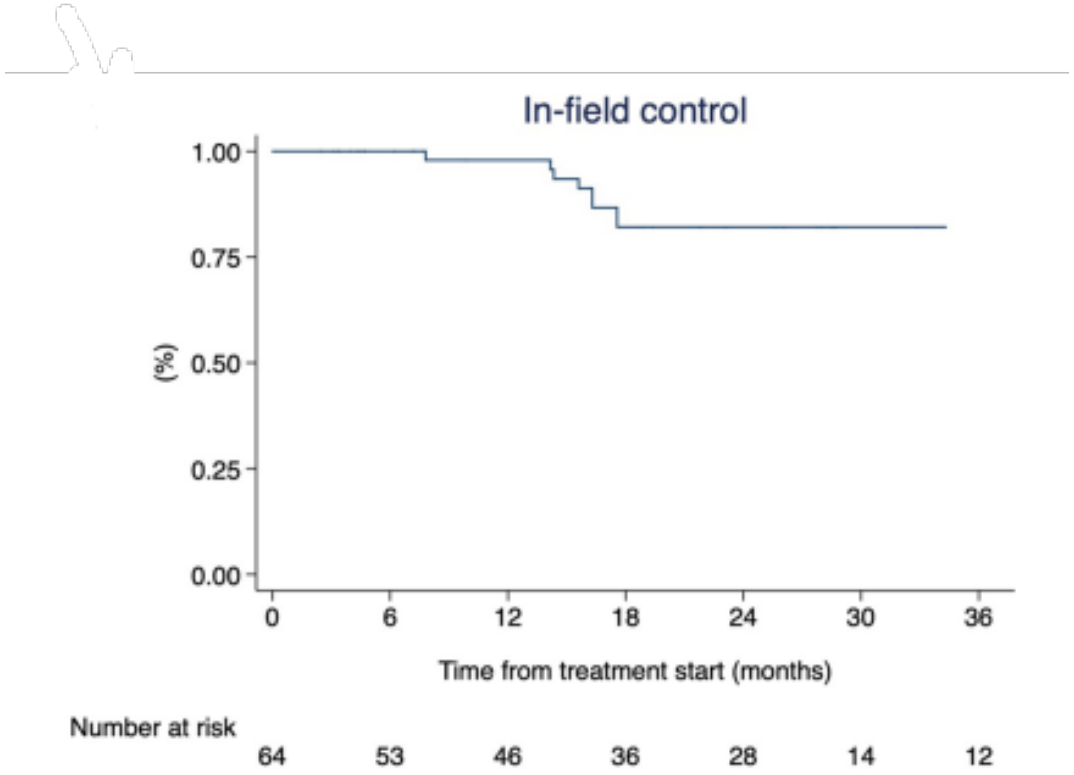
van Werkhoven, Acta Oncologica, 2024

Node

Résultats

- ✓ 52 patients
- ✓ 64 lésions
- ✓ LC à 1, 2 et 3 ans : 97.9%, 82.1% and 82.1%



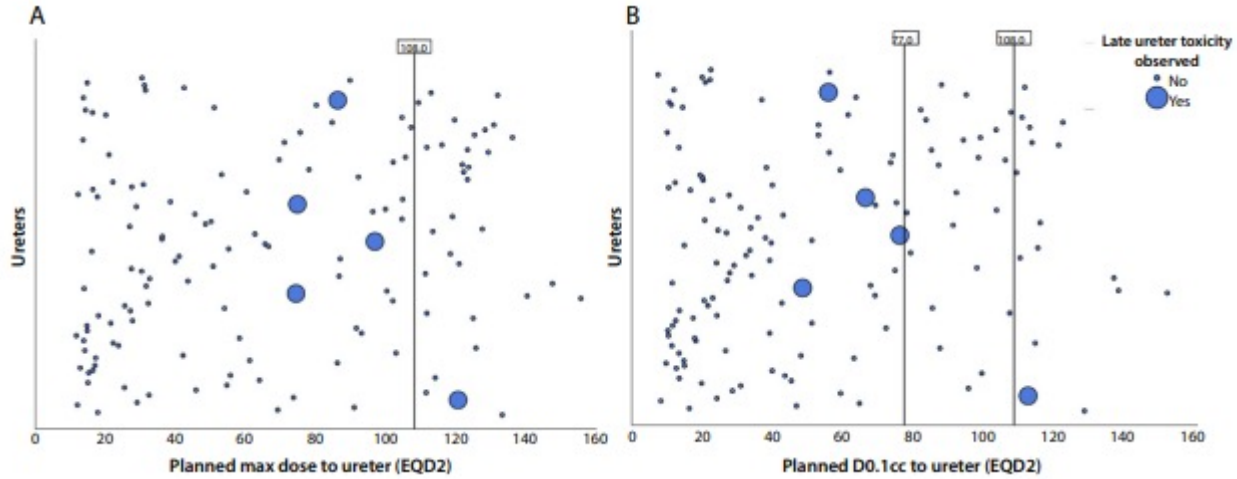


Franzese, Clinical & Experimental Metastasis, 2020

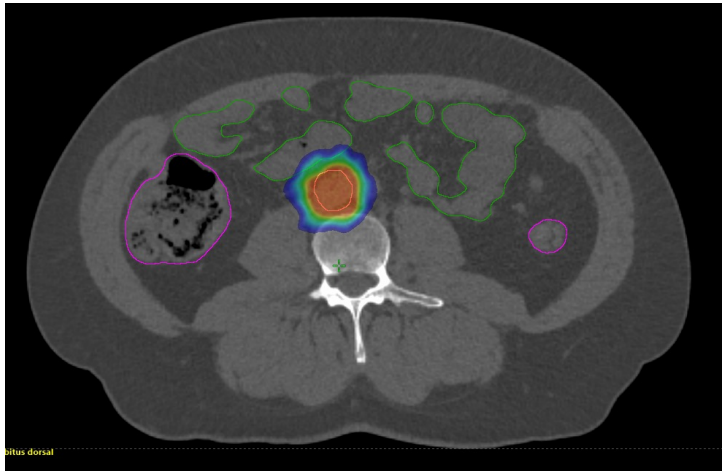
Node

Quels schémas

- ✓ 48 Gy en 6 fractions
- ✓ 45 Gy en 5 fractions
- ✓ 35 Gy en 5 fractions
- ✓ 40 Gy en 5 fractions
- ✓ 36Gy en 6 fractions



- ✓ Difficulté à prédire la toxicité
  - ✓ Fractionnement
  - ✓ Mobilités OAR



Dosimetric parameters of the gastro-intestinal organs in EQD_2^{10}.

		D_{max} (EQD_2^{10})	$D_{0.2cc}$ (EQD_2^{10})	$D_{0.5cc}$ (EQD_2^{10})	D_{1cc} (EQD_2^{10})	D_{2cc} (EQD_2^{10})	D_{5cc} (EQD_2^{10})	D_{10cc} (EQD_2^{10})
All treatments (n = 55)	Median	61.5	48.6	43.7	38.6	29.6	22.6	15.3
	IQR	43.9–72.2	30.1–59.6	25.9–54.9	21.7–50.5	17.2–42.0	12.1–30.2	9.2–24.4
	Range	7.3–90.2	5.9–72.9	5.0–61.9	5–61.9	4.5–55.4	3.7–45.7	3.0–38.6
Patients with toxicity (n = 20)	Median	67.4	55.9	50.4	44.5	38.1	27.1	20.9
	IQR	54.1–67.4	41.8–66.0	35.3–60.8	29.3–52.3	23.4–45.1	16.2–36.5	12.6–29.4
	Range	12.7–84.3	10.1–72.9	9.1–67.1	8.1–61.9	7.3–55.4	6.5–45.7	5.9–38.6
Patients without toxicity (n = 35)	Median	60.0	43.7	37.8	30.2	22.9	15.6	11.7
	IQR	33.3–71.3	23.9–57.9	21.6–53.9	19.3–47.3	15.4–39.2	11.4–29.0	8.9–21.0
	Range	7.3–90.2	5.9–72.7	5.4–67.3	5.0–61.6	4.5–54.7	3.7–45.3	3.0–38.0
P-value*		**0.090**	**0.037**	**0.036**	**0.031**	**0.033**	**0.025**	**0.031**

van Werkhoven, IJROBP, 2025; van Werkhoven, Radiother Oncol, 2025

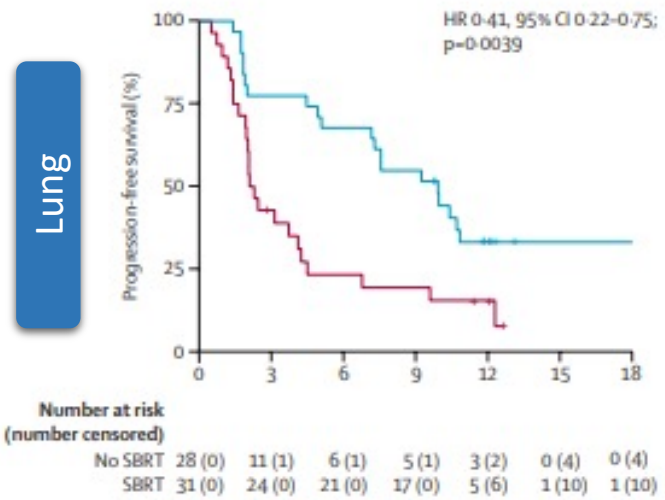
Indications

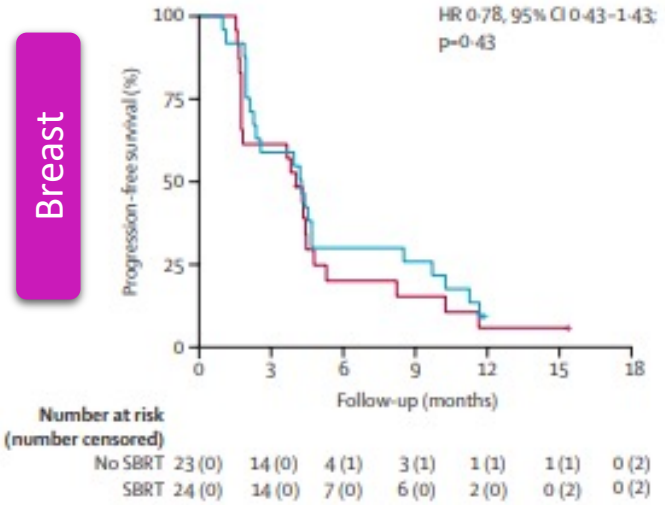
Bone

- Ré-irradiation
  - Protection de la dose à la moelle
    - Fractionnement potentiellement classique
- Cancer radiorésistant
  - Mélanome, Cancer du rein
- Patients oligométastatiques
  - 1 à 3 (5) métastases
  - 1 à 3 organes
- *Toutes lésions douloureuses?*
- *Radiothérapie préventive?*

?

Cancer du sein?
Cancer de la prostate?
Cancer pulmonaire?





Tsai, Lancet, 2024 ; Hanna, Lancet, 2024; Reddy, IJROBP, 2023, Chmura, ASCO, 2022

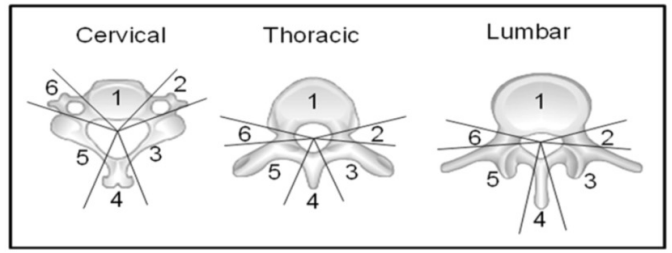
Définitions des volumes

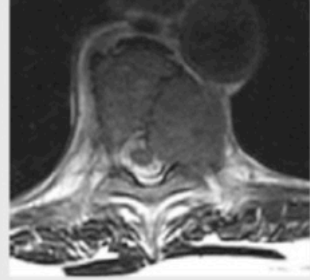
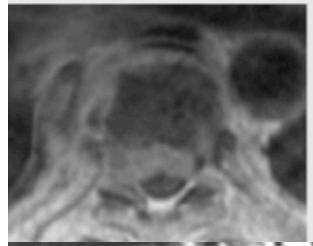
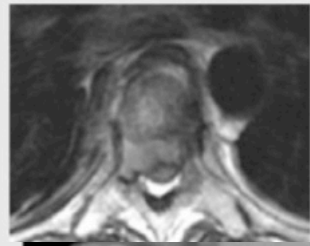
Bone

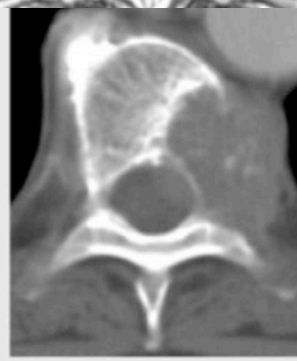
Rachis

- Os périphériques
  - Intérêt IRM +/- ou TEP
  - CTV = GTV + 5mm (respect corticale)

- Rachis
  - Recommandations RTOG
  - IRM millimétrique si possible en position de traitement
  - T1 + Gadolinium pour le GTV
  - T2 pour la Moelle épinière / Queue de cheval





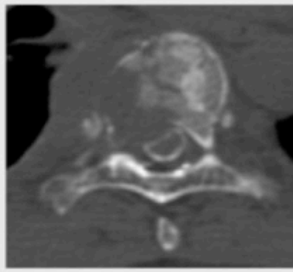


Table 3 Guidelines for spinal SRS bony CTV delineation

GTV involvement	ISRC GTV anatomic classification	ISRC bony CTV recommendation	CTV description
Any portion of the vertebral body	1	1	Include the entire vertebral body
Lateralized within the vertebral body	1	1, 2	Include the entire vertebral body and the ipsilateral pedicle/transverse process
Diffusely involves the vertebral body	1	1, 2, 6	Include the entire vertebral body and the bilateral pedicles/transverse processes
GTV involves vertebral body and unilateral pedicle	1, 2	1, 2, 3	Include entire vertebral body, pedicle, ipsilateral transverse process, and ipsilateral lamina
GTV involves vertebral body and bilateral pedicles/transverse processes	3	2, 3, 4	Include entire vertebral body, bilateral pedicles/transverse processes, and bilateral laminae
GTV involves unilateral pedicle	2	2, 3 ± 1	Include pedicle, ipsilateral transverse process, and ipsilateral lamina, ± vertebral body
GTV involves unilateral lamina	3	2, 3, 4	Include lamina, ipsilateral pedicle/transverse process, and spinous process
GTV involves spinous process	4	3, 4, 5	Include entire spinous process and bilateral laminae

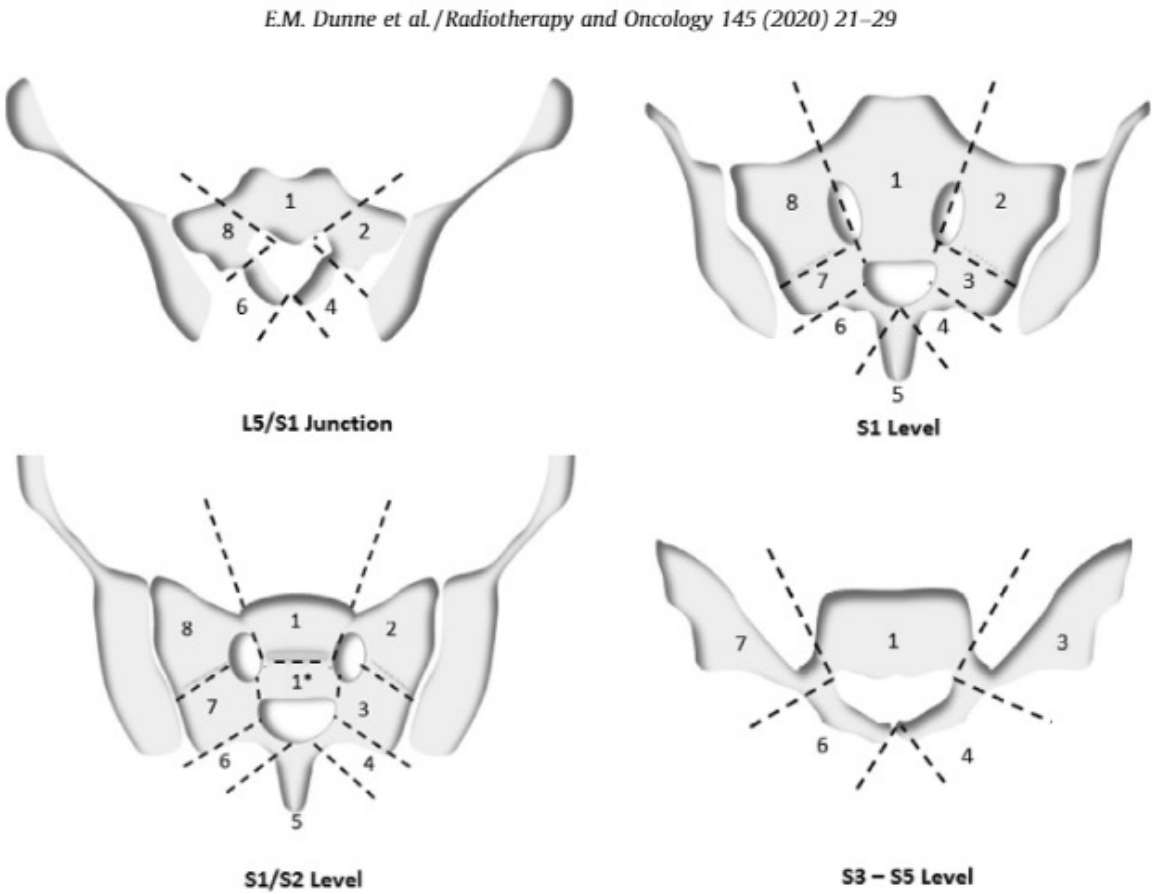
Abbreviations: CTV = clinical target volume; GTV = gross tumor volume; ISRC = International Spine Radiosurgery Consortium.

Cox, IJROBP, 2012; Redmond, IJROBP, 2018, Dunne, IJROBP, 2022, Dunne, IJROBP, 2021

Définitions des volumes

Bone

Os périphérique Et Sacrum



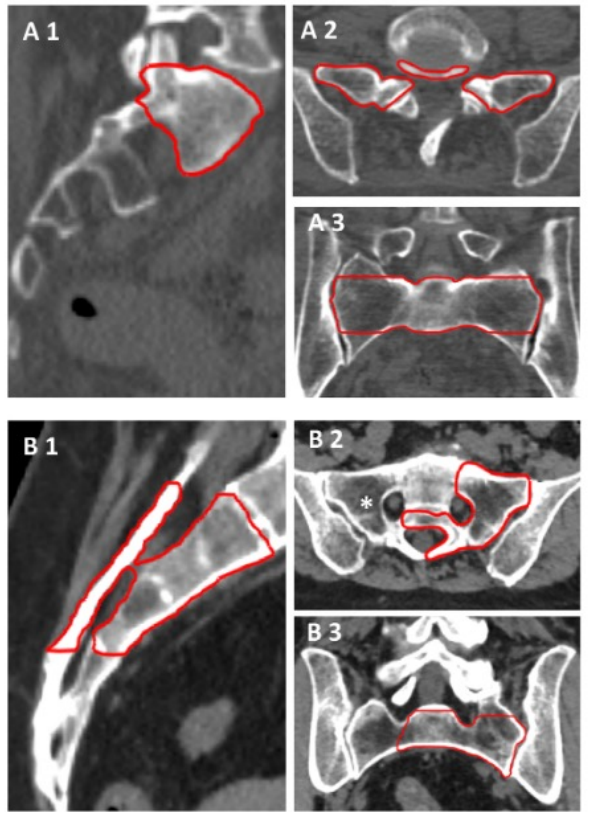
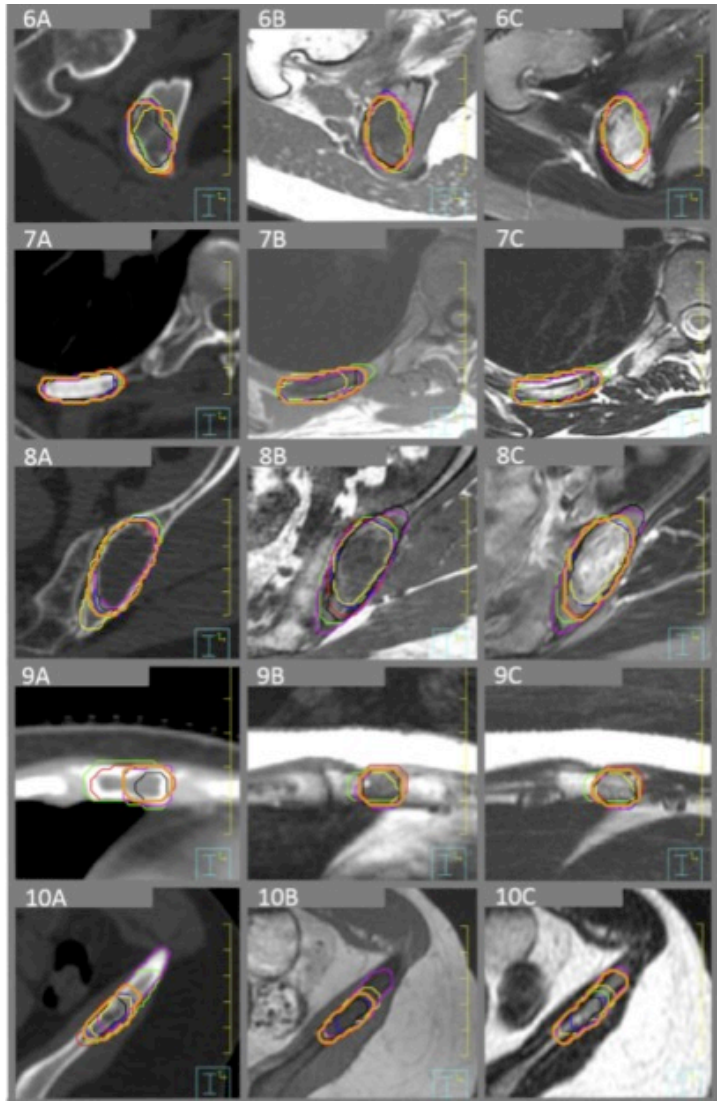
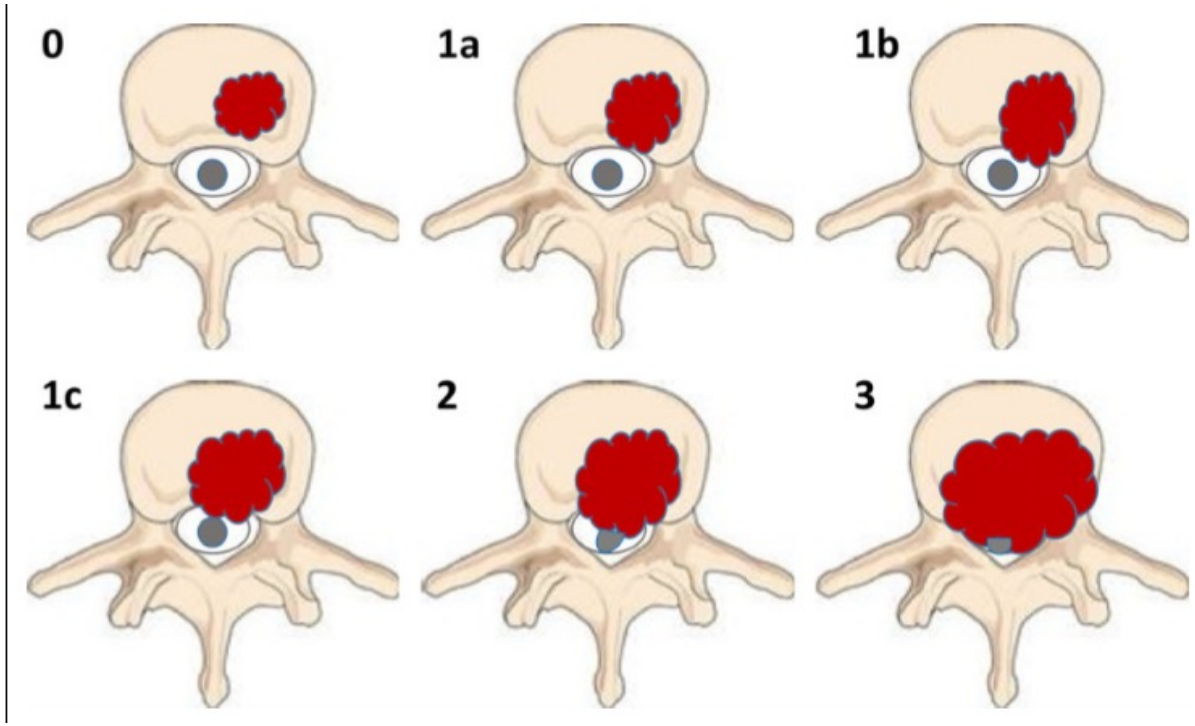


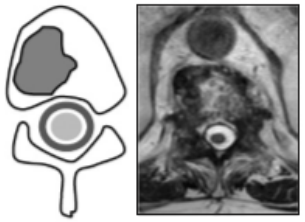
Fig. 3. Sagittal, axial and coronal CT images at the level of S1 (A1–A3, Case 8) and S2 (B1–3, Case 4). * Ossification line separating the right anterior and posterior ala (B2). *Abbreviations*: CT, computed tomography.



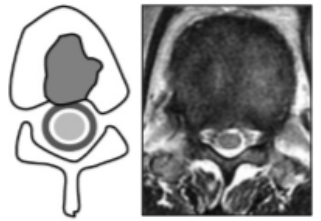
Raman, IJROBP, 2018; Prins, APM, 2017 , Lopez-Campos, Clinical Trans Oncol, 2022, Nguyen, IJROBP, 2022 , Dunne, Radiother Oncol ,2020

Contre indication

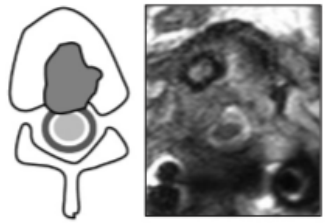




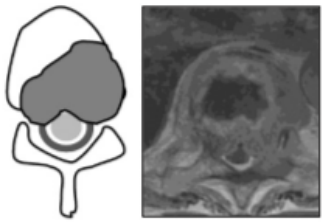
Grade 0
Bone involvement only
No canal compromise



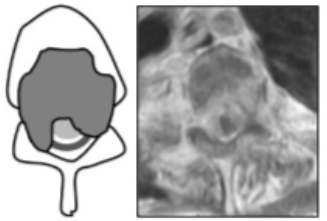
Grade I
Involvement of epidural fat



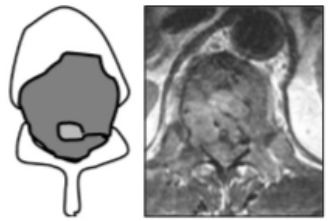
Grade II
Impingement of thecal sac



Grade III
Impingement of spinal cord

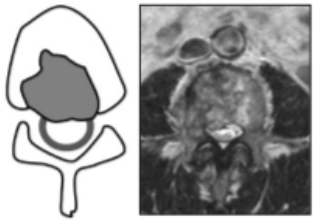


Grade IV
Compression and/or
displacement of spinal cord
Partial block of CSF

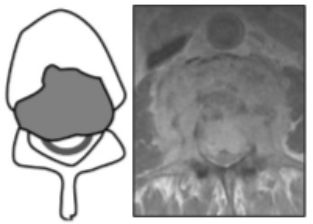


Grade V
Spinal cord compression and
Complete block of CSF

At cauda level



Grade II
≤50% canal



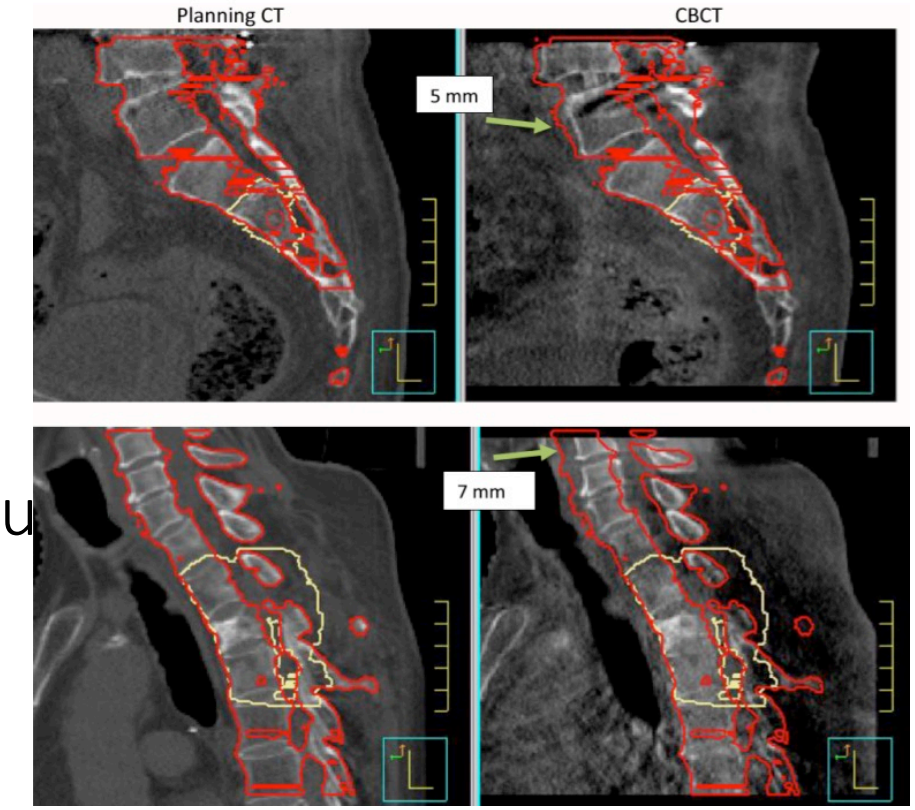
Grade IV
>50% canal compromise

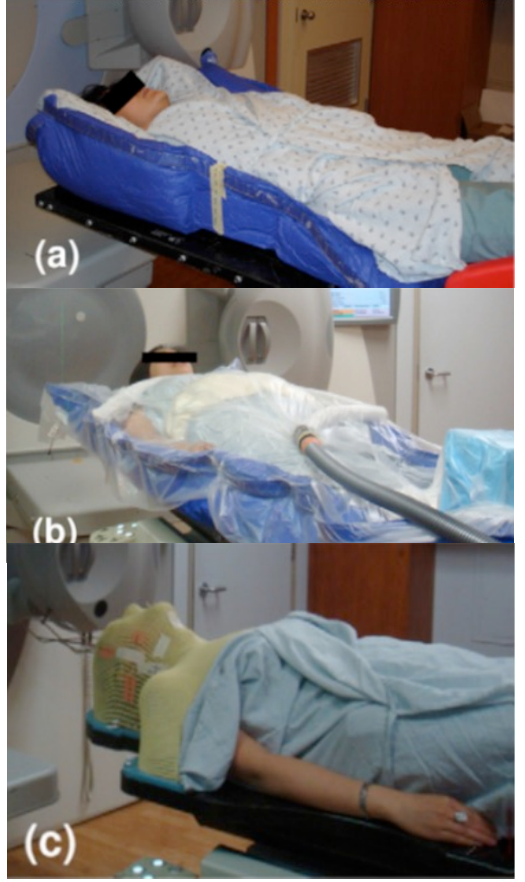
Samuel, ROJ, 2015; Tseng, Global Spine Journal, 2017

Imagerie de repositionnement

Bone

- Dépend:
  - De la localisation
  - De la précision attendue
  - Du mode de traitement
    - Type de contrôle
    - Durée du traitement
- Attention aux volumes contigu
- Importance IRM/ TDM





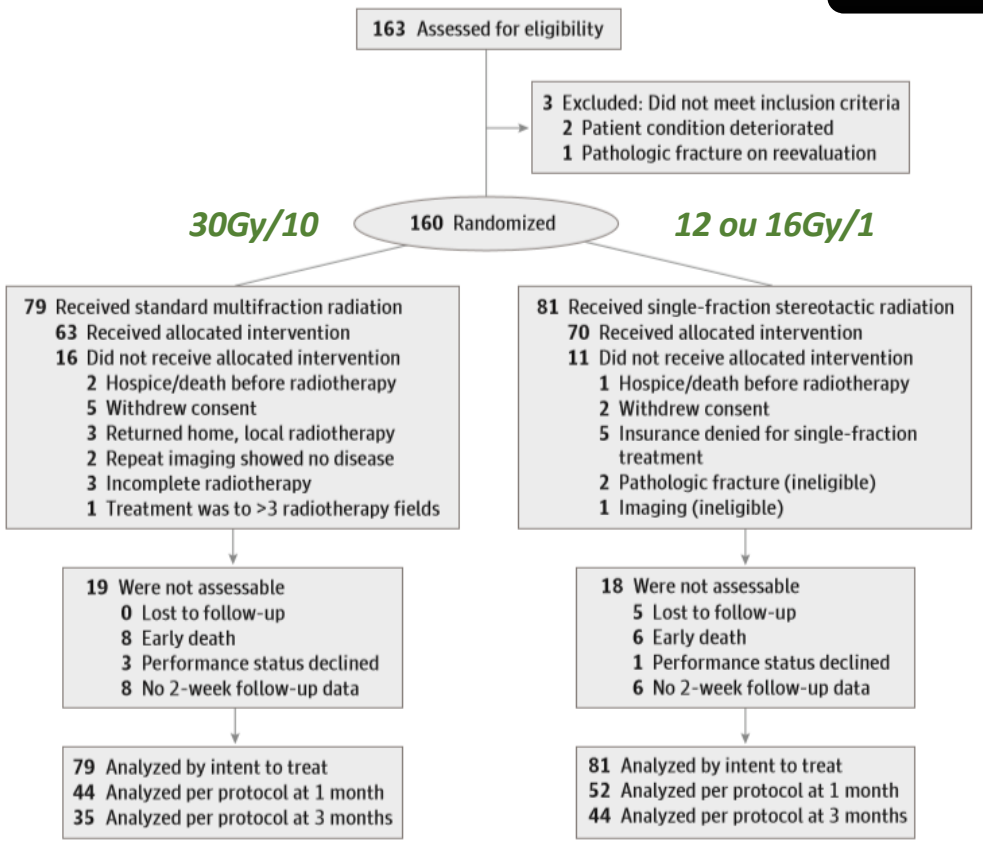
Wangs, Rad Oncol Physics, 2017, , Hadj Henni, Rad Oncol, 2021

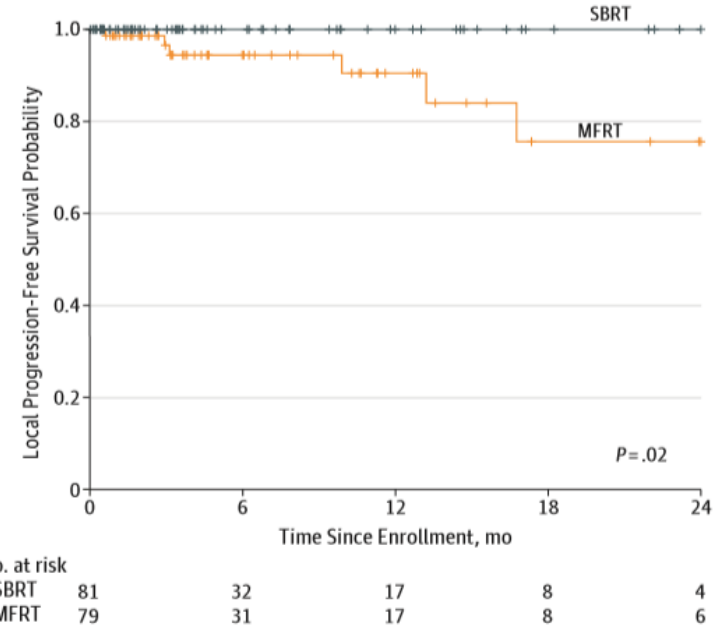
Phase III

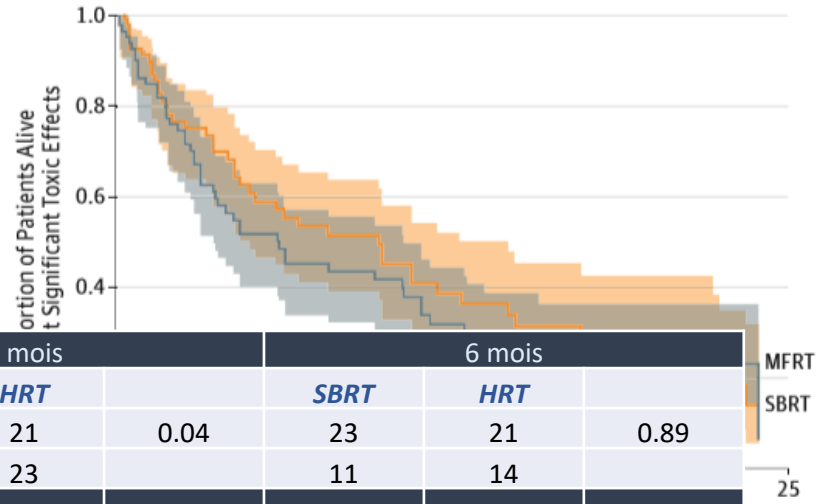
Quelle efficacité?

Rachis

Bone







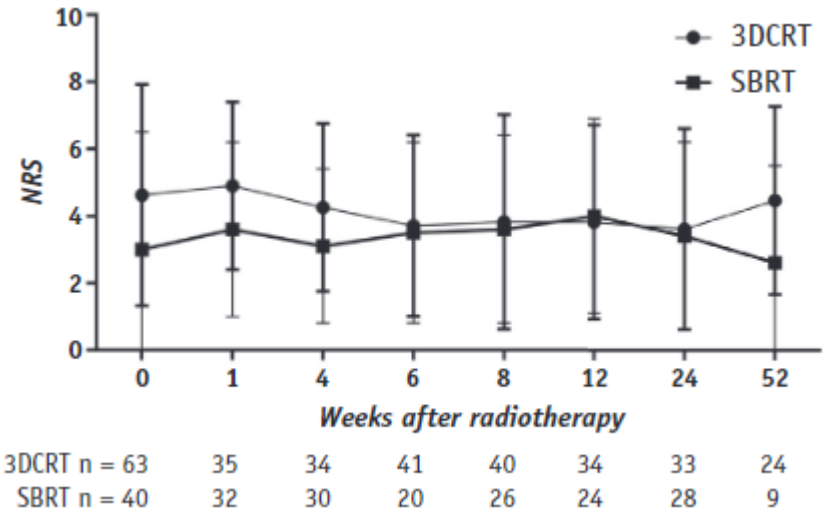
ITT		1 mois			3 mois			6 mois		
		SBRT	*HRT*		*SBRT*	*HRT*		*SBRT*	*HRT*	
	Respondeurs	44	30	0.19	39	21	0.04	23	21	0.89
	Non respondeurs	20	25		15	23		11	14	
PP										
	Respondeurs	69	55	0.15	73	49	0.04	68	61	0.78
	Non respondeurs	31	45		27	51		32	39	

Nguyen QN, JAMA Oncol, 2019

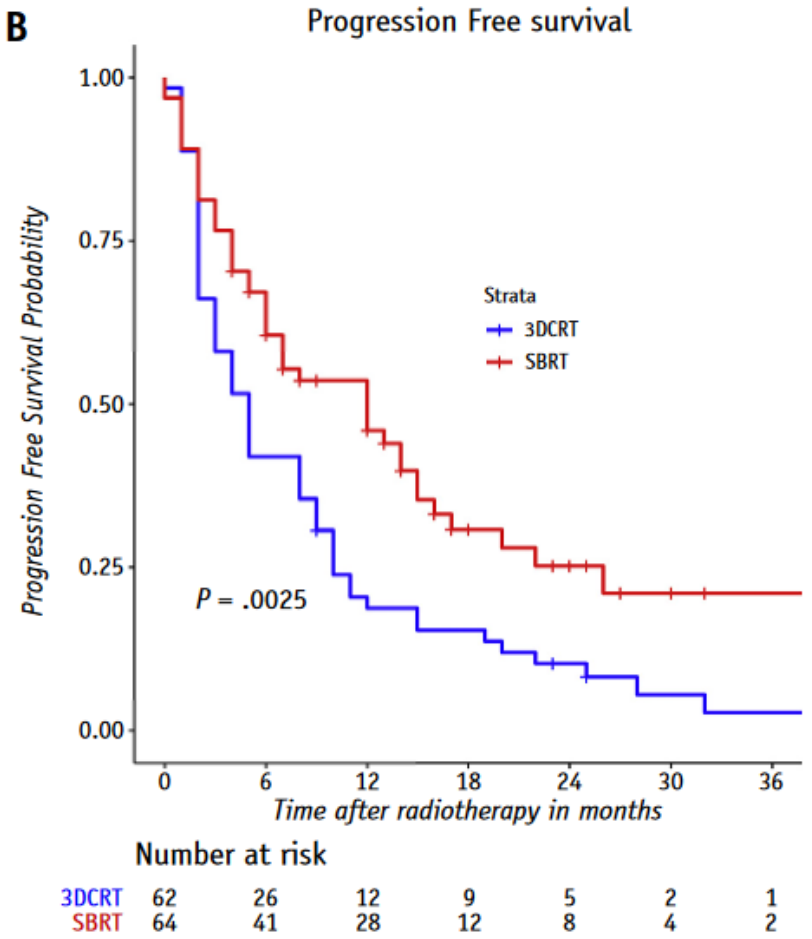
Quelle efficacité?

Bone

douleur



PFS



PRESENT Cohorte

Van de Ven, IJROBP, 2020

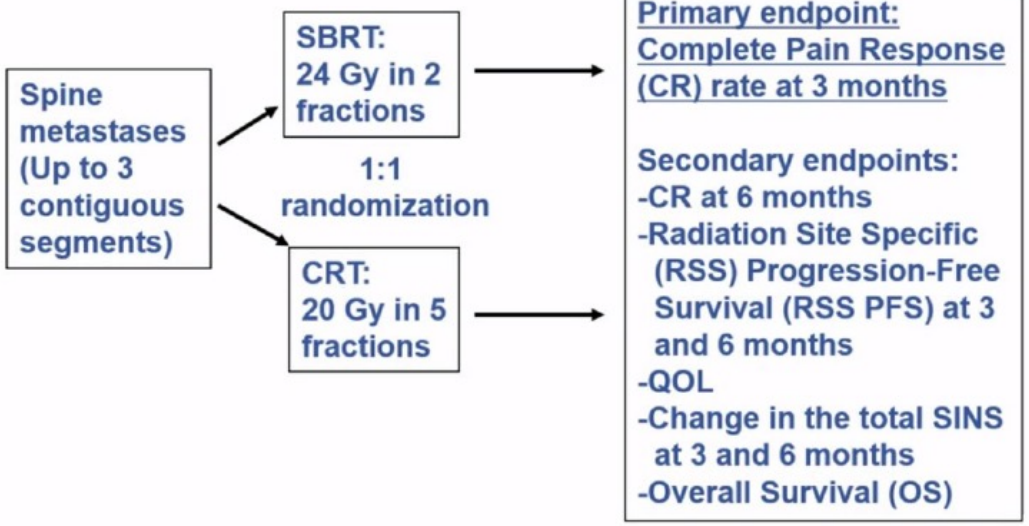
Phase III

Quelle efficacité?

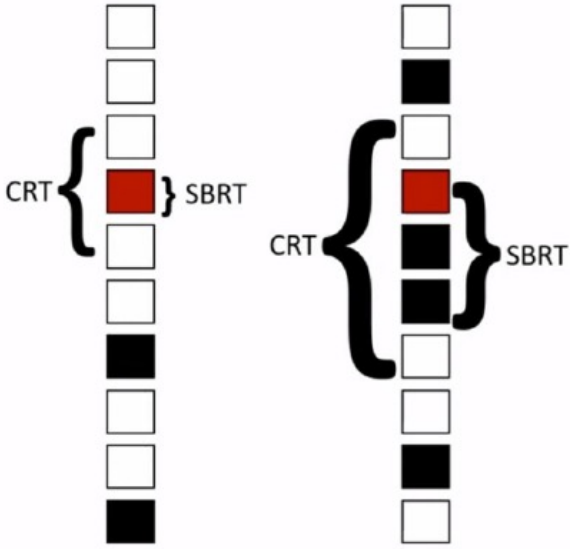
Rachis

Bone

Schema



- Stratification factors: radioresistant (GI, RCC, melanoma, sarcoma) vs. radiosensitive, and presence vs. absence of extra-osseous extension (Mass type)



Red: Target spinal segment volume
Red +/- Black: Treatment Volume
{: Included segments in a SBRT treatment volume and segments encompassed in a CRT treatment field adjusting for margins

Response	CRT (N=115)	SBRT (N=114)
3 month assessment		
Complete response	**14 %**	**35%**
Partial response	25%	18%
Stable disease	30%	24%
Progressive disease	12%	6%
Indeterminant	19%	18%
Mean change in total SINS (standard deviation)	**-0.49 (1.61)**	**-0.94 (1.69)**

Response	CRT (N=115)	SBRT (N=114)
6 month assessment		
Complete response	**16%**	**32%**
Partial response	16%	9%
Stable disease	27%	23%
Progressive disease	7%	4%
Indeterminant	34%	32%
Mean change in total SINS (standard deviation)	**-0.74 (1.99)**	**-0.73 (1.86)**

Sahgal, Lancet Oncol, 2021

Phase III

Quelle efficacité?

Rachis

Bone

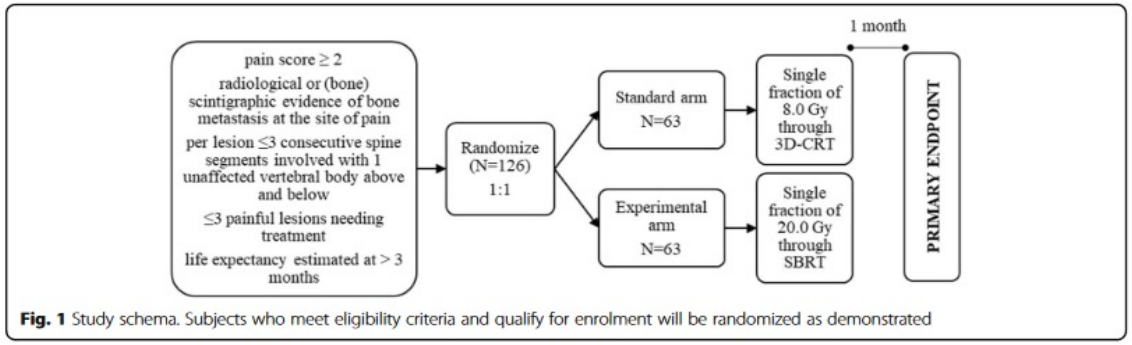
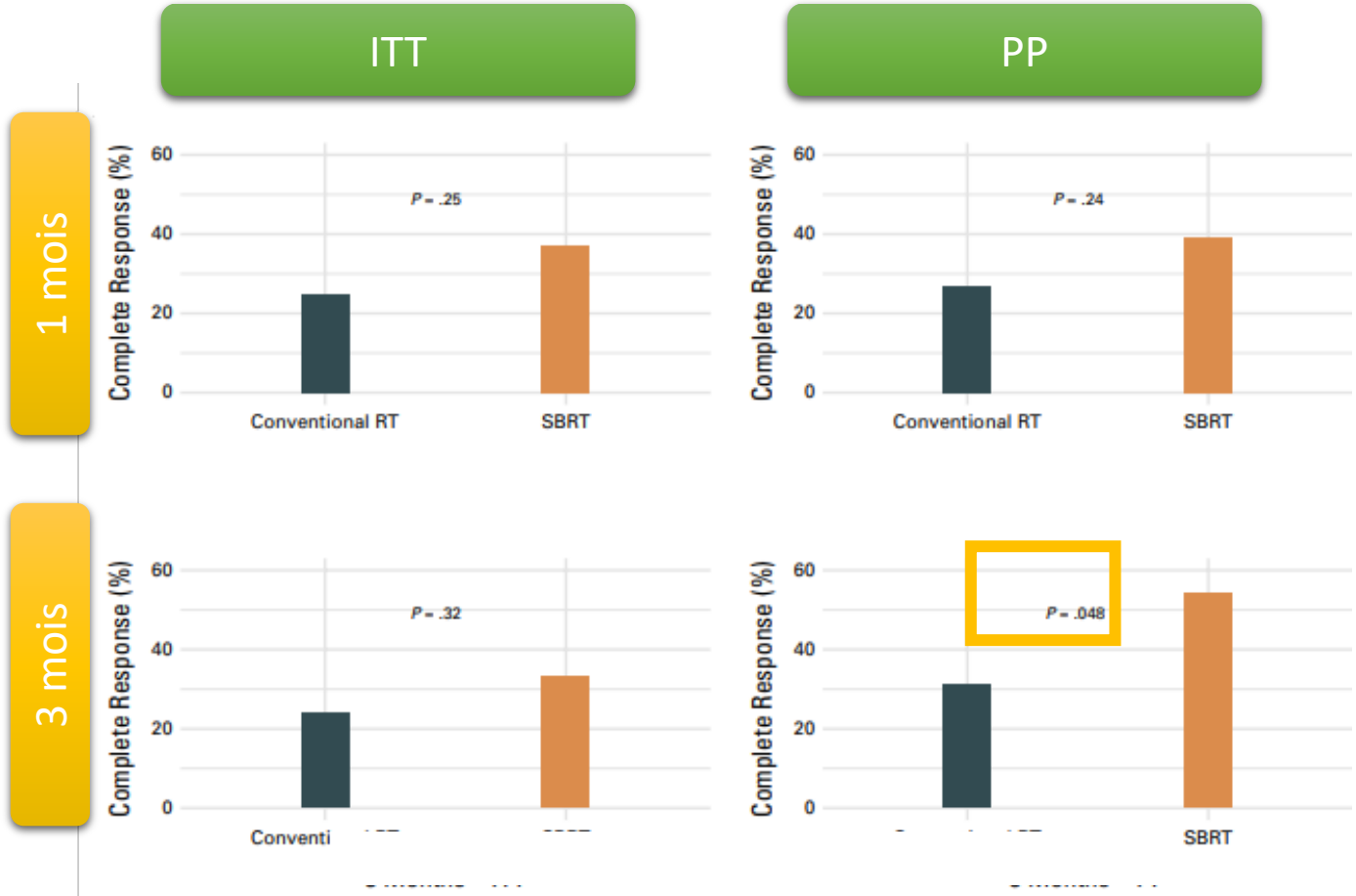


Fig. 1 Study schema. Subjects who meet eligibility criteria and qualify for enrolment will be randomized as demonstrated



Mercier, BMC, 2019 ; Mercier, Radiation Oncology, 2025

Phase III

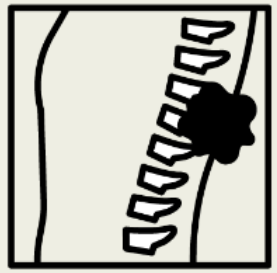
Quelle efficacité?

Rachis

Bone

POPULATION

184 Men, 155 Women



Adults with 1 to 3 newly diagnosed vertebral metastases

Mean age, 62.6 y (range, 23-93 y)

SETTINGS / LOCATIONS

59 Institutions in the US, Canada, and Israel

INTERVENTION

214 Participants randomized and analyzed at 3 mo

138 Stereotactic radiosurgery (SRS)
16-Gy or 18-Gy single-dose SRS delivered to the involved spine only

76 Conventional external beam radiotherapy (cEBRT)
8-Gy single-dose cEBRT administered to the involved spine plus 1 spine segment above and below

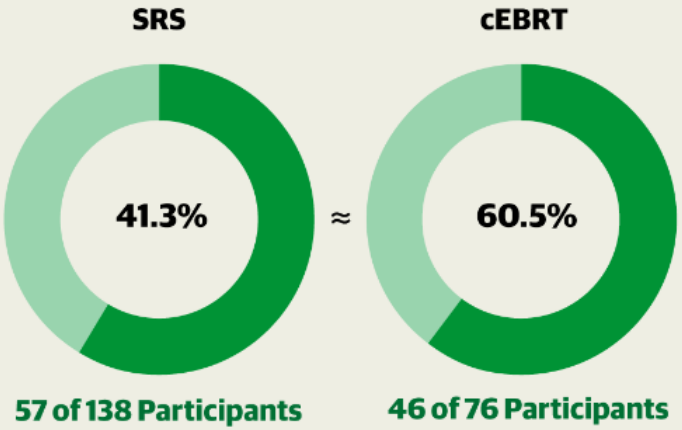
PRIMARY OUTCOME

Pain response at 3-mo posttreatment, defined as pain score of 0 (or ≥3 point decline) at the index site and no increases in narcotic pain medication or secondary site pain score; pain measured using the Numerical Rating Pain Scale (NRPS; range, 0 [no pain] to 10 [extreme pain])

FINDINGS

There was no significant difference between SRS and cEBRT in the proportion of participants with pain response

Proportion of participants with pain response at 3 mo



Between-group difference, SRS vs cEBRT: -19 percentage points (95% CI, -32.9 to -5.5); 1-sided *P* value = .99

Ryu, JAMA Oncol, 2023

Méta analyse

Quelle efficacité?

Rachis

Bone

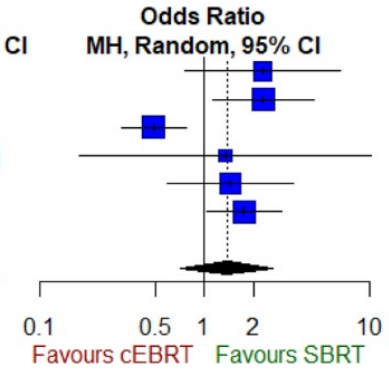
Réponse à 3 mois

Réponse globale

Study	SBRT Events	SBRT Total	cEBRT Events	cEBRT Total	Weight	Odds Ratio MH, Random, 95% CI
Sprave 2018	16	27	11	28	14.4%	2.25 [0.76; 6.61]
Nguyen 2019	31	81	17	79	18.9%	2.26 [1.12; 4.55]
Ryu 2019	84	209	75	130	21.8%	0.49 [0.32; 0.77]
Sakr 2020	8	10	9	12	7.1%	1.33 [0.18; 10.12]
Pielkenrood 2020	18	45	14	44	16.8%	1.43 [0.60; 3.41]
Sahgal 2021	60	114	45	115	20.9%	1.73 [1.02; 2.92]
Total (95% CI)		**486**		**408**	**100.0%**	**1.37 [0.72; 2.60]**

Heterogeneity: $Tau^2 = 0.4437$; $Chi^2 = 21.53$, df = 5 ($P < 0.01$); $I^2 = 77\%$

P -value= 0.34



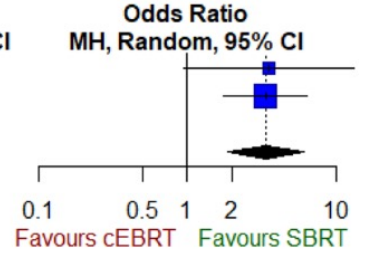
A: Overall pain response at 3 months

Réponse complète

Study	SBRT Events	SBRT Total	cEBRT Events	cEBRT Total	Weight	Odds Ratio MH, Random, 95% CI
Sprave 2018	10	27	4	28	19.8%	3.53 [0.95; 13.15]
Sahgal 2021	40	114	16	115	80.2%	3.34 [1.74; 6.43]
Total (95% CI)		**141**		**143**	**100.0%**	**3.38 [1.88; 6.07]**

Heterogeneity: $Tau^2 = 0$; $Chi^2 = 0.01$, df = 1 ($P = 0.94$); $I^2 = 0\%$

P -value < 0.01



B: Complete pain response at 3 months

Lee, Critical Reviews in Oncolog, 2022; Bindels Jama Network, 2023

Méta analyse

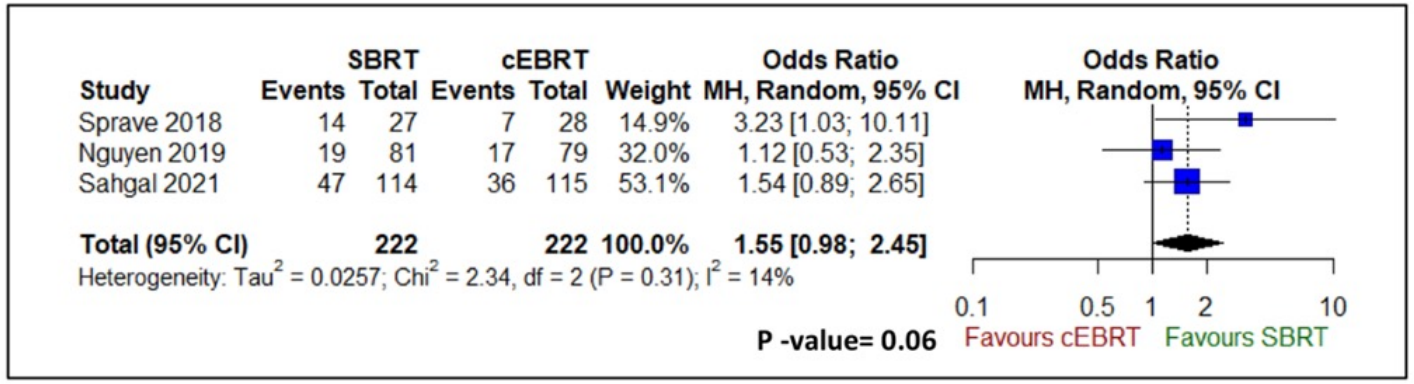
Quelle efficacité?

Bone

Rachis

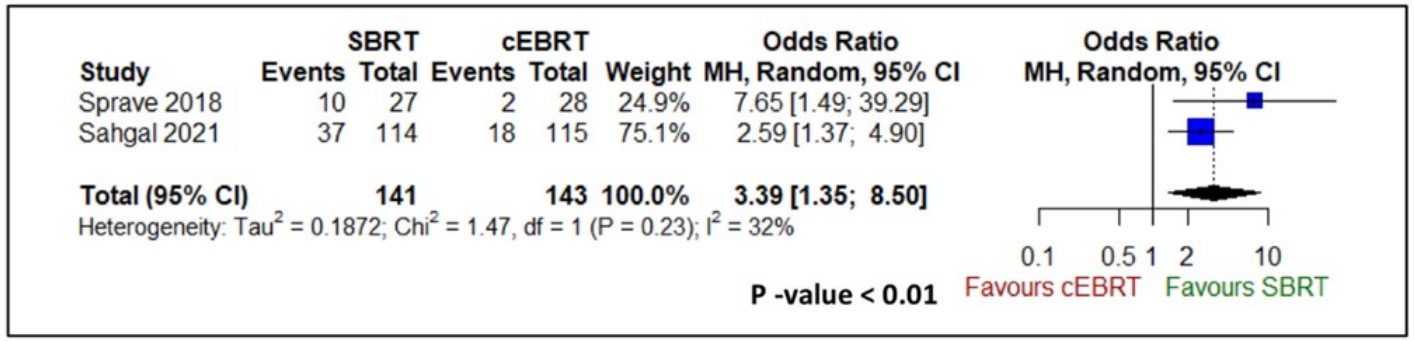
Réponse à 6 mois

Réponse globale



C: Overall pain response at 6 months

Réponse complète



D: Complete pain response at 6 months

Lee, Critical Reviews in Oncolog, 2022; Bindels Jama Network, 2023

Méta analyse

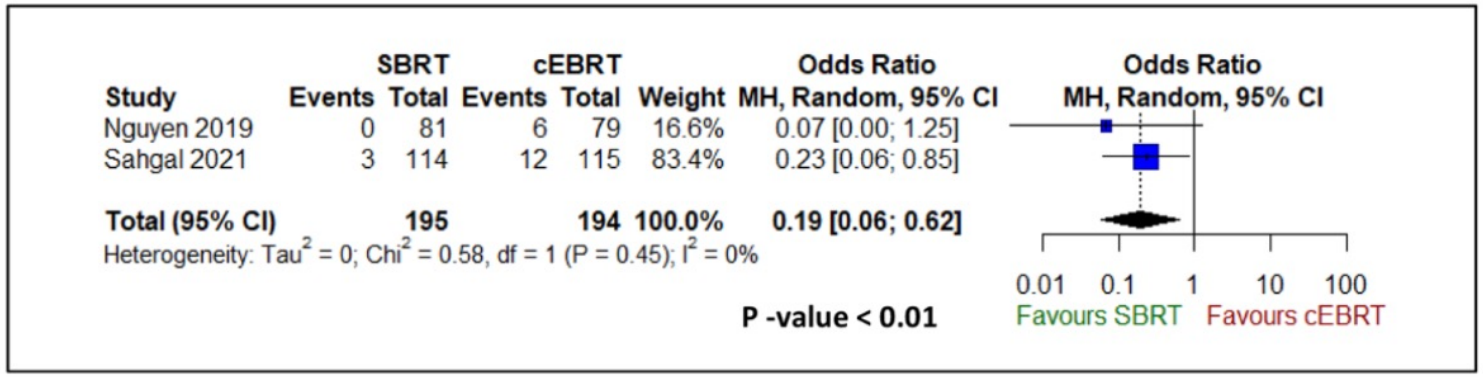
Quelle efficacité?

Bone

Rachis

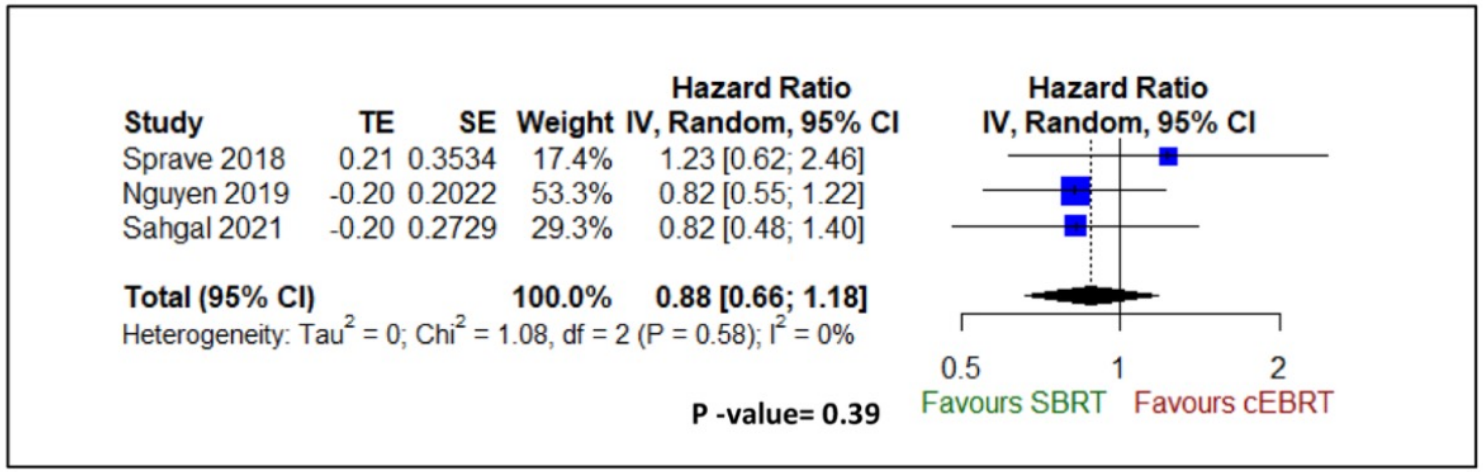
Contrôle

Contrôle local



A: Local progression

Survie Globale



B: Overall survival

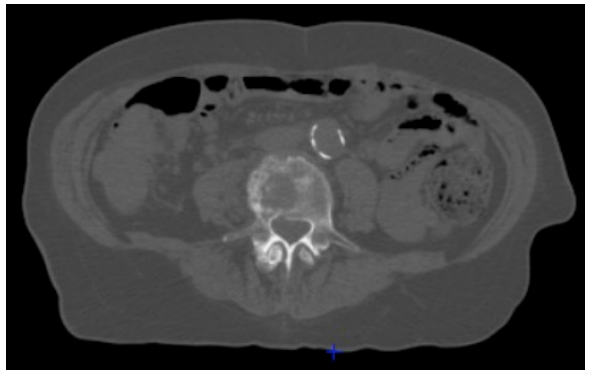
Lee, Critical Reviews in Oncolog, 2022; Bindels Jama Network, 2023

Méta analyse

Quelles complications?

Rachis

Bone



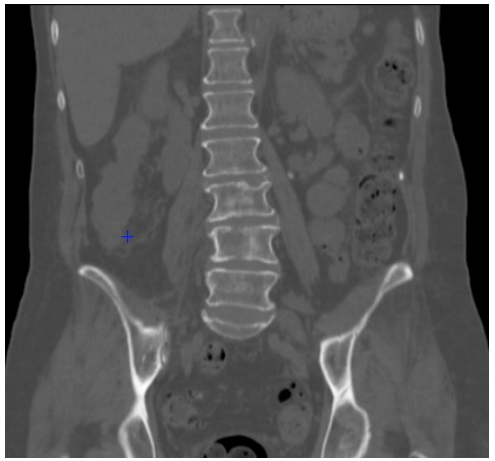


Table 3. Significant Predictors of VCF on Univariate and Multivariate Analysis

Factor	Univariate *P*	Multivariable Fine and Grey Model *P*	HR	95% CI
Vertebral body collapse	< .001	Global, < .001		
≥ 50% VCF		.0189	6.92	1.38 to 34.77
< 50% VCF		< .001	8.98	4.48 to 18.00
No VCF but > 50% of vertebral body involved		< .001	4.46	2.08 to 9.57
Dose/fraction, Gy	< .001	Global, < .001		
≥ 24		< .001	5.25	2.29 to 12.01
20-23		< .001	4.91	1.96 to 12.28
Alignment	.0027	< .001	2.99	1.57 to 5.70
Bone lesion type	< .001	.0022	3.53	1.58 to 7.93
Paraspinal/epidural extension	.0036	NS		

NOTE. For vertebral body collapse, the reference is no VCF and less than 50% vertebral body involvement; for dose/fraction, the reference is ≤ 19 Gy/fraction; the reference for alignment was normal, and yphosis/scoliosis and subluxation/translation were grouped as only one patient had subluxation; and the reference for bone lesion was grouped according to mixed and osteoblastic tumor versus osteolytic, given that the majority of VCFs occurred in lytic tumors.

Abbreviations: HR, hazard ratio; NS, not significant; VCF, vertebral compression fracture.

Sahgal, JCO, 2013; Lee, Pratical Rad Oncol, 2021

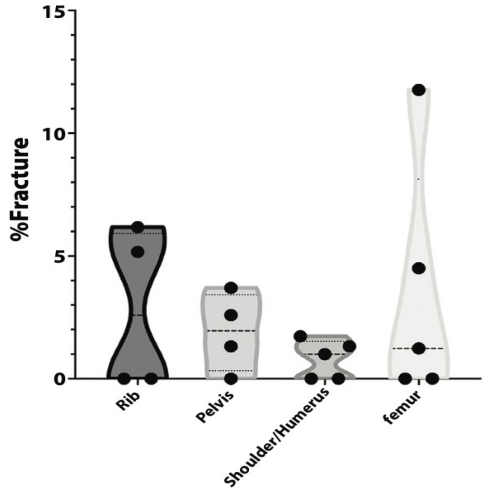
Méta analyse

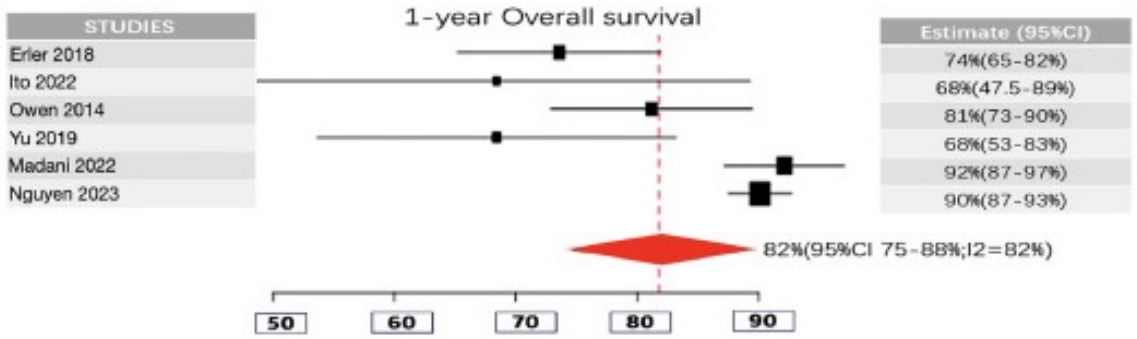
Quelles complications?

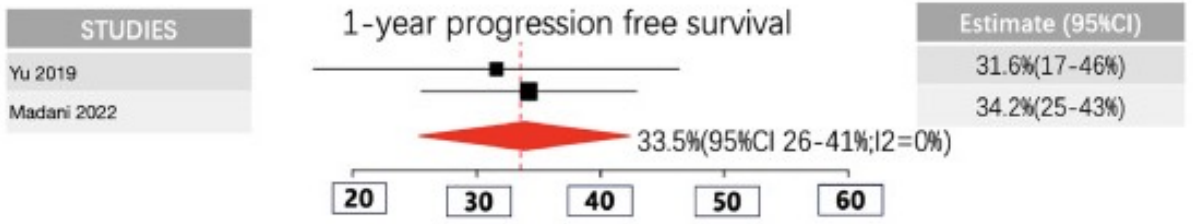
Bone

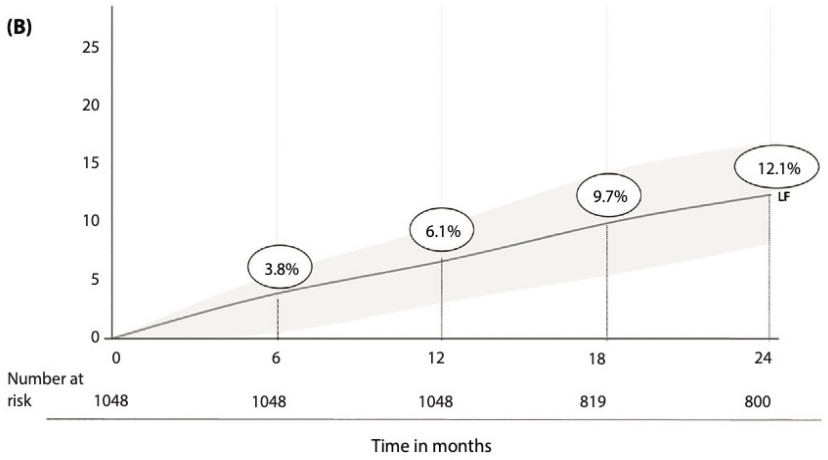
Hors rachis

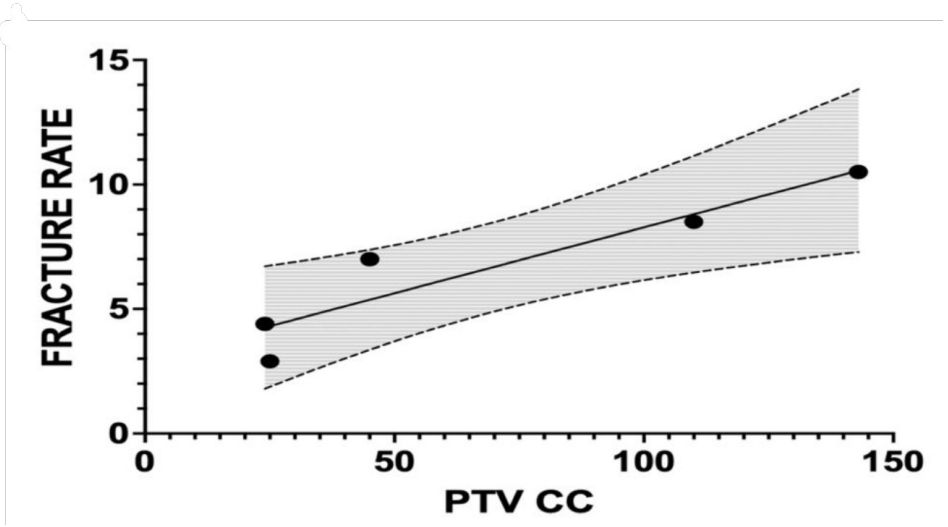
- Fracture: cotes, fémur
- Flaire-up: 7.5%











Moraes, IJROBP, 2024, Singh, IJROBP, 2024

Analyse post hoc

Quelle efficacité?

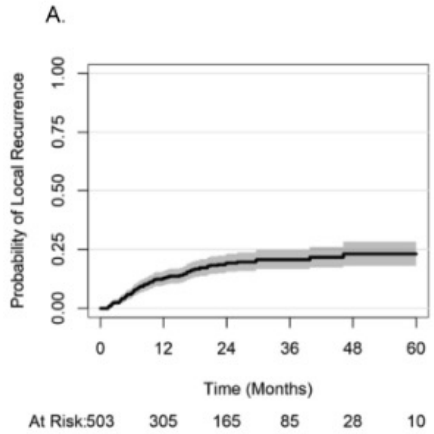
Bone

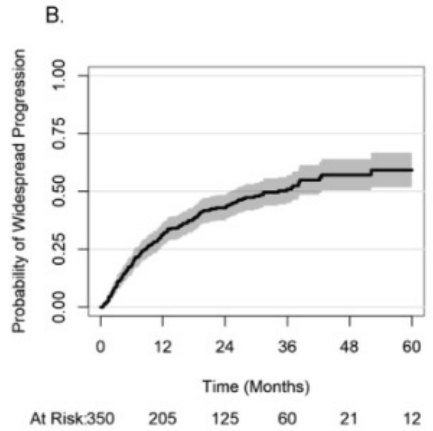
Table 3
Final multivariable regression models for local recurrence.

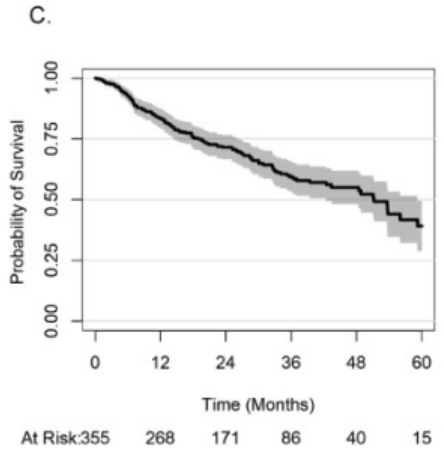
Covariate for All Bone Lesions	Sub-HR (95% CI)	*p* value
Radioresistant Histology	2.49 (1.61–3.87)	<0.001
Treatment at initial oligometastatic presentation to SBRT	0.58 (0.34–0.97)	0.038
PTV size ≥ median	2.11 (1.28–3.46)	0.0033
PTV Dmin (BED10) ≥ median	0.53 (0.33–0.87)	0.011

Covariate for Non-Spine Bone Lesions	Sub-HR (95% CI)	*p* value
Primary Histology		
Prostate (ref)	1	
Renal cell	10.8 (3.21–36.1)	<0.001
NSCLC	6.48 (2.05–20.5)	0.0015
Other	2.60 (0.75–9.0)	0.13
PTV size ≥ median	5.02 (1.39–18.2)	0.014

Covariate for Spine Lesions	Sub-HR (95% CI)	*p* Value
Radioresistant Histology	2.11 (1.25–3.57)	0.0051
PTV Dmin (BED10) ≥ median	0.46 (0.26–0.82)	0.0085
Epidural Disease	1.99 (1.13–3.49)	0.016







CAO, Rad Oncol, 2021

Cohorte prospective

Quelle efficacité?

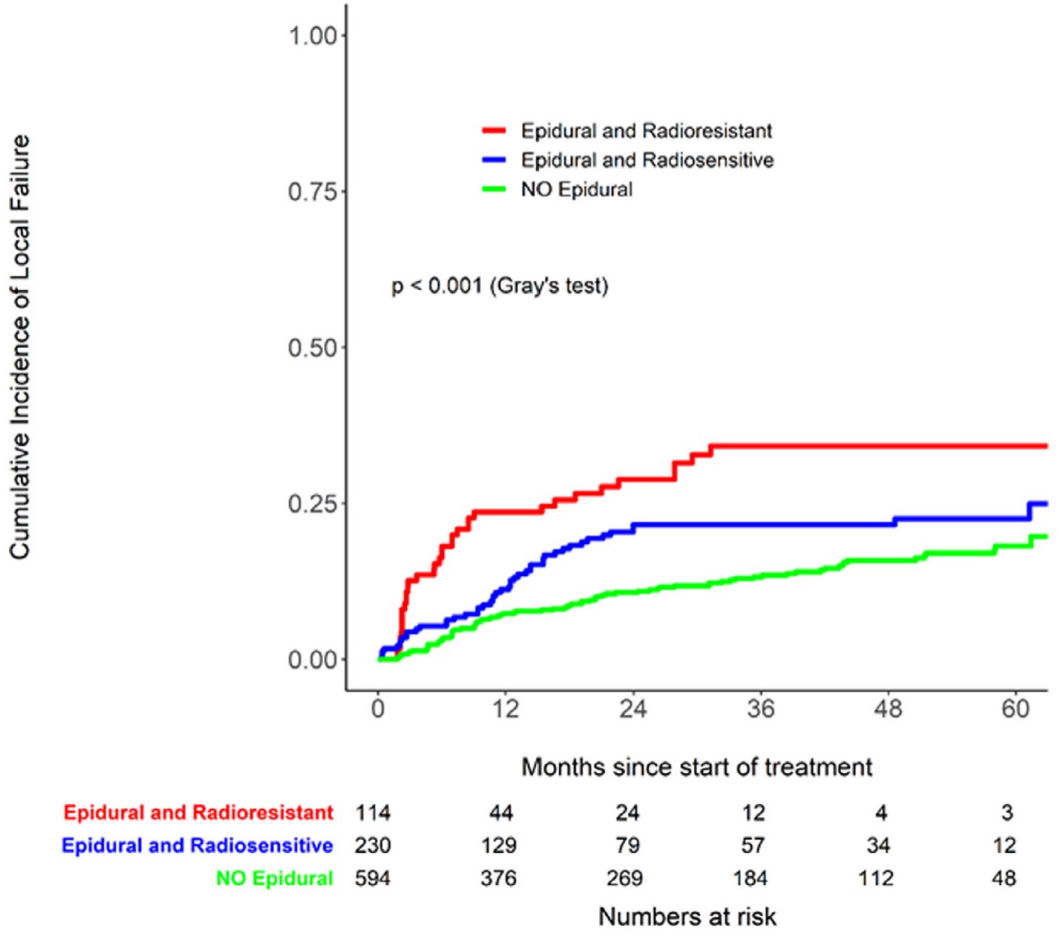
Rachis

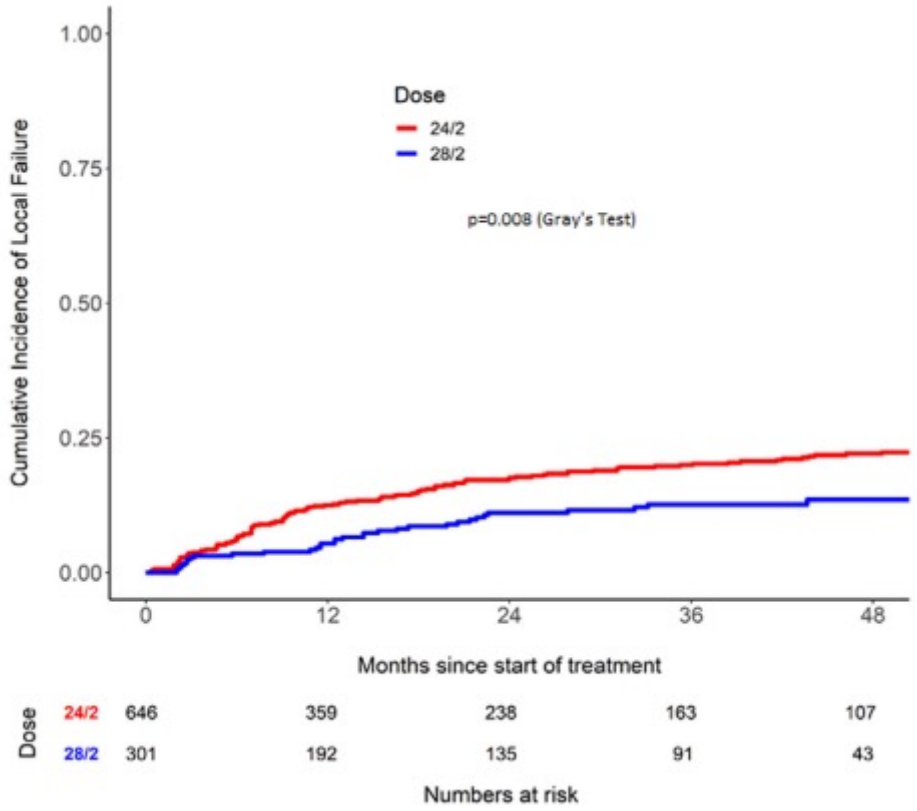
Bone

✓

28Gy/2 (159)

24Gy/2 (343)





Zeng, IJROBP, 2022

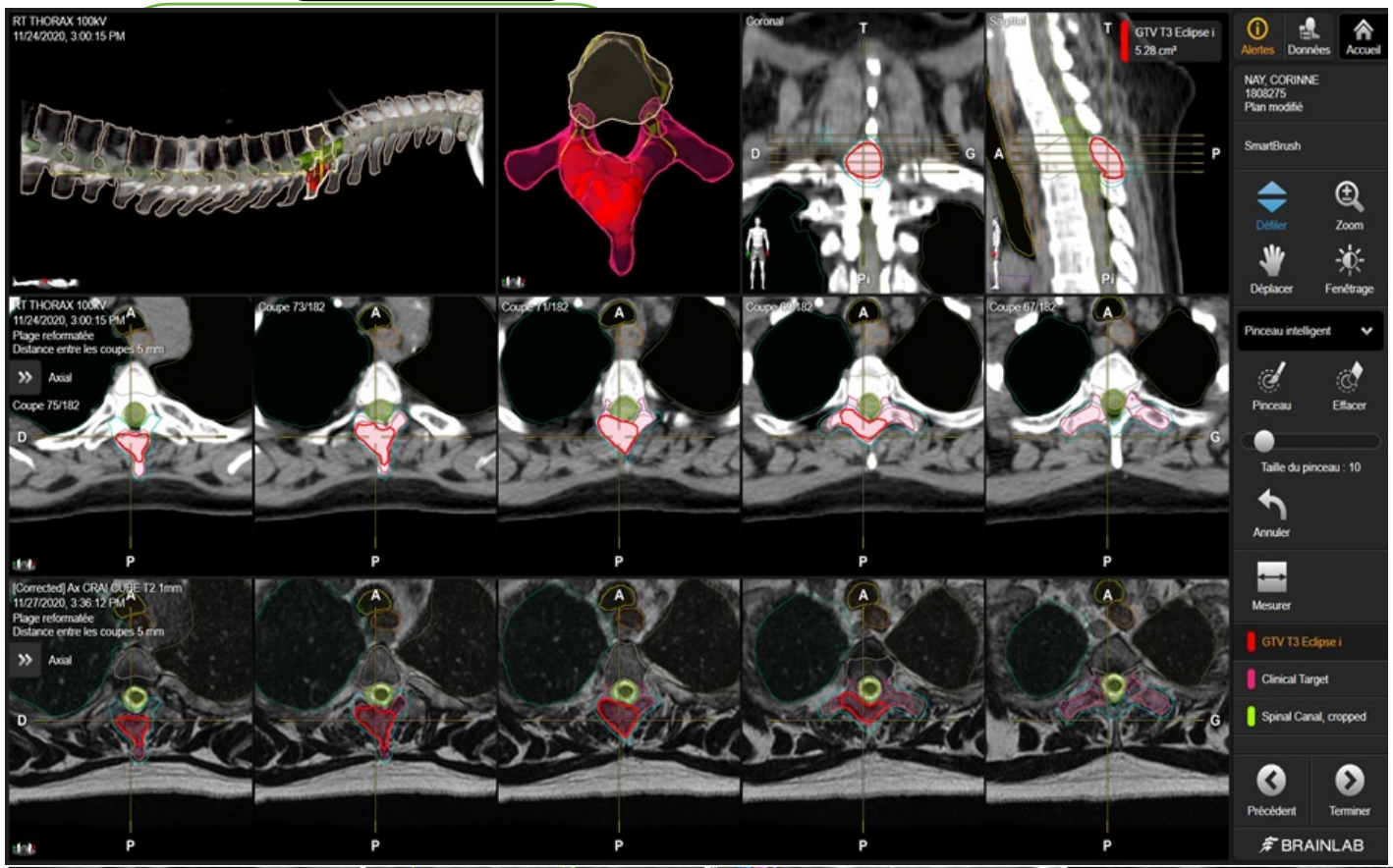
Quality control

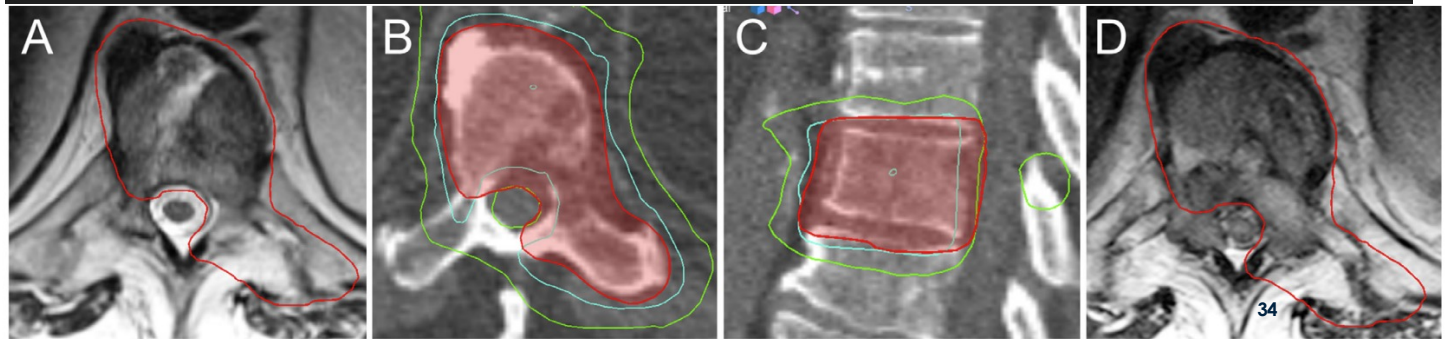
Bone

Rachis

- ✓ 283 patients
- ✓ 360 lesions

- ✓ 17% of deviations



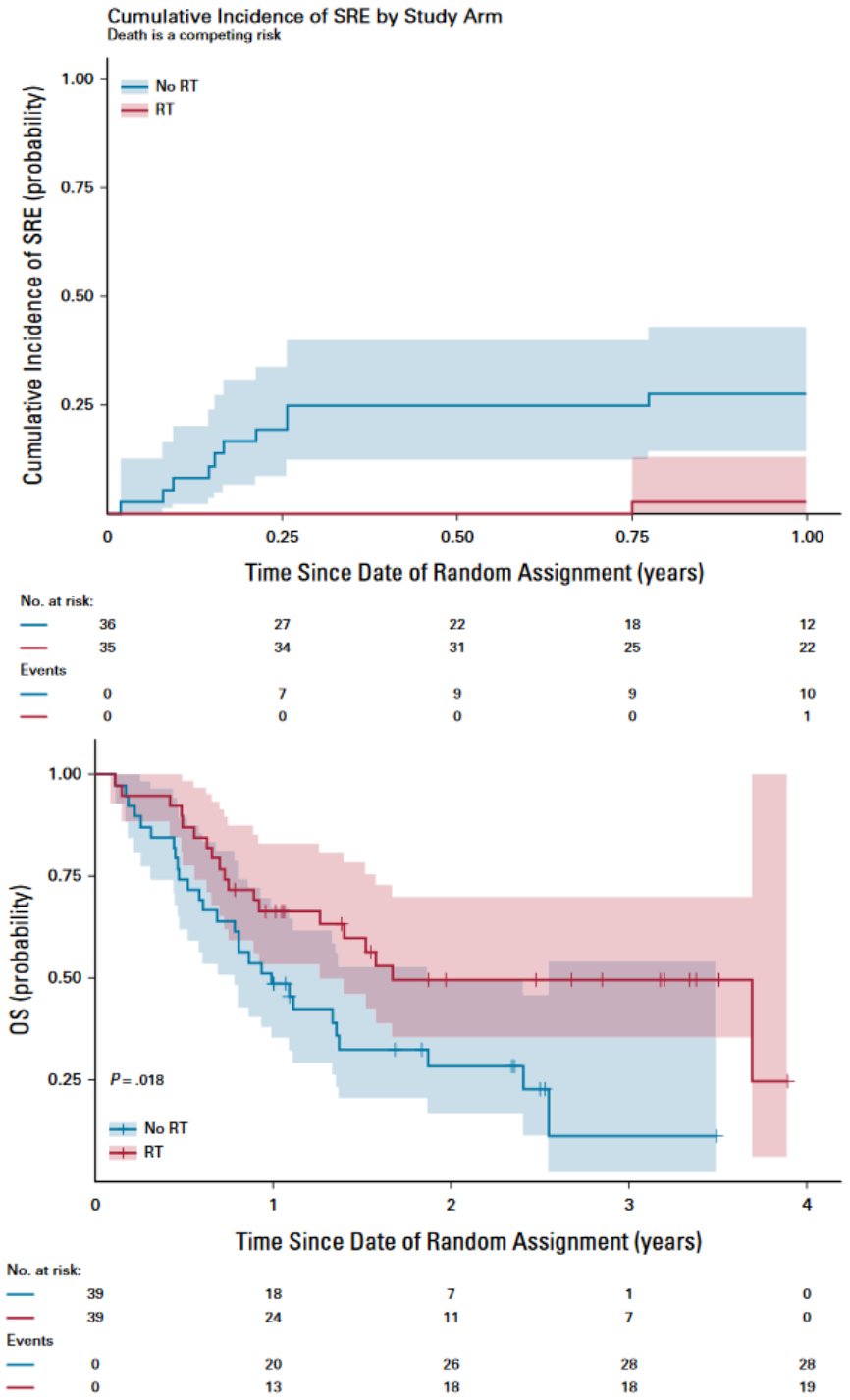


Chen, Radiother Oncol, 2022; Rogé, Frontiers Oncology, 2022

Radiothérapie préventive

- Radiothérapie prophylactique
- Phase II
- 78 patients randomisés
- 37 lésions rachidiennes
- Facteurs d'OS en multivarié
  - RT
  - Type de primitif

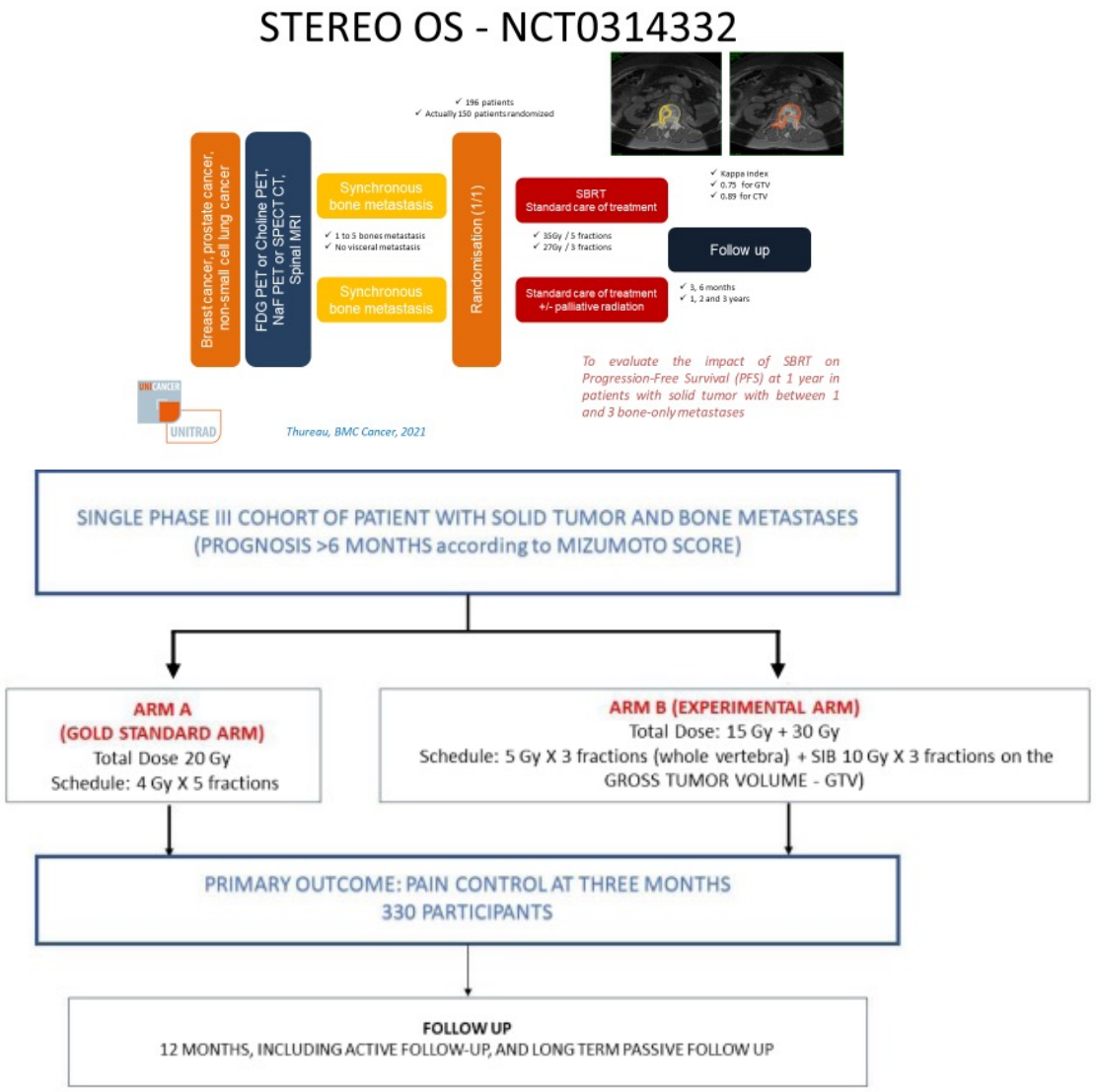
- Type de RT
  - 27/3 19 lésions
  - 20/5, 30/10 ou 8/1



Gillespie, Radiat Oncol, 2023

Conclusion

- Pour quels patients?
  - Oligométastatique
  - Oligoprogressif
- Quels fractionnements?
  - Importance de la dose
- Quels objectifs cliniques?
  - Douleur
  - Control local
  - PFS, OS….



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Radiotherapy for bone metastases

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