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# Diagnostik und Therapie früher und fortgeschrittener Mammakarzinome

## Adjuvante Strahlentherapie



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## Adjuvante Radiotherapie (RT)

- **Versionen 2002 – 2021:**  
**Blohmer / Budach / Friedrich / Friedrichs / Göhring / Huober / Janni /  
 Krug / Kühn / Möbus / Rody / Scharl / Seegenschmiedt / Souchon /  
 Thomssen / Untch / Wenz**
  
- **Version 2022:**  
**Budach / Krug / Kühn / Schmidt**

### Search Strategy

Search Terms: Radiotherapy Breast Cancer

Source: Pubmed 1/2010 – 1/2021

Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials


1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al. Lancet. 2014 Jun 21;383(9935):2127-35.

Effect of radiotherapy after breast-conserving surgery on 10-year recurrence and 15-year breast cancer death: meta-analysis of individual patient data for 10,801 women in 17 randomised trials

1. Early Breast Cancer Trialists' Collaborative Group (EBCTCG), Darby S, McGale P, Correa C, et al. Lancet. 2011 Nov 12;378(9804):1707-16.

Overview of the randomized trials of radiotherapy in ductal carcinoma in situ of the breast

1. Early Breast Cancer Trialists' Collaborative Group (EBCTCG), Correa C, McGale P, Taylor C, et al. Natl Cancer Inst Monogr. 2010;2010(41):162-77.



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## Vorbemerkung

- **Diese Empfehlungen zur adjuvanten Strahlentherapie bei Brustkrebs basieren auf einer Konsensdiskussion zwischen Experten der Arbeitsgemeinschaft für Gynäkologische Onkologie (AGO) und der Deutschen Gesellschaft für Radioonkologie (DEGRO).**
- **Für technische Details zur Durchführung der Strahlentherapie verweisen wir auf die entsprechenden aktualisierten Leitlinien der DEGRO.**

1. Sedlmayer F, Sautter-Bihl ML, Budach W, et al; Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). DEGRO practical guidelines: radiotherapy of breast cancer I: radiotherapy following breast conserving therapy for invasive breast cancer. Strahlenther Onkol. 2013 Oct;189(10):825-33.
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Radiotherapie (RT) nach brusterhaltenden Operationen (BEO; invasive Karzinome)			
	Oxford		
	LoE	GR	AGO
▪ Bestrahlung der operierten Brust	1a	A	++
▪ Moderat hypofraktionierte RT (Gesamtdosis ca. 40 Gy in ca. 15-16 Fraktionen in ca. 3 bis 5 Wochen)	1a	A	++
▪ Konventionell fraktionierte RT (Gesamtdosis ca. 50 Gy in ca. 25-28 Fraktionen in ca. 5-6 Wochen)	1a	B	+
▪ Ultra-hypofraktionierte RT (Gesamtdosis 26 bzw. 28,5 Gy in 5 Fraktionen über 1 oder 5 Wochen)	1b	B	+/-
▪ Bei Lebenserwartung < 10 Jahre und pT1, pN0, R0, ER / PR positiv, HER2-negativ, endokriner adjuvanter Therapie (alle Faktoren) kann unter Inkaufnahme eines erhöhten Lokalrezidivrisikos nach individueller Beratung auf die RT verzichtet werden.	1a	B	+

### Moderate Hypofractionation

1. Haviland JS, Owen JR, Dewar JA, et al; START Trialists' Group. The UK Standardisation of Breast Radiotherapy (START) trials of radiotherapy hypofractionation for treatment of early breast cancer: 10-year follow-up results of two randomised controlled trials. *Lancet Oncol.* 2013 Oct;14(11):1086-94.
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#### Ultra-Hypofractionation

1. Brunt AM, Haviland JS, Sydenham M et al. Ten-Year Results of FAST: A Randomized Controlled Trial of 5-Fraction Whole-Breast Radiotherapy for Early Breast Cancer. *J Clin Oncol*. 2020 Oct 1;38(28):3261-3272.
2. Brunt AM, Haviland JS, Wheatley DA et al. Hypofractionated breast radiotherapy for 1 week versus 3 weeks (FAST-Forward): 5-year efficacy and late normal tissue effects results from a multicentre, non-inferiority, randomised, phase 3 trial. *Lancet*. 2020 May 23;395(10237):1613-1626.
3. Whelan T, Levine M, Sussman J. Hypofractionated Breast Irradiation: What's Next? *J Clin Oncol*. 2020 Oct 1;38(28):3245-3247.
4. Krug D, Baumann R, Combs SE et al. Moderate hypofractionation remains the standard of care for whole-breast radiotherapy in breast cancer: Considerations regarding FAST and FAST-Forward. *Strahlenther Onkol*. 2021;197:269–280.
5. Meattini I, Becherini C, Boersma L et al. European Society for Radiotherapy and Oncology Advisory Committee in Radiation Oncology Practice consensus recommendations on patient selection and dose and fractionation for external beam radiotherapy in early breast cancer. *Lancet Oncol*. 2022;23(1):e21-e31.

#### Elderly patients with low-risk features

1. Hughes KS, Schnaper LA, Bellon J et al. Lumpectomy plus tamoxifen with or without irradiation in women age 70 years or older with early breast cancer: long-term follow-up of CALGB 9343. J Clin Oncol. 2013 Jul 1;31(19):2382-7.
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FAST / FAST-Forward		
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	FAST	FAST Forward
	<b>Timeframe</b>	2004-2007
	<b>Sample size</b>	915
	<b>Dosse / Fractionation</b>	50 Gy / 2 Gy / 5 weeks 30 Gy / 6 Gy / 5 weeks 28,5 Gy / 5,7 Gy / 5 weeks
	<b>Median follow-up</b>	119.8 months
	<b>Primary endpoint</b>	change in photographic breast appearance
	<b>Inclusion criteria</b>	pT1-2 (< 3 cm) pN0 Age ≥ 50 years Breast conserving surgery No chemotherapy
	<b>Boost</b>	No
		Approx. 25%, 5-8 x 2 Gy
Brunt AM et al. J Clin Oncol. 2020 Oct 1;38(28):3261-3272. Brunt AM et al. Lancet. 2020 May 23;395(10237):1613-1626.		

### Ultra-Hypofractionation

1. Brunt AM, Haviland JS, Sydenham M et al. Ten-Year Results of FAST: A Randomized Controlled Trial of 5-Fraction Whole-Breast Radiotherapy for Early Breast Cancer. J Clin Oncol. 2020 Oct 1;38(28):3261-3272.
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4. Krug D, Baumann R, Combs SE et al. Moderate hypofractionation remains the standard of care for whole-breast radiotherapy in breast cancer: Considerations regarding FAST and FAST-Forward. Strahlenther Onkol. 2021;197:269–280.




FAST / FAST-Forward						
	FAST (10 year-data)			FAST Forward (5 year-data)		
	Dose	Frequency	Hazard ratio (95%-CI)	Dose	Frequency	Hazard ratio (95%-CI)
<b>Ipsilateral in-breast recurrence</b>	50 Gy	0.7%	-	40 Gy	2.1%	-
	30 Gy	1.4%	HR 1.36 (0.3-6.06)	27 Gy	1.7%	HR 0.86 (0.51-1.44)
	28.5 Gy	1.7%	HR 1.35 (0.3-6.05)	26 Gy	1.4%	HR 0.67 (0.38-1.16)
<b>Moderate / marked normal tissue effects breast / chestwall</b>	50 Gy	33.6%	-	40 Gy	26.8%	-
	30 Gy	50.4%	<b>HR 1.79 (1.37-2.34)</b>	27 Gy	35.1%	<b>HR 1.41 (1.23-1.61)</b>
	28.5 Gy	47.6%	<b>HR 1.45 (1.10-1.91)</b>	26 Gy	28.5%	HR 1.09 (0.95-1.27)

Brunt AM et al. J Clin Oncol. 2020 Oct 1;38(28):3261-3272. Brunt AM et al. Lancet. 2020 May 23;395(10237):1613-1626.

### Ultra-Hypofractionation

1. Brunt AM, Haviland JS, Sydenham M et al. Ten-Year Results of FAST: A Randomized Controlled Trial of 5-Fraction Whole-Breast Radiotherapy for Early Breast Cancer. J Clin Oncol. 2020 Oct 1;38(28):3261-3272.
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3. Whelan T, Levine M, Sussman J. Hypofractionated Breast Irradiation: What's Next? J Clin Oncol. 2020 Oct 1;38(28):3245-3247.
4. Krug D, Baumann R, Combs SE et al. Moderate hypofractionation remains the standard of care for whole-breast radiotherapy in breast cancer: Considerations regarding FAST and FAST-Forward. Strahlenther Onkol. 2021;197:269–280.

	<b>BCS <math>\geq</math> 70 y &lt; 4 cm cN0 : Tamoxifen vs. Tamoxifen + RT</b> <b>Time:1994-1999, since 8/1996 only pT1cN0 ER / PR+ or unknown allowed</b>			
© AGO e. V. in der DGGG e.V. sowie in der DKG e.V.  Guidelines Breast Version 2022.1D  www.ago-online.de FORSCHEN LEHREN HEILEN	<b>@10 yrs (95% C.I.)</b>	<b>Tamoxifen</b>	<b>Tamoxifen plus Radiotherapy</b>	<b>Hazard Ratio</b>
	<b>Local recurrence-free (<math>\Delta</math> = 8 %)</b>	<b>90% (85%-93%)</b>	<b>98% (96%-99%)</b>	<b>HR = 0.18 (95% CI, 0.07 to 0.42; P &lt; .001)</b>
	<b>Mastectomy-free</b>	<b>96% (93% - 98%)</b>	<b>98% (96% - 99%)</b>	<b>HR = 0.50 (95% CI, 0.17 to 1.48; n.s.)</b>
	<b>Distant metastasis-free</b>	<b>95% (91% - 97%)</b>	<b>95 % (92% - 97%)</b>	<b>HR = 1.20 (95% CI, 0.63 to 2.32; n.s)</b>
	<b>Overall survival</b>	<b>66% (61% - 71%)</b>	<b>67% (62% - 72%)</b>	<b>HR = 0.95 (95% CI, 0.77 to 1.18; n.s.)</b>
Hughes KE et al J Clin Oncol 2013; 31:2382-2387				

1. Hughes KS, Schnaper LA, Bellon J et al: Lumpectomy plus tamoxifen with or without irradiation in women age 70 years or older with early breast cancer: long-term follow-up of CALGB 9343. J Clin Oncol. 2013 Jul 1;31(19):2382-7.

Boostbestrahlung nach BEO beim invasiven Karzinom			
	Oxford		
	LoE	GR	AGO
<b>Boost-RT des Tumorbettes (verbesserte lokale Kontrolle, kein Überlebensvorteil)</b>			
▪ Prämenopausal	1b	B	++
▪ Postmenopausal, sofern > T1*, G3, HER2-positiv, triple-negativ, EIC (mindestens 1 Faktor)	2b	B	+
<b>Techniken</b>			
▪ Perkutan (Photonen, Elektronen) als sequentieller Boost	1a	A	++
▪ Multikatheter-Brachytherapie	1a	A	++
▪ Perkutan als simultan integrierter Boost (bei konventionell fraktionierter RT)	1b	B	+
▪ Perkutan als simultan integrierter Boost (bei hypofraktionierter RT)	2b	B	+/-
▪ Intraoperative Radiotherapie (als vorgezogener Boost)	2b	B	+

\* kontinuierliche Variable bzgl. Rezidiv

### Boost in general (EBRT/Brachytherapy, sequential)

1. Bartelink H, Maingon P, Poortmans P, et al: European Organisation for Research and Treatment of Cancer Radiation Oncology and Breast Cancer Groups. Whole-breast irradiation with or without a boost for patients treated with breast-conserving surgery for early breast cancer: 20-year follow-up of a randomised phase 3 trial. Lancet Oncol. 2015 Jan;16(1):47-56.
2. Jones HA, Antonini N, Hart AA et al. Impact of pathological characteristics on local relapse after breast-conserving therapy: a subgroup analysis of the EORTC boost versus no boost trial. J Clin Oncol. 2009 Oct 20;27(30):4939-47.
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### Boost-RT in premenopausal p.

### Boost-RT in postmenopausal p.

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2. Livi L, Borghesi S, Saieva C et al. Benefit of radiation boost after whole-breast radiotherapy. *Int J Radiat Oncol Biol Phys*. 2009 Nov 15;75(4):1029-34.
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#### Simultaneous-integrated boost (conventionally fractionated RT)

1. Hörner-Rieber J, Forster T, Hommertgen A et al. Intensity-modulated radiotherapy (IMRT) with simultaneously integrated boost shortens treatment time and is non-inferior to conventional radiotherapy followed by sequential boost in adjuvant breast cancer treatment: results of a large randomized phase III trial (IMRT-MC2 trial). *Int J Radiat Oncol Biol Phys*. 2020 Dec 12:S0360-3016(20)34651-4.
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#### Simultaneous-integrated boost (hypofractionated RT)

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2. Van Parijs H, Miedema G, Vinh-Hung V, et al (2012) Short course radiotherapy with simultaneous integrated boost for stage I-II breast cancer, early toxicities of a randomized clinical trial. *Radiat Oncol* 7:80–10.
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#### Intraoperative irradiation (IORT/IOERT)

##### As boost-irradiation followed by WBI

1. Ciabattini A, Gregucci F, Fastner G et al. IOERT versus external beam electrons for boost radiotherapy in stage I/II breast cancer: 10-year results of a phase III randomized study. *Breast Cancer Res.* 2021;23(1):46.
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 ASSOCIATION GYNAECOLOGISCHE ONKOLOGIE
   
 DEUTSCHLAND
   


# EORTC 22881-10882: Boost vs no Boost (Endpoint: Ipsilateral Breast Recurrence)

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@20 yrs (95% C.I.)	Boost (n = 2.661)	No boost (n = 2.657)	Hazard Ratio (95% C.I.)
<u>Overall Survival</u> ( $\Delta$ = -1.4%)	59.7% (56.3–63.0)	61.1% (57.6–64.3)	HR 1.05 (0.92–1.19) n.s.
<b>Cumulative Risk of Ipsilateral Breast Tumour Recurrence</b>			
All patients	12.0% (9.8–14.4)	16.4% (14.1–18.8)	HR = 0.65 (0.52–0.81); p < 0.0001
≤ 40 years ( $\Delta$ = 11.6%)	24.4% (14.9–33.8)	36.0% (25.8–46.2)	HR = 0.56 (0.34–0.92); p = 0.003
41–50 years ( $\Delta$ = 5.9%)	13.5% (9.5–17.5)	19.4% (14.7–24.1%)	HR = 0.66 (0.45–0.98); p = 0.007
51–60 years ( $\Delta$ = 2.96%)	10.3% (6.3–14.3)	13.2% (9.8–16.7)	HR = 0.69 (0.46–1.04); p = 0.020
> 60 years ( $\Delta$ = 3.0%)	9.7% (5.0–14.4)	12.7% (7.4–18.0)	HR = 0.66 (0.42–1.04); p = 0.019


(Median F/U 17.2 y)

nach: Bartelink et al. Lancet Oncol 2015; 16: 47–56

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# EORTC 22881-10882: Boost vs. no Boost

## (Endpoint: Any First Recurrence)

@15 yrs / 20 yrs (95% C.I.)	Boost (n = 2.661)	No boost (n = 2.657)	Hazard Ratio (95% C.I.)	
<u>Overall Survival</u> ( $\Delta$ = - 1.4%)	59.7% (56.3–63.0)	61.1% (57.6–64.3)	HR 1.05 (0.92–1.19) n.s.	
<u>Cumulative Risk of Any First Recurrence</u>				
All patients ( $\Delta \geq 4\%$ )	@15y @20y	28.1% 32.8%	32.1% 38.7%	HR = 0.92 (0.81-1.04), n.s.
$\leq 40$ years ( $\Delta > 6\%$ )	@15y @20y	41.5% 49.5%	48.1% 56.8%	HR = 0.80 (0.56-1.15), n.s.
41–50 years	@15y @20y	34.0% 38.6%	35.6% 44.2%	HR = 0.91 (0.71-1.16), n.s.
51–60 years	@15y @20y	28.5% 34.7%	28.7% 36.2%	HR = 0.96 (0.76-1.21), n.s.
> 60 years	@15y @20y	27.4% 32.1%	29.1% 32.8%	HR = 0.94 (0.74-1.19), n.s.

(Median F/U 17.2 y)

acc. Bartelink et al. Lancet Oncol 2015; 16: 47–56. Suppl.

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1. Bartelink H, Maingon P, Poortmans P, et al; European Organisation for Research and Treatment of Cancer Radiation Oncology and Breast Cancer Groups. Whole-breast irradiation with or without a boost for patients treated with breast-conserving surgery for early breast cancer: 20-year follow-up of a randomised phase 3 trial. Lancet Oncol. 2015 Jan;16(1):47-56.
2. Vrieling C et al. European Organisation for Research and Treatment of Cancer, Radiation Oncology and Breast Cancer Groups. Prognostic Factors for Local Control in Breast Cancer After Long-term Follow-up in the EORTC Boost vs No Boost Trial: A Randomized Clinical Trial. JAMA Oncol. 2017 Jan 1;3(1):42-48



Teilbrustbestrahlung nach BEO beim invasiven Karzinom			
	Oxford		
	LoE	GR	AGO
<b>Intraoperative Radiotherapie (niedriges Risiko)*</b>			
<ul style="list-style-type: none"> <li>Als alleinige Radiotherapie-Maßnahme während der ersten Brust-OP (IORT 50 kV, IOERT) <ul style="list-style-type: none"> <li>&gt; 50 Jahre</li> <li>&gt; 70 Jahre</li> </ul> </li> </ul>			
	1b	A	+/-
	1b	A	+
<b>Postoperative Teilbrustbestrahlung (niedriges Risiko)*</b>			
Interstitielle Multikatheter-Brachytherapie	1b	A	+
Intrakavitäre Ballontechnik	2b	B	-
Intensitätsmodulierte Radiotherapie (IMRT) (5 x 6 Gy über 2 Wochen)	1b	A	+
3D-konformale Radiotherapie (15 x 2,67 Gy über 3 Wochen)	1b	A	+
3D-konformale Radiotherapie (10 x 3,8 Gy über 2 Wochen)	2b	B	+/-
3D-konformale Radiotherapie (10 x 3,85 Gy über 1 Woche)	1b	A	+/-
Definition des Zielvolumens und praktische Durchführung siehe DEGRO practical guidelines			
* nur bei pT1 pN0 R0 G1-2, HR+, nicht-lobulär, > 50 J., kein extensives DCIS			

### Intraoperative irradiation (IORT/IOERT)

IORT using 50 kV or IOERT (pT1 pN0 R0 G1-2, non-lobular, age >50 y, no extensive DCIS, IORT during first surgery, HR+)

1. Vaidya JS, Bulsara M, Baum M et al. Long term survival and local control outcomes from single dose targeted intraoperative radiotherapy during lumpectomy (TARGIT-IORT) for early breast cancer: TARGIT-A randomised clinical trial. BMJ. 2020 Aug 19;370:m2836.
2. Vaidya JS, Bulsara M, Saunders C et al. Effect of Delayed Targeted Intraoperative Radiotherapy vs Whole-Breast Radiotherapy on Local Recurrence and Survival: Long-term Results From the TARGIT-A Randomized Clinical Trial in Early Breast Cancer. JAMA Oncol. 2020 Jul 1;6(7):e200249.
3. Vaidya JS, Bulsara M, Baum M et al. New clinical and biological insights from the international TARGIT-A randomised trial of targeted intraoperative radiotherapy during lumpectomy for breast cancer Brit J Cancer. 2021. 125:380–389.
4. Orecchia R, Veronesi U, Maisonneuve P et al., Intraoperative irradiation for early breast cancer (ELIOT): long-term recurrence and survival outcomes from a single-centre, randomised, phase 3 equivalence trial. Lancet Oncol. 2021. 22:597–608.

### >70 yrs

1. Abbott AM, Dossett LA, Loftus L, et al: Intraoperative radiotherapy for early breast cancer and age: clinical characteristics and outcomes. Am J Surg. 2015 Oct;210(4):624-8.

2. Vaidya JS, Wenz F, Bulsara M, et al: TARGIT trialists' group. Risk-adapted targeted intraoperative radiotherapy versus whole-breast radiotherapy for breast cancer: 5-year results for local control and overall survival from the TARGIT-A randomised trial. *Lancet*. 2014 Feb 15;383(9917):603-13.
3. Veronesi U, Orecchia R, Maisonneuve P, et al. Intraoperative radiotherapy versus external radiotherapy for early breast cancer (ELIOT): a randomised controlled equivalence trial. *Lancet Oncol*. 2013 Dec;14(13):1269-77.
4. Vaidya JS, Wenz F, Bulsara M et al. An international randomised controlled trial to compare TARGeted Intraoperative radioTherapy (TARGIT) with conventional postoperative radiotherapy after breast-conserving surgery for women with early-stage breast cancer (the TARGIT-A trial). *Health Technol Assess* 2016;20(73).

#### Postoperative partial breast irradiation as sole radiotherapy modality (ABPI)

##### Interstitial brachytherapy

1. Aristei C, Palumbo I, Capezzali G, et al. Outcome of a phase II prospective study on partial breast irradiation with interstitial multi-catheter highdose rate brachytherapy. *Radiother Oncol* 2013;108:236-241.
2. Strnad V, Ott OJ, Hildebrandt G, et al: Groupe Européen de Curiethérapie of European Society for Radiotherapy and Oncology (GEC-ESTRO). 5-year results of accelerated partial breast irradiation using sole interstitial multicatheter brachytherapy versus whole-breast irradiation with boost after breast-conserving surgery for low-risk invasive and in-situ carcinoma of the female breast: a randomised, phase 3, non-inferiority trial. *Lancet*. 2016 Jan 16;387(10015):229-38.
3. Schäfer R, Strnad V, Polgár C et al. Quality-of-life results for accelerated partial breast irradiation with interstitial brachytherapy versus whole-breast irradiation in early breast cancer after breast-conserving surgery (GEC-ESTRO): 5-year results of a randomised, phase 3 trial. *Lancet Oncol*. 2018 Jun;19(6):834-844.
4. Polgár C, Ott OJ, Hildebrandt G et al. Late side-effects and cosmetic results of accelerated partial breast irradiation with interstitial brachytherapy versus whole-breast irradiation after breast-conserving surgery for low-risk invasive and in-situ carcinoma of the female breast: 5-year results of a randomised, controlled, phase 3 trial. *Lancet Oncol*. 2017 Feb;18(2):259-268.
5. Strnad V, Major T, Polgar C et al. ESTRO-ACROP guideline: Interstitial multi-catheter breast brachytherapy as Accelerated Partial Breast Irradiation alone or as boost - GEC-ESTRO Breast Cancer Working Group practical recommendations. *Radiother Oncol*. 2018 Sep;128(3):411-420.
6. Polgár C, Major T, Takácsi-Nagy Z et al. Breast-Conserving Surgery Followed by Partial or Whole Breast Irradiation: Twenty-Year Results of a Phase 3 Clinical Study. *Int J Radiat Oncol Biol Phys*. 2020 Nov 10;S0360-3016(20)34492-8

#### Intracavity balloon technique

1. Benitez PR, Keisch ME, Vicini F, et al.: Five-year results: the initial clinical trial of MammoSite balloon brachytherapy for partial breast irradiation in early-stage breast cancer. Am J Surg. 2007 Oct;194(4):456-62.

#### IMRT (5x6 Gy)

1. Livi L, Meattini I, Marrazzo L, et al. Accelerated partial breast irradiation using intensity-modulated radiotherapy versus whole breast irradiation: 5-year survival analysis of a phase 3 randomised controlled trial. Eur J Cancer. 2015 Jan 17. pii: S0959-8049(15)00002-7.
2. Meattini I, Saieva C, Miccinesi G et al. Accelerated partial breast irradiation using intensity modulated radiotherapy versus whole breast irradiation: Health-related quality of life final analysis from the Florence phase 3 trial. Eur J Cancer. 2017 May;76:17-26.
3. Meattini I, Marrazzo L, Saieva C et al. Accelerated Partial-Breast Irradiation Compared With Whole-Breast Irradiation for Early Breast Cancer: Long-Term Results of the Randomized Phase III APBI-IMRT-Florence Trial. J Clin Oncol. 2020 Dec 10;38(35):4175-4183.

#### 3D-conformal RT (15x2.67 Gy over two weeks)


1. Coles CE, Griffin CL, Kirby AM et al. Partial-breast radiotherapy after breast conservation surgery for patients with early breast cancer (UK IMPORT LOW trial): 5-year results from a multicentre, randomised, controlled, phase 3, non-inferiority trial. Lancet. 2017 Sep 9;390(10099):1048-1060.
2. Bhattacharya IS, Haviland JS, Kirby AM et al. Patient-Reported Outcomes Over 5 Years After Whole- or Partial-Breast Radiotherapy: Longitudinal Analysis of the IMPORT LOW (CRUK/06/003) Phase III Randomized Controlled Trial. J Clin Oncol. 2019 Feb 1;37(4):305-317.

#### 3D-conformal RT (10x3.85 Gy over two weeks)

1. Ott OJ, Strnad V, Stillkrieger W et al. Accelerated partial breast irradiation with external beam radiotherapy : First results of the German phase 2 trial. Strahlenther Onkol. 2017 Jan;193(1):55-61.

### 3D-conformal RT (10x3.85 Gy over one week)

1. Olivotto IA, Whelan TJ, Parpia S, et al. Interim cosmetic and toxicity results from RAPID: a randomized trial of accelerated partial breast irradiation using three-dimensional conformal external beam radiation therapy. *J Clin Oncol*. 2013 Nov 10;31(32):4038-45.
2. Whelan TJ, Julian JA, Berrang TS et al. External beam accelerated partial breast irradiation versus whole breast irradiation after breast conserving surgery in women with ductal carcinoma in situ and node-negative breast cancer (RAPID): a randomised controlled trial. *Lancet*. 2019 Dec 14;394(10215):2165-2172.
3. Vicini FA, Cecchini RS, White JR et al. Long-term primary results of accelerated partial breast irradiation after breast-conserving surgery for early-stage breast cancer: a randomised, phase 3, equivalence trial. *Lancet*. 2019 Dec 14;394(10215):2155-2164.
4. Ganz PA, Cecchini RS, White JR et al. Patient-reported outcomes (PROs) in NRG oncology/NSABP B-39/RTOG 0413: A randomized phase III study of conventional whole breast irradiation (WBI) versus partial breast irradiation (PBI) in stage 0, I, or II breast cancer. *Journal of Clinical Oncology* 37, no. 15\_suppl (May 20, 2019) 508-508. Presented at ASCO Annual Meeting 2019



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## Daten zur Teilbrustbestrahlung

**NSABP B-39 / RTOG 0413 (Vicini FA et al. Lancet. 2019 Dec 14;394(10215):2155-2164.)**

- Randomised phase III equivalence trial, 4216 pat., 2005-2013, DCIS or invasive carcinoma ≤ 3 cm, 0-3 involved lymph nodes, age > 18 y
- 50 Gy / 25 fr. +/- boost vs. APBI with
  - 38.5 Gy / 10 fr. in one week (external beam irradiation)
  - 34 Gy / 10 fr. in one week (Multicatheter- or Single lumen-Brachytherapy)
- **"We observed an HR of 1.22 with a 90% CI of 0.94–1.58, which did not meet the equivalence criteria and favoured whole-breast irradiation. The 10-year cumulative incidence of IBTR was 3.9% (95% CI 3.1–5.0) in the whole-breast irradiation group and 4.6% (3.7–5.7) in the APBI group for an absolute difference of 0.7%."**
- **"Significantly more evaluable patients in the APBI group had recurrence-free interval events than patients in the whole-breast irradiation group (figure 3). The 10-year point estimate of recurrence-free interval for the whole breast irradiation group was 93.4% (95% CI 92.1–94.6), and in the APBI group it was 91.8% (90.4–93.0; figure 3)".**
- **"Our findings support whole-breast irradiation but the absolute outcome difference compared with APBI is small, so partial breast irradiation might also be an acceptable treatment for some patients. "**

1. Vicini FA, Cecchini RS, White JR et al. Long-term primary results of accelerated partial breast irradiation after breast-conserving surgery for early-stage breast cancer: a randomised, phase 3, equivalence trial. Lancet. 2019 Dec 14;394(10215):2155-2164.



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## Daten zur Teilbrustbestrahlung

**RAPID (Whelan TJ et al. Lancet. 2019 Dec 14;394(10215):2165-2172.)**

- Randomised phase III non-inferiority trial, 2135 pat., 2006-2011, DCIS or invasive carcinoma ≤ 3 cm, pN0, age ≥ 40 y., no ILC
- 42.56 / 16 fr. or 50 Gy / 25 fr. +/- Boost vs. APBI 38.5 Gy / 10 fr. in one week (external beam irradiation)
- "In patients treated with APBI, the 5 year cumulative rate of IBTR was 2.3% (95% CI 1.4–3.2) and the 8 year cumulative rate was 3.0% (1.9–4.0). In patients treated with whole breast irradiation, the 5 year cumulative rate of IBTR was 1.7% (0.9–2.5) and the 8 year cumulative rate was 2.8% (1.8–3.9; figure 2). The HR for APBI versus whole breast irradiation was 1.27 (90% CI 0.84–1.91). Thus, the upper bound of the estimated 90% CI did not exceed the non-inferiority margin of 2.02."
- "Late radiation toxicity (grade ≥2 [...]) was more common in patients treated with APBI (346 [32%] of 1070 patients) than whole breast irradiation (142 [13%] of 1065 patients; p < 0.0001). Adverse cosmesis [...] was more common in patients treated with APBI than in those treated by whole breast irradiation at 3 years (absolute difference, 11.3%, 95% CI 7.5–15.0), 5 years (16.5%, 12.5–20.4), and 7 years (17.7%, 12.9–22.3)."

1. Whelan TJ, Julian JA, Berrang TS et al. External beam accelerated partial breast irradiation versus whole breast irradiation after breast conserving surgery in women with ductal carcinoma in situ and node-negative breast cancer (RAPID): a randomised controlled trial. Lancet. 2019 Dec 14;394(10215):2165-2172.



# Postmastektomie-Bestrahlung (PMRT)\* der Thoraxwand

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- > 3 positive Lymphknoten
- 1-3 positive Lymphknoten (hohes Risiko)
- 1-3 positive Lymphknoten (niedriges Risiko\*)
- T3 / T4
  - pT3 pN0 R0 (ohne zusätzliche Risikofaktoren)
- R0-Resektion nicht erreichbar (bei invasiven Tumoren)
- Bei jungen Patientinnen mit hohem Rückfallrisiko

Die Indikationen zur PMRT und regionalen RT sind unabhängig von der adjuvanten systemischen Therapie

Inflammatorisches Karzinom: RT der Thoraxwand und der Lymphabflussregionen

Oxford		
LoE	GR	AGO
1a	A	++
1a	A	+
5	D	+/-
1a	A	++
2b	B	+/-
1a	A	++
2b	B	++
1a	A	
2c	B	++

\* Zur Definition „niedriges Risiko“ siehe nächste Folie Indikation zur Brustwandbestrahlung (PMRT)

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1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al. Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
2. Overgaard M, Hansen PS, Overgaard J, et al. Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy. Danish Breast Cancer Cooperative Group 82b Trial. N Engl J Med. 1997 Oct 2;337(14):949-55.
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5. Jagsi R. Postmastectomy radiation therapy: an overview for the practicing surgeon. ISRN Surg. 2013 Sep 11;2013:212979.
6. Kyndi M, Overgaard M, Nielsen HM, et al. High local recurrence risk is not associated with large survival reduction after postmastectomy radiotherapy in high-risk breast cancer: a subgroup analysis of DBCG 82 b&c. Radiother Oncol. 2009 Jan;90(1):74-9.
7. Shen H, Zhao L, Wang L, et al. Postmastectomy radiotherapy benefit in Chinese breast cancer patients with T1-T2 tumor and 1-3 positive axillary lymph nodes by molecular subtypes: an analysis of 1369 cases. Tumour Biol. 2015 Dec 2. [Epub ahead of print]

Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with > 3 tumor infiltrated lymph nodes (Lnn.)

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al.: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.

Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with 1–3 tumor infiltrated lymph nodes (Lnn.) high risk

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
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4. Overgaard M, Jensen MB, Overgaard J, et al: Postoperative radiotherapy in high-risk postmenopausal breast-cancer patients given adjuvant tamoxifen: Danish Breast Cancer Cooperative Group DBCG 82c randomised trial. Lancet. 1999 May 15;353(9165):1641-8.
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Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with 1–3 tumor infiltrated lymph nodes (Lnn.) low risk

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
2. Wenz F, Sperk E, Budach W, et al: Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). DEGRO practical guidelines for radiotherapy of breast cancer IV: radiotherapy following mastectomy for invasive breast cancer. Strahlenther



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3. Truong PT, Olivotto IA, Kader HA, et al: Selecting breast cancer patients with T1-T2 tumors and one to three positive axillary nodes at high postmastectomy locoregional recurrence risk for adjuvant radiotherapy. Int J Radiat Oncol Biol Phys. 2005 Apr 1;61(5):1337-47.
4. Jagsi R. Postmastectomy radiation therapy: an overview for the practicing surgeon. ISRN Surg. 2013 Sep 11;2013:212979.
5. Kyndi M, Overgaard M, Nielsen H et al. High local recurrence risk is not associated with large survival reduction after postmastectomy radiotherapy in high-risk breast cancer: a subgroup analysis of DBCG 82 b&c. Radiother Oncol. 2009 Jan;90(1):74-9.

#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with T3 / T4 breast cancer

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
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#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with pT3 pN0 R0 breast cancer (and no additional risk factors)

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al. Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
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3. Valli MC; Association of Radiotherapy and Oncology of the Mediterranean arEa (AROME). Controversies in loco-regional treatment: post-mastectomy radiation for pT2-pT3N0 breast cancer arguments in favour. Crit Rev Oncol Hematol. 2012 Dec;84 Suppl 1:e70-4.

#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with if R0 is impossible to reach (for invasive tumor)

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
2. Freedman GM, Fowble BL, Hanlon AL, et al. A close or positive margin after mastectomy is not an indication for chest wall irradiation except in women aged fifty or younger. Int J Radiat Oncol Biol Phys. 1998 Jun 1;41(3):599-605.

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#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in young pts with high risk features

1. Garg AK, Oh JL, Oswald MJ, et al. Effect of postmastectomy radiotherapy in patients <35 years old with stage II-III breast cancer treated with doxorubicin-based neoadjuvant chemotherapy and mastectomy. *Int J Radiat Oncol Biol Phys* 2007; 69: 1478–83.
2. Cardoso F, Loibl S, Pagani O, et al.; European Society of Breast Cancer Specialists. The European Society of Breast Cancer Specialists recommendations for the management of young women with breast cancer. *Eur J Cancer* 2012;48:3355-77.
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4. Mallon PT, McIntosh SA. Post mastectomy radiotherapy in breast cancer: a survey of current United Kingdom practice. *J BUON* 2012;17:245-8.
5. van der Sangen MJ, van de Wiel FM, Poortmans PM, et al. Are breast conservation and mastectomy equally effective in the treatment of young women with early breast cancer? Long-term results of a population-based cohort of 1,451 patients aged ≤ 40 years. *Breast Cancer Res Treat* 2011;127:207-15.

#### Indications for Postmastectomy Radiotherapy (PMRT) to the Chest Wall and regional RT are independent of adjuvant systemic treatment

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. *Lancet*. 2014 Jun 21;383(9935):2127-35.

#### Post-mastectomy radiotherapy (PMRT) and regional nodal irradiation for patients with inflammatory breast cancer

1. Cardoso F, Paluch-Shimon S, Senkus E et al. 5th ESO-ESMO international consensus guidelines for advanced breast cancer (ABC 5). *Ann Oncol*. 2020;31(12):1623-1649.

2. Ueno NT, Fernandez JRE, Cristofanilli M et al. International Consensus on the Clinical Management of Inflammatory Breast Cancer from the Morgan Welch Inflammatory Breast Cancer Research Program 10th Anniversary Conference. J Cancer. 2018; 9(8): 1437–1447.
3. Rueth NM, Lin HY, Bedrosian I et al. Underuse of trimodality treatment affects survival for patients with inflammatory breast cancer: an analysis of treatment and survival trends from the National Cancer Database. J Clin Oncol. 2014;32(19):2018-24.
4. Dawood S, Lei X, Dent R et al. Survival of women with inflammatory breast cancer: a large population-based study. Ann Oncol. 2014;25(6):1143-51.
5. Dawood S, Merajver SD, Viens P et al. International expert panel on inflammatory breast cancer: consensus statement for standardized diagnosis and treatment. Ann Oncol. 2011;22(3):515-523.

DEGRO practical guidelines for radiotherapy of breast cancer: radiotherapy following mastectomy for invasive breast cancer.

1. Wenz F, Sperk E, Budach W, et al: Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). Strahlenther Onkol. 2014 Aug;190(8):705-14.
2. Hehr T, Baumann R, Budach W et al; Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). Radiotherapy after skin-sparing mastectomy with immediate breast reconstruction in intermediate-risk breast cancer : Indication and technical considerations. Strahlenther Onkol. 2019 Nov;195(11):949-963.

<b>Indikation zur Brustwandbestrahlung (PMRT) bei 1–3 axillären Lymphknotenmetastasen</b>		
Auf PMRT kann verzichtet werden <b>LoE 3b B AGO +</b>	PMRT zu diskutieren <b>LoE 3b B AGO +/-</b>	PMRT empfohlen <b>LoE 3b B AGO +</b>
<b>ER pos, G1, HER2 neg, pT1 (wenn mind. 3 der 4 Kriterien zutreffen)</b>  Kyndi et al. 2009	Patientinnen, für die die genannten Risikokriterien (high-risk / low- risk) nicht zutreffen	<b>≥ 45 J. UND &gt; 25% pos. ax. Lnn bei axillärer Dissektion ODER &lt; 45 J. UND (ER neg. ODER &gt;25% pos. ax. Lnn bei axillärer Dissektion ODER medialer Tumorsitz)</b>  Truong et al. 2005  <b>&lt; 40 J. ODER HER2 pos. ODER Lymphovaskuläre Invasion</b>  Shen H et al. 2015  <b>G3 ODER Lymphovaskuläre Invasion oder triple-negativ</b>  Verschiedene Publikationen
Anmerkung: „Besteht eine Indikation zur Bestrahlung der Lymphabflusswege sollte auch eine Bestrahlung der Brustwand erfolgen.“		

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
2. Overgaard M, Hansen PS, Overgaard J, et al. Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy. Danish Breast Cancer Cooperative Group 82b Trial. N Engl J Med. 1997 Oct 2;337(14):949-55.
3. Overgaard M, Jensen MB, Overgaard J, et al. Postoperative radiotherapy in high-risk postmenopausal breast-cancer patients given adjuvant tamoxifen: Danish Breast Cancer Cooperative Group DBCG 82c randomised trial. Lancet. 1999 May 15;353(9165):1641-8.
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5. Jagsi R. Postmastectomy radiation therapy: an overview for the practicing surgeon. ISRN Surg. 2013 Sep 11;2013:212979.
6. Kyndi M, Overgaard M, Nielsen HM, et al. High local recurrence risk is not associated with large survival reduction after postmastectomy radiotherapy in high-risk breast cancer: a subgroup analysis of DBCG 82 b&c. Radiother Oncol. 2009 Jan;90(1):74-9.
7. NCCN Guidelines for Treatment of Cancer by Site  
"http://www.nccn.org/professionals/physician\_gls/pdf/breast.pdf" download 2016
8. Shen H, Zhao L, Wang L, et al: Postmastectomy radiotherapy benefit in Chinese breast cancer patients with T1-T2 tumor and 1-3 positive axillary lymph nodes by molecular subtypes: an analysis of 1369 cases. Tumour Biol. 2015 Dec 2. [Epub ahead of print]

Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with > 3 tumor infiltrated lymph nodes (Lnn.)

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.

Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with 1–3 tumor infiltrated lymph nodes (Lnn.) high risk

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al. Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.
2. Wenz F, Sperk E, Budach W, et al. Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). DEGRO practical guidelines for radiotherapy of breast cancer IV: radiotherapy following mastectomy for invasive breast cancer. Strahlenther Onkol. 2014 Aug;190(8):705-14.
3. Overgaard M, Hansen PS, Overgaard J, et al: Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy. Danish Breast Cancer Cooperative Group 82b Trial. N Engl J Med. 1997 Oct 2;337(14):949-55.
4. Overgaard M, Jensen MB, Overgaard J et al: Postoperative radiotherapy in high-risk postmenopausal breast-cancer patients given adjuvant tamoxifen: Danish Breast Cancer Cooperative Group DBCG 82c randomised trial. Lancet. 1999 May 15;353(9165):1641-8.
5. Truong PT, Olivetto IA, Kader HA, et al. Selecting breast cancer patients with T1-T2 tumors and one to three positive axillary nodes at high postmastectomy locoregional recurrence risk for adjuvant radiotherapy. Int J Radiat Oncol Biol Phys. 2005 Apr 1;61(5):1337-47.
6. Jagsi R. Postmastectomy radiation therapy: an overview for the practicing surgeon. ISRN Surg. 2013 Sep 11;2013:212979.
7. Kyndi M, Overgaard M, Nielsen HM et al. High local recurrence risk is not associated with large survival reduction after postmastectomy radiotherapy in high-risk breast cancer: a subgroup analysis of DBCG 82 b&c. Radiother Oncol. 2009 Jan;90(1):74-9.
8. NCCN Guidelines for Treatment of Cancer by Site  
“[http://www.nccn.org/professionals/physician\\_gls/pdf/breast.pdf](http://www.nccn.org/professionals/physician_gls/pdf/breast.pdf)” download 2016
9. Shen H, Zhao L, Wang L et al: Postmastectomy radiotherapy benefit in Chinese breast cancer patients with T1-T2 tumor and 1-3 positive axillary lymph nodes by molecular subtypes: an analysis of 1369 cases. Tumour Biol. 2015 Dec 2. [Epub ahead of print]

Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with 1–3 tumor infiltrated lymph nodes (Lnn.) low risk

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after

mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. *Lancet*. 2014 Jun 21;383(9935):2127-35.

2. Wenz F, Sperk E, Budach W, et al: Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). DEGRO practical guidelines for radiotherapy of breast cancer IV: radiotherapy following mastectomy for invasive breast cancer. *Strahlenther Onkol*. 2014 Aug;190(8):705-14.
3. Truong PT, Olivetto IA, Kader HA et al. Selecting breast cancer patients with T1-T2 tumors and one to three positive axillary nodes at high postmastectomy locoregional recurrence risk for adjuvant radiotherapy. *Int J Radiat Oncol Biol Phys*. 2005 Apr 1;61(5):1337-47.
4. Jagsi R. Postmastectomy radiation therapy: an overview for the practicing surgeon. *ISRN Surg*. 2013 Sep 11;2013:212979.
5. Kyndi M, Overgaard M, Nielsen HM, et al. High local recurrence risk is not associated with large survival reduction after postmastectomy radiotherapy in high-risk breast cancer: a subgroup analysis of DBCG 82 b&c. *Radiother Oncol*. 2009 Jan;90(1):74-9.
6. NCCN Guidelines for Treatment of Cancer by Site  
“[http://www.nccn.org/professionals/physician\\_gls/pdf/breast.pdf](http://www.nccn.org/professionals/physician_gls/pdf/breast.pdf)” download 2016

#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with T3 / T4 breast cancer

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al. Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. *Lancet*. 2014 Jun 21;383(9935):2127-35.
2. Valli MC; Association of Radiotherapy and Oncology of the Mediterranean arEa (AROME). Controversies in loco-regional treatment: post-mastectomy radiation for pT2-pT3N0 breast cancer arguments in favour. *Crit Rev Oncol Hematol*. 2012 Dec;84 Suppl 1:e70-4.

#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with pT3 pN0 R0 breast cancer (and no additional risk factors)

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. *Lancet*. 2014 Jun 21;383(9935):2127-35.
2. Boutrus R, Taghian AG; Association of Radiotherapy and Oncology of the Mediterranean arEa (AROME). Post mastectomy radiation for large node negative breast cancer: time for a second look. *Crit Rev Oncol Hematol*. 2012 Dec;84 Suppl 1:e75-8.
3. Valli MC; Association of Radiotherapy and Oncology of the Mediterranean arEa (AROME). Controversies in loco-regional treatment: post-mastectomy radiation for pT2-pT3N0 breast cancer arguments in favour. *Crit Rev Oncol Hematol*. 2012 Dec;84 Suppl 1:e70-4.

#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in pts. with if R0 is impossible to reach (for invasive tumor)

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. *Lancet*. 2014 Jun 21;383(9935):2127-35.
2. Freedman GM, Fowble BL, Hanlon AL, et al: A close or positive margin after mastectomy is not an indication for chest wall irradiation except in women aged fifty or younger. *Int J Radiat Oncol Biol Phys*. 1998 Jun 1;41(3):599-605.
3. Truong PT, Olivotto IA, Speers CH, et al. A positive margin is not always an indication for radiotherapy after mastectomy in early breast cancer. *Int J Radiat Oncol Biol Phys*. 2004 Mar 1;58(3):797-804.
4. Jagsi R. Postmastectomy radiation therapy: an overview for the practicing surgeon. *ISRN Surg*. 2013 Sep 11;2013:212979.
5. Rowell NP. Are mastectomy resection margins of clinical relevance? A systematic review. *Breast*. 2010 Feb;19(1):14-22.
6. Rowell NP. Radiotherapy to the chest wall following mastectomy for node-negative breast cancer: a systematic review. *Radiother Oncol*. 2009 Apr;91(1):23-32.

#### Postmastectomy Radiotherapy (PMRT) to the Chest Wall in young pts with high risk features

1. Garg AK, Oh JL, Oswald MJ, et al. Effect of postmastectomy radiotherapy in patients <35 years old with stage II-III breast cancer treated with doxorubicin-based neoadjuvant chemotherapy and mastectomy. *Int J Radiat Oncol Biol Phys* 2007; 69: 1478–83.
2. Cardoso F, Loibl S, Pagani O, et al.; European Society of Breast Cancer Specialists. The European Society of Breast Cancer Specialists recommendations for the management of young women with breast cancer. *Eur J Cancer* 2012;48:3355-77.
3. Dragun AE, Huang B, Gupta S, et al. One decade later: trends and disparities in the application of post-mastectomy radiotherapy since the release of the American Society of Clinical Oncology clinical practice guidelines. *Int J Radiat Oncol Biol Phys* 2012;83:e591-6.
4. Mallon PT, McIntosh SA. Post mastectomy radiotherapy in breast cancer: a survey of current United Kingdom practice. *J BUON* 2012;17:245-8.
5. van der Sangen MJ, van de Wiel FM, Poortmans PM, et al. Are breast conservation and mastectomy equally effective in the treatment of young women with early breast cancer? Long-term results of a population-based cohort of 1,451 patients aged ≤ 40 years. *Breast Cancer Res Treat* 2011;127:207-15.

#### Indications for Postmastectomy Radiotherapy (PMRT) to the Chest Wall and regional RT are independent of adjuvant systemic treatment

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C et al: Effect of radiotherapy after

mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.


Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials.

1. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C et al: Lancet. 2014 Jun 21;383(9935):2127-35.

DEGRO practical guidelines for radiotherapy of breast cancer: radiotherapy following mastectomy.

1. Wenz F, Sperk E, Budach W, et al; Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). Strahlenther Onkol. 2014 Aug;190(8):705-14.
2. Hehr T, Baumann R, Budach W et al; Breast Cancer Expert Panel of the German Society of Radiation Oncology (DEGRO). Radiotherapy after skin-sparing mastectomy with immediate breast reconstruction in intermediate-risk breast cancer : Indication and technical considerations. Strahlenther Onkol. 2019 Nov;195(11):949-963.





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FORSCHEN  
LEHREN  
HEILEN

## Boost bei PMRT

	Oxford		
	LoE	GR	AGO
▪ Eine Boost-Bestrahlung der Thoraxwand hat keinen Einfluss auf das brustkrebspezifische und Gesamtüberleben	2a	B	
▪ Eine Boost-Bestrahlung der Thoraxwand sollte nur bei nachgewiesener R1 / R2-Situation ohne Möglichkeit einer Nachresektion erfolgen	5	D	++
▪ Reicht der Tumor nach Mastektomie (unter Mitnahme der Pectoralisfaszie) an den pectoralen Absetzungsrand heran und ist ein faszienüberschreitendes Tumorwachstum klinisch nicht zu erkennen, ist von einer R0-Situation auszugehen. Eine Boostbestrahlung ist nicht erforderlich	5	D	++

### Thoracic wall boost irradiation

1. Mayadev J, Fish K, Valicenti R et al. Utilization and impact of a postmastectomy radiation boost for invasive breast cancer, Pract Radiat Oncol. 2014 Nov-Dec;4(6):e269-78

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# Radiotherapie der Axilla bei Patientinnen mit positiven Sentinel-Lymphknoten\*\* ohne axilläre Dissektion

**BET und ACOSOG Z0011-Kriterien<sup>+</sup> erfüllt**

- Radiotherapie der Brust unter Einschluss von Level 1 + 2 bis 5 mm unterhalb der Vena axillaris (PTV)

Oxford		
LoE	GR	AGO
2b	B	++*

**BET und ACOSOG Z0011-Kriterien<sup>+</sup> nicht erfüllt**

- Radiotherapie der Axilla (analog AMAROS)

1b	B	+++*
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**Nach ME, RT der Thoraxwand indiziert und ACOSOG Z0011-Kriterien<sup>+</sup> nicht erfüllt oder ME und RT der Thoraxwand nicht geplant**

- Radiotherapie der Axilla (analog AMAROS)

1b	B	++
----	---	----

**≥ 3 pos. SLN**

- Radiotherapie der Axilla (analog AMAROS)

1b	B	+
----	---	---

\* Studienteilnahme empfohlen

\*\* Makrometastasen

+ < T3, keine palpablen LK, R0, 1-2 befallene SN, kein extrakapsuläres Wachstum, keine NACT

1-2 pos SLN: BCT: No further treatment to the axilla neither axillary dissection nor RT of the axilla (criteria according ACOSOG Z0011)

1. Giuliano AE, Hunt KK, Ballmann KV, et al Axillary dissection vs no axillary dissection in women with breast invasive cancer and sentinel node metastasis. A randomised clinical trial. JAMA 2011;305(6):569-575.
2. Galimberti V, Cole BF, Zurrada S, et al: International Breast Cancer Study Group Trial 23-01 investigators. Axillary dissection versus no axillary dissection in patients with sentinel-node micrometastases (IBCSG 23-01): a phase 3 randomised controlled trial. Lancet Oncol. 2013 Apr;14(4):297-305.
3. Jagsi R, Manjoet C, Moni J, et al. Radiation field design in the ACOSOG Z0011 (Alliance) trial. J Clin Oncol 2014;Nov 10;32(32): 3600-6

1-2 pos SLN: BCT: Axillary dissection

1. Giuliano AE, Hunt KK, Ballmann KV, et al. Axillary dissection vs no axillary dissection in women with breast invasive cancer and sentinel node metastasis. A randomised clinical trial. JAMA 2011;305(6):569-575.
2. Jagsi R, Manjoet C, Moni J, et al. Radiation field design in the ACOSOG Z0011 (Alliance) trial. J Clin Oncol 2014;Nov 10;32(32): 3600-6

1-2 pos SLN: BCT: radiotherapy of the axilla

1. Donker M, Tienhoven G, Straver ME et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer (EORTC 10981-22023 AMAROS) a randomised, multicenter open label, phase 3 non inferiority trial. Lancet Oncol 2014;15:1333-10

2. Rutgers et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer patients – 10-year results of the EORTC AMAROS trial. Presented at SABCS 2018.

1-2 pos SLN: Mastectomy: If RT of chestwall is indicated, axillary dissection or radiotherapy of the axilla

1. Donker M, Tienhoven G, Straver ME et al: Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer (EORTC 10981-22023 AMAROS) a randomised, multicenter open label, phase 3 non inferiority trial. Lancet Oncol 2014;15:1333-10.
2. Rutgers et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer patients – 10-year results of the EORTC AMAROS trial. Presented at SABCS 2018.

1-2 pos SLN: Mastectomy: If RT of chestwall is indicated, no axillary treatment (criteria ACOSOG Z011)

EXPERT OPINION, extrapolated from:

1. Giuliano AE, Hunt KK, Ballmann KV, et al. Axillary dissection vs no axillary dissection in women with breast invasive cancer and sentinel node metastasis. A randomised clinical trial. JAMA 2011;305(6):569-5753.
2. Galimberti V, Cole BF, Zurrada S et al: International Breast Cancer Study Group Trial 23-01 investigators. Axillary dissection versus no axillary dissection in patients with sentinel-node micrometastases (IBCSG 23-01): a phase 3 randomised controlled trial. Lancet Oncol. 2013 Apr;14(4):297-305.

1-2 pos SLN: Mastectomy: If RT of chestwall is not planned, axillary dissection or radiotherapy of the axilla

EXPERT OPINION, extrapolated from:

1. Donker M, Tienhoven G, Straver ME, et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer (EORTC 10981-22023 AMAROS) a randomised, multicenter open label, phase 3 non inferiority trial. Lancet Oncol 2014;15:1333-10.
2. Rutgers et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer patients – 10-year results of the EORTC AMAROS trial. Presented at SABCS 2018.

≥3 positive SLN: Axillary LN dissection

1. Giuliano AE, Hunt KK, Ballmann KV, et al. Axillary dissection vs no axillary dissection in women with breast invasive cancer and sentinel node metastasis. A randomised clinical trial. JAMA 2011;305(6):569-575.
2. Donker M, Tienhoven G, Straver ME, et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer (EORTC

10981-22023 AMAROS) a randomised, multicenter open label, phase 3 non inferiority trial. Lancet Oncol 2014;15:1333-10.

3. Rutgers et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer patients – 10-year results of the EORTC AMAROS trial. Presented at SABCS 2018.
4. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.

>=3 positive SLN: Radiotherapy of the axilla

1. Giuliano AE, Hunt KK, Ballmann KV, et al: Axillary dissection vs no axillary dissection in women with breast invasive cancer and sentinel node metastasis. A randomised clinical trial. JAMA 2011;305(6):569-575.
2. Donker M, Tienhoven G, Straver ME, et al: Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer (EORTC 10981-22023 AMAROS) a randomised, multicenter open label, phase 3 non inferiority trial. Lancet Oncol 2014;15:1333-10.
3. Rutgers et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer patients – 10-year results of the EORTC AMAROS trial. Presented at SABCS 2018.
4. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, et al: Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014 Jun 21;383(9935):2127-35.

<p>© AGO e. V. in der DGGG e.V. sowie in der DKG e.V.</p> <p>Guidelines Breast Version 2022.1D</p> <p>www.ago-online.de</p>	<u>Zusätzliche RT der Axilla nach primärer Operation</u>		Oxford		
	(bei Indikation zur Radiotherapie der Mamma/Brustwand <sup>1</sup> +/- supra- / infraklavikulärer und parasternaler RT <sup>2</sup> )		LoE	GR	AGO
	Erweiterung des PTV (planning target volume) zur Erfassung von Level I-II <sup>3</sup>				
	pN-Status				
	pN0(sn) / pN1mic(sn)		1b	B	--
	pN0/+ nach ALND		1a	A	--
	pN+(sn) analog ACOSOG Z0011 (keine ALND)		2b	B	+
	pN+(sn) nicht analog ACOSOG Z0011 → gemäß AMAROS-Studie <sup>4</sup> (ALND nicht erfolgt)		1b	B	++
	R2-Situation Axilla		5	D	++
	<sup>1</sup> Eine inzidentelle Dosisbelastung in Teilen von Level I/II ist technisch nicht zu umgehen. <sup>2</sup> Die Indikation für eine RT der SCG/ICG und der IMC ist separat zu prüfen. <sup>3</sup> Bis 5 mm unterhalb der Vena axillaris. <sup>4</sup> ≤ cT3, cN0, keine NACT, RT immer in Kombination mit supra- und infraklavikulärer RT				

### Sentinel node negative

1. Krag DN, Anderson SJ, Julian TB, et al: Sentinel-lymph-node resection compared with conventional axillary-lymph-node dissection in clinically node-negative patients with breast cancer: overall survival findings from the NSABPB-32 randomised phase 3 trial. Lancet Oncol 2010; 11: 927–33.
2. Galimberti V, Manika A, Maisonneuve P, et al. Long-term follow-up of 5262 breast cancer patients with negative sentinel node and no axillary dissection confirms low rate of axillary disease. Eur J Surg Oncol. 2014 Oct;40(10):1203-8.

### Complete Axillary lymph node dissection after positive sentinel lymph node may be omitted in certain cases due to lack of benefit in prospectively randomized studies

1. Galimberti V, Cole BF, Zurrada S, et al. International Breast Cancer Study Group Trial 23-01 investigators. Axillary dissection versus no axillary dissection in patients with sentinel-node micrometastases (IBCSG 23-01): a phase 3 randomised controlled trial. Lancet Oncol. 2013 Apr;14(4):297-305.
2. Giuliano AE, Ballman KV, McCall L, et al. Effect of Axillary Dissection vs No Axillary Dissection on 10-Year Overall Survival Among Women With Invasive Breast Cancer and Sentinel Node Metastasis: The ACOSOG Z0011 (Alliance) Randomized Clinical Trial. JAMA. 2017 Sep 12;318(10):918-926.
3. Jagsi R, Manjoet C, Moni J, et al. Radiation field design in the ACOSOG Z0011 (Alliance) trial. J Clin Oncol 2014;Nov 10;32(32): 3600-6

#### Regional nodal irradiation without ALND in non-Z0011-eligible patients

1. Donker M, Tienhoven G, Straver ME et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer (EORTC 10981-22023 AMAROS) a randomised, multicenter open label, phase 3 non inferiority trial. Lancet Oncol 2014;15:1333-10
2. Rutgers et al. Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer patients – 10-year results of the EORTC AMAROS trial. Presented at SABCS 2018.

#### Tumor residuals after axillary dissection

1. Interdisziplinäre S3-Leitlinie für die Diagnostik, Therapie und Nachsorge des Mammakarzinoms, Aktualisierung 2017 Version 4.2.  
Herausgeber: Leitlinienprogramm Onkologie der AWMF, Deutschen Krebsgesellschaft e.V. und Deutschen Krebshilfe e.V.

Zusätzliche RT der Axilla nach neoadjuvanter Chemotherapie		Oxford		
(bei Indikation zur Radiotherapie der Mamma/Brustwand <sup>1</sup> +/- supra- / infraklavikulärer und parasternaler RT <sup>2</sup> )		LoE	GR	AGO
Erweiterung des PTV (planning target volume) zur Erfassung von Level I-II <sup>3</sup>				
N-Status prä/post NACT	pN-Status			
cN0 / ycN0	ypN0(sn)	S	D	-
cN0 / ycN0	ypN1mic(sn) / ypN+(sn) (keine ALND erfolgt)	S	D	+ <sup>4</sup>
pN <sup>+</sup> <sub>CNB</sub> / ycN0	ypN0(sn/TAD)	S	D	+/- <sup>4</sup>
pN <sup>+</sup> <sub>CNB</sub> / ycN0	ypN1mic(sn/TAD) / ypN+(sn/TAD) (keine ALND erfolgt)	S	D	+ <sup>4</sup>
cN0/cN+	ypN0/+ nach ALND	2b	B	-
	R2-Situation Axilla	S	D	++

<sup>1</sup> Eine inzidentelle Dosisbelastung in Teilen von Level I/II ist technisch nicht zu umgehen. <sup>2</sup>Die Indikation für eine RT der SCG/ICG und der IMC ist separat zu prüfen. <sup>3</sup>Bis 5 mm unterhalb der Vena axillaris. <sup>4</sup>Studienteilnahme empfohlen.

### Statement surgical intervention in the axilla before or after neoadjuvant chemotherapy

1. Ryu JM, Lee SK, Kim JY, et al. Predictive Factors for Nonsentinel Lymph Node Metastasis in Patients With Positive Sentinel Lymph Nodes After Neoadjuvant Chemotherapy: Nomogram for Predicting Nonsentinel Lymph Node Metastasis. Clin Breast Cancer. 2017 Nov;17(7):550-55
2. Galimberti V, Ribeiro Fontana SK, Maisonneuve P. Sentinel node biopsy after neoadjuvant treatment in breast cancer: five-year follow-up of patients with clinically node-negative or node-positive disease before treatment. Eur J Surg Oncol 2016;42(3) 361-8
3. Martelli G, Miceli R, Folli S, et al. Sentinel node biopsy after primary chemotherapy in cT2 N0/1 breast cancer patients: Long-term results of a retrospective study. Eur J Surg Oncol. 2017 Nov;43(11):2012-2020.
4. Kahler-Ribeiro-Fontana S, Pagan E, Magnoni F, et al.: Long-term standard sentinel node biopsy after neoadjuvant treatment in breast cancer: a single institution ten-year follow-up, Eur J Surg Oncol. 2020 Oct 15;S0748-7983(20)30846-5.

### Axillary intervention after PST

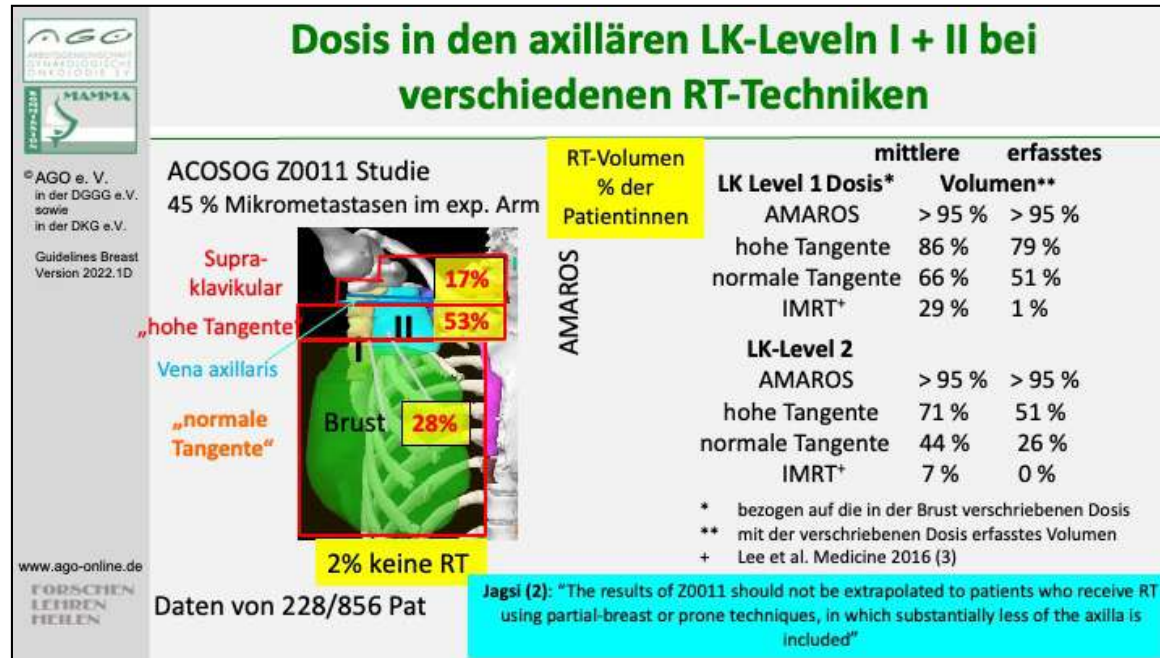
1. Tee SR, Devane LA, Evoy D et al. Meta-analysis of sentinel lymph node biopsy after neoadjuvant chemotherapy in patients with initial biopsy-proven node-positive breast cancer. Br J Surg. 2018 Nov;105(12):1541-1552.
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5. Wong SM , Almana N , Choi J et al: Prognostic Significance of Residual Axillary Nodal Micrometastases and Isolated Tumor Cells After Neoadjuvant Chemotherapy for Breast Cancer, *Ann Surg Oncol.* 2019 Oct;26(11):3502-3509.

#### Tumor residuals after axillary dissection

1. Interdisziplinäre S3-Leitlinie für die Diagnostik, Therapie und Nachsorge des Mammakarzinoms, Aktualisierung 2017 Version 4.2.  
Herausgeber: Leitlinienprogramm Onkologie der AWMF, Deutschen Krebsgesellschaft e.V. und Deutschen Krebshilfe e.V.





1. Giuliano et al. Effect of Axillary Dissection vs No Axillary Dissection on 10-Year Overall Survival Among Women With Invasive Breast Cancer and Sentinel Node Metastasis: The ACOSOG Z0011 (Alliance) Randomized Clinical Trial. JAMA. 2017 Sep 12;318(10):918-926
2. Jagsi R et al. Radiation field design in the ACOSOG Z0011 (Alliance) Trial. J Clin Oncol. 2014 Nov 10;32(32):3600-6
3. Lee J et al.. Dosimetric evaluation of incidental irradiation to the axilla during whole breast radiotherapy for patients with left-sided early breast cancer in the IMRT era. Medicine (Baltimore). 2016 Jun;95(26):e403

Radiotherapie (RT) anderer lokoregionärer Lymphabflussregionen (SCG / ICG)			
	Oxford		
	LoE	GR	AGO
<b><u>RT der supra- / infraklavikulären Lymphregion</u></b>			
▪ <b>≥ 4 befallene axilläre Lymphknoten oder Befall im Level III oder der supra- / infraklavikulären Lymphknoten</b>	<b>1b</b>	<b>A</b>	<b>++</b>
▪ <b>1–3 befallene axilläre Lymphknoten<sup>1</sup> bei</b> - zentralem oder medialem Sitz und G2-3 oder ER / PR-negativ - prämenopausale Patientin und G2-3 oder ER / PR-negativ	<b>2a</b>	<b>B</b>	<b>+</b>
▪ <b>pN0 und prämenopausal bei zentralen oder medialen Sitz und G2-3 und ER / PR-negativ</b>	<b>2a</b>	<b>B</b>	<b>+/-</b>
<sup>1</sup> = gilt nicht für Mikrometastasen			

### Radiotherapy (RT) of Other Locoregional Lymph Node Areas (SCG/ICG)

1. Yates L, Kirby A, Crichton S, et al. Risk factors for regional nodal relapse in breast cancer patients with one to three positive axillary nodes. Int J Radiat Oncol Biol Phys. 2012 Apr 1;82(5):2093-103.
2. Viani GA, Godoi da Silva LB, Viana BS. Patients with N1 breast cancer: who could benefit from supraclavicular fossa radiotherapy? Breast. 2014 Dec;23(6):749-53.

### Supra-/infraclavicular lymphatic regions

#### RT to Supra-/infraclavicular lymphatic regions if ≥ pN2a

1. Poortmans PM, Collette S, Kirkove C et al. Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):317-27.
2. Poortmans PM, Weltens C, Fortpied C, et al. Internal mammary and medial supraclavicular lymph node chain irradiation in stage I-III breast cancer (EORTC 22922/10925): 15-year results of a randomised, phase 3 trial. Lancet Oncol. 2020 Dec;21(12):1602-1610.
3. Poortmans PM, Struikmans H, De Brouwer P et al., Side Effects 15 Years After Lymph Node Irradiation in Breast Cancer: Randomized EORTC Trial 22922/10925. J Nat Cancer Inst. 2021;113:1360-1368.
4. Whelan TJ, Olivetto IA, Parulekar WR et al. Regional Nodal Irradiation in Early-Stage Breast Cancer. N Engl J Med. 2015 Jul

23;373(4):307-16.

5. Budach W, Kammers K, Boelke E, et al. Adjuvant radiotherapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials. *Radiat Oncol.* 2013 Nov 14 ;8:267.
6. P. F. Nguyen-Tan, L. Vincent, F. Methot et al., "The incidence of supraclavicular failure in patients with T1-2 breast cancer an four or more positive nodes treated by conservative surgery and tangential breast irradiation without regional nodal irradiation," *International Journal of Radiation Oncology Biology Physics*, vol. 42, supplement 1, p. 249, 1998.
7. Whelan TJ, Olivotto IA, Parulekar WR, et al. MA.20 Study Investigators. Regional Nodal Irradiation in Early-Stage Breast Cancer. *N Engl J Med.* 2015 Jul 23;373(4):307-16.
8. Budach W, Bölke E, Kammers K, et al. Adjuvant radiation therapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials- an update. *Radiat Oncol.* 2015 Dec 21;10(1):258.
9. Dodwell et al. Regional lymph node irradiation in early stage breast cancer: An EBCTCG meta-analysis of 13,000 women in 14 trials. Presented at SABCS 2018

#### RT to Supra-/intraclavicular lymphatic regions if Level III involved

1. Poortmans PM, Collette S, Kirkove C et al. Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. *N Engl J Med.* 2015 Jul 23;373(4):317-27.
2. Poortmans PM, Weltens C, Fortpied C, et al. Internal mammary and medial supraclavicular lymph node chain irradiation in stage I-III breast cancer (EORTC 22922/10925): 15-year results of a randomised, phase 3 trial. *Lancet Oncol.* 2020 Dec;21(12):1602-1610.
3. Whelan TJ, Olivotto IA, Parulekar WR et al. Regional Nodal Irradiation in Early-Stage Breast Cancer. *N Engl J Med.* 2015 Jul 23;373(4):307-16.
4. Budach W, Bölke E, Kammers K, et al. Adjuvant radiation therapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials- an update. *Radiat Oncol.* 2015 Dec 21;10(1):258.
5. Budach W, Kammers K, Boelke E, et al. Adjuvant radiotherapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials. *Radiat Oncol.* 2013 Nov 14 ;8:267.
6. Dodwell et al. Regional lymph node irradiation in early stage breast cancer: An EBCTCG meta-analysis of 13,000 women in 14 trials. Presented at SABCS 2018

#### RT to Supra-/intraclavicular lymphatic regions if pN1a high risk

1. Poortmans PM, Collette S, Kirkove C et al. Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):317-27.
2. Poortmans PM, Weltens C, Fortpied C, et al. Internal mammary and medial supraclavicular lymph node chain irradiation in stage I-III breast cancer (EORTC 22922/10925): 15-year results of a randomised, phase 3 trial. Lancet Oncol. 2020 Dec;21(12):1602-1610.
3. Whelan TJ, Olivotto IA, Parulekar WR et al. Regional Nodal Irradiation in Early-Stage Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):307-16.
4. Budach W, Bölke E, Kammers K et al. Adjuvant radiation therapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials- an update. Radiat Oncol. 2015 Dec 21;10(1):258.
5. Whelan TJ, Ackerman I, Chapman JW, et al: NCIC-CTG MA.20: An intergroup trial of regional nodal irradiation in early breast cancer. J Clin Oncol ASCO Annual Meeting Proceed (Post-Meeting Edition) 2011:29.
6. Dodwell et al. Regional lymph node irradiation in early stage breast cancer: An EBCTCG meta-analysis of 13,000 women in 14 trials. Presented at SABCS 2018

RT to Supra-/intraclavicular lymphatic regions if pN1a low risk

1. Poortmans PM, Collette S, Kirkove C, et al; EORTC Radiation Oncology and Breast Cancer Groups. Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):317-27.
2. Poortmans PM, Weltens C, Fortpied C, et al. Internal mammary and medial supraclavicular lymph node chain irradiation in stage I-III breast cancer (EORTC 22922/10925): 15-year results of a randomised, phase 3 trial. Lancet Oncol. 2020 Dec;21(12):1602-1610.
3. Whelan TJ, Olivotto IA, Parulekar WR, et al. MA.20 Study Investigators. Regional Nodal Irradiation in Early-Stage Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):307-16.
4. Budach W, Bölke E, Kammers K, et al. Adjuvant radiation therapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials- an update. Radiat Oncol. 2015 Dec 21;10(1):258.
5. Dodwell et al. Regional lymph node irradiation in early stage breast cancer: An EBCTCG meta-analysis of 13,000 women in 14 trials. Presented at SABCS 2018

RT to Supra-/intraclavicular lymphatic regions if pN0 high risk, if radiotherapy of the internal mammary chain is indicated (see below)

1. Poortmans PM, Collette S, Kirkove C, et al; EORTC Radiation Oncology and Breast Cancer Groups. Internal Mammary and Medial

Supraclavicular Irradiation in Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):317-27.

2. Poortmans PM, Weltens C, Fortpied C, et al. Internal mammary and medial supraclavicular lymph node chain irradiation in stage I-III breast cancer (EORTC 22922/10925): 15-year results of a randomised, phase 3 trial. Lancet Oncol. 2020 Dec;21(12):1602-1610.
3. Whelan TJ, Olivotto IA, Parulekar WR, et al; MA.20 Study Investigators. Regional Nodal Irradiation in Early-Stage Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):307-16.
4. Budach W, Bölke E, Kammers K et al. Adjuvant radiation therapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials- an update. Radiat Oncol. 2015 Dec 21;10(1):258.
5. Budach W, Kammers K, Boelke E, et al. Adjuvant radiotherapy of regional lymph nodes in breast cancer - a meta-analysis of randomized trials. Radiat Oncol. 2013 Nov 14 ;8:267.
6. Dodwell et al. Regional lymph node irradiation in early stage breast cancer: An EBCTCG meta-analysis of 13,000 women in 14 trials. Presented at SABCS 2018

RT to Supra-/infraclavicular lymphatic regions after NACT/NAT (indications as for PMRT)

1. Please check slide on radiotherapy after NACT

Radiotherapie (RT) anderer lokoregionärer Lymphabflussregionen (IMC)			
	Oxford		
	LoE	GR	AGO
<b>Mammaria interna Lymphknotenregion (IMC)</b>			
▪ pN0 und prämenopausal und zentraler oder medialer Sitz und G2-3 und ER / PR-negativ	1b	B	+/-
▪ 1–3 befallene axilläre Lymphknoten <sup>1</sup> bei - zentralem oder medialem Sitz und G2-3 oder ER / PR-negativ - prämenopausale Patientin und G2-3 oder ER / PR-negativ	2a	B	+
▪ ≥ 4 befallene axilläre Lymphknoten bei	2a	B	+
▪ befallene Mammaria interna Lymphknoten	2a	B	+
▪ bei kardialen Risiko oder bei Gabe von Trastuzumab	2b	A	--

<sup>1</sup> gilt nicht für Mikrometastasen

## Radiotherapy (RT) of Other Locoregional Lymph Node Areas (IMN)

### Internal mammaia lymph node region (IMN)

#### RT to Internal mammaia lymph node region (IMC) if pN0 high risk with central/medial tumors

1. Hennequin C, Bossard N, Servagi-Vernat S, et al. Ten-Year Survival Results of a Randomized Trial of Irradiation of Internal Mammary Nodes After Mastectomy. Int J Radiation Oncol Biol Phys 2013; 86 (5): 860-866.
2. Chang JS, Park W, YB Kim, et al. Long-term Survival Outcomes Following Internal Mammary Node Irradiation in Stage II-III Breast Cancer: Results of a Large Retrospective Study With 12-Year Follow-up. Int J Radiation Oncol Biol Phys, 2013; 86 (5): 867-872.
3. Poortmans PM, Collette S, Kirkove C et al. Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):317-27.
4. Poortmans PM, Weltens C, Fortpied C, et al. Internal mammary and medial supraclavicular lymph node chain irradiation in stage I-III breast cancer (EORTC 22922/10925): 15-year results of a randomised, phase 3 trial. Lancet Oncol. 2020 Dec;21(12):1602-1610.
5. Poortmans PM, Struikmans H, De Brouwer P et al., Side Effects 15 Years After Lymph Node Irradiation in Breast Cancer: Randomized EORTC Trial 22922/10925. J Nat Cancer Inst. 2021;113:1360-1368.
6. Whelan TJ, Olivotto IA, Parulekar WR et al. Regional Nodal Irradiation in Early-Stage Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):307-16.

7. Dodwell et al. Regional lymph node irradiation in early stage breast cancer: An EBCTCG meta-analysis of 13,000 women in 14 trials. Presented at SABCS 2018

RT to Internal mammary lymph node region (IMN) if pN1-pN2 and HR positive in patients who had systemic chemotherapy

1. Hennequin C, Bossard N, Servagi-Vernat S, et al. Ten-Year Survival Results of a Randomized Trial of Irradiation of Internal Mammary Nodes After Mastectomy. *Int J Radiation Oncol Biol Phys* 2013; 86 (5): 860-866.
2. Chang JS, Park W, YB Kim, et al. Long-term Survival Outcomes Following Internal Mammary Node Irradiation in Stage II-III Breast Cancer: Results of a Large Retrospective Study With 12-Year Follow-up. *Int J Radiation Oncol Biol Phys*, 2013; 86 (5): 867-872.
3. Poortmans PM, Collette S, Kirkove C et al. Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. *N Engl J Med*. 2015 Jul 23;373(4):317-27.
4. Poortmans PM, Weltens C, Fortpied C, et al. Internal mammary and medial supraclavicular lymph node chain irradiation in stage I-III breast cancer (EORTC 22922/10925): 15-year results of a randomised, phase 3 trial. *Lancet Oncol*. 2020 Dec;21(12):1602-1610.
5. Poortmans PM, Struikmans H, De Brouwer P et al., Side Effects 15 Years After Lymph Node Irradiation in Breast Cancer: Randomized EORTC Trial 22922/10925. *J Nat Cancer Inst*. 2021;113:1360-1368.
6. Whelan TJ, Olivotto IA, Parulekar WR et al. Regional Nodal Irradiation in Early-Stage Breast Cancer. *N Engl J Med*. 2015 Jul 23;373(4):307-16.
7. Dodwell et al. Regional lymph node irradiation in early stage breast cancer: An EBCTCG meta-analysis of 13,000 women in 14 trials. Presented at SABCS 2018
8. Kim YB, Byun HK, Kim DY et al. Effect of Elective Internal Mammary Node Irradiation on Disease-Free Survival in Women With Node-Positive Breast Cancer: A Randomized Phase 3 Clinical Trial. *JAMA Oncol*. 2021;e216036. doi: 10.1001/jamaoncol.2021.6036.



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## Fraktionierung der Radiotherapie lokoregionärer Lymphabflussregionen

	Oxford		
	LoE	GR	AGO
<ul style="list-style-type: none"> <li>■ <b>Konventionell fraktionierte RT (Gesamtdosis ca. 50 Gy in ca. 25–28 Fraktionen in ca. 5–6 Wochen)</b></li> </ul>	1a	A	++
<ul style="list-style-type: none"> <li>■ <b>Moderat hypofraktionierte RT (Gesamtdosis ca. 40–43,5 Gy in ca. 15–16 Fraktionen in ca. 3 bis 5 Wochen)</b></li> </ul>	2b	B	+/-

1. Poortmans PM, Collette S, Kirkove C et al. Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):317-27.
2. Whelan TJ, Olivotto IA, Parulekar WR et al. Regional Nodal Irradiation in Early-Stage Breast Cancer. N Engl J Med. 2015 Jul 23;373(4):307-16.
3. Wang SL, Fang H, Song YW et al. Hypofractionated versus conventional fractionated postmastectomy radiotherapy for patients with high-risk breast cancer: a randomised, non-inferiority, open-label, phase 3 trial. Lancet Oncol. 2019 Mar;20(3):352-360.
4. Bellefqih S, Elmajjaoui S, Aarab J et al. Hypofractionated Regional Nodal Irradiation for Women With Node-Positive Breast Cancer. Int J Radiat Oncol Biol Phys. 2017 Mar 1;97(3):563-570.
5. Badiyan SN, Shah C, Arthur D et al. Hypofractionated regional nodal irradiation for breast cancer: examining the data and potential for future studies. Radiother Oncol. 2014 Jan;110(1):39-44.
6. Haviland JS, Mannino M, Griffin C et al. Late normal tissue effects in the arm and shoulder following lymphatic radiotherapy: Results from the UK START (Standardisation of Breast Radiotherapy) trials. Radiother Oncol. 2018 Jan;126(1):155-162.



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## Hypofraktionierte Radiotherapie der Thoraxwand und Lymphabflusswege

**Wang et al. Lancet Oncol. 2019 Mar;20(3):352-360.**

- Randomised phase III non-inferiority trial, 820 pat., 2008-2016, T3/4 and / or  $\geq 4$  involved lymph nodes, 50 Gy / 25 fr. vs. 43.5 Gy / 15 fr.
- 98% 2D-planned radiotherapy, no treatment of the internal mammary lymph nodes
- "The 5-year cumulative incidence of locoregional recurrence was 8.3% (90% CI 5.8–10.7) in the hypo- fractionated radiotherapy group compared with 8.1% (90% CI 5.4–10.6) in the conventional fractionated radiotherapy group (absolute difference 0.2%, 90% CI –3.0 to 2.6; HR 1.10, 90% CI 0.72 to 1.69; figure 2).
- "In conclusion, this study provides high-level evidence for the clinical use of hypofractionated postmastectomy radiotherapy for patients with high-risk breast cancer. It can be recommended in clinical practice to patients who do not plan breast reconstruction and will not receive internal mammary node irradiation."

1. Wang SL, Fang H, Song YW et al.  
Hypofractionated versus conventional fractionated postmastectomy radiotherapy for patients with high-risk breast cancer: a randomised, non-inferiority, open-label, phase 3 trial. Lancet Oncol. 2019 Mar;20(3):352-360.

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# Multivariate Analysis of Overall Survival: Effect of Radiotherapy of the Internal Mammaria Lymph Nodes

(median follow-up 10.9 yrs)

Adjuvant treatment	n*	Hazard ratio (95% CI)
No adjuvant reported	625	0.91 (0.59 - 1.39)
Chemotherapy	954	1.05 (0.84 - 1.32)
Endocrine therapy	1185	0.82 (0.63 - 1.06)
Both (endocrine th. and chemotherapy)	1200	0.72 (0.55 - 0.94)
<b>Total</b>	<b>4004</b>	<b>0.88</b> <b>(0.76 - 1.01)</b>

\* missing data on 40 patients

Poortmans et al. ECCO Amsterdam 2013

1. Poortmans P, Struikmans H, Kirkove C, et al: Irradiation of the internal mammary and medial supraclavicular lymph nodes in stage I to III breast cancer: 10 years results of the EORTC Radiation Oncology and Breast Cancer Groups phase III trial 22922/10925. Eur J Cancer, 2013; 49 (Suppl. 3): abstr. #2BA.

<p>© AGO e. V. in der DGGG e.V. sowie in der DKG e.V.</p> <p>Guidelines Breast Version 2022.1D</p> <p>www.ago-online.de</p> <p>FORSCHEN LEHREN HEILEN</p>	Radiotherapie nach NACT					Oxford		
	Prätherapeutisch	Posttherapeutisch	RT-BET	PMRT	RT-LAW*	LoE	GR	AGO
	Lokal fortgeschritten	pCR / keine pCR	Ja	ja	ja	1a/1a/1a	A/A/A	++/+/+
	cT1/2 cN1+**	ypT1+ o. ypN1 + (keine pCR)	ja	ja	ja	1a/2b/2b	A/B/B	++/+/+
	cT1/2 cN1+**	ypT0/is ypN0	ja	Risikofälle <sup>1</sup>		2b/2b/2b	B/B/B	+/-/+
	cT1/2 cN0 (Sonogr. obligat)	ypN+ o. ypT3/4	ja	ja	ja	2b/2b/2b	B/B/B	+/-/+
	cT1/2 cN0 (Sonogr. obligat)	ypT0/is ypN0	ja	nein	nein	2b/2b/2b	A/B/B	+/-/-
<b>Lokal fortgeschritten: T3-4 oder cN2-N3</b>								
<sup>1</sup> Kriterien für hohes Rezidivrisiko: <ul style="list-style-type: none"> <li>▪ pN0 prämenopausal hohes Risiko: zentraler oder medialer Sitz, und (G2-3 und ER / PR-negativ)</li> <li>▪ prätherapeutisch pN1a/ cN+* hohes Risiko: zentraler oder medialer Sitz und (G2-3 oder ER / PR-negativ) oder prämenopausal, lateraler Sitz und (G2-3 oder ER/PR-negativ)</li> </ul>								
* bzgl. Erfassung von Axilla-Level I/II s. Folien „Zusätzliche RT der Axilla nach primärer Operation“ / „Zusätzliche RT der Axilla nach neoadjuvanter Chemotherapie“. ** = durch Stanzbiopsie gesichert								


1. Cortazar P, Zhang L, Untch M, et al (2014) Pathological complete response and long-term clinical benefit in breast cancer: the CTNeoBC pooled analysis. Lancet 384:164–172. doi: 10.1016/S0140-6736(13)62422-8
2. Mamounas EP, Anderson SJ, Dignam JJ, et al (2012) Predictors of Locoregional Recurrence After Neoadjuvant Chemotherapy: Results From Combined Analysis of National Surgical Adjuvant Breast and Bowel Project B-18 and B-27. J Clin Oncol 30:3960–3966. doi: 10.1200/JCO.2011.40.8369
3. Recht A, Comen EA, Fine RE, et al (2016) Postmastectomy Radiotherapy: An American Society of Clinical Oncology, American Society for Radiation Oncology, and Society of Surgical Oncology Focused Guideline Update. J Clin Oncol 34:4431–4442. doi: 10.1200/JCO.2016.69.1188
4. EBCTCG EBCTCG, McGale P, Taylor C, et al (2014) Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet 383:2127–2135. doi: 10.1016/S0140-6736(14)60488-8
5. Poortmans PM, Collette S, Kirkove C, et al (2015) Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer. N Engl J Med 373:317–327. doi: 10.1056/NEJMoa1415369
6. Whelan TJ, Olivetto IA, Parulekar WR, et al (2015) Regional Nodal Irradiation in Early-Stage Breast Cancer. N Engl J Med 373:307–316. doi: 10.1056/NEJMoa1415340
8. Marks LB, Kaidar-Person O, Poortmans P (2017) Regarding Current Recommendations for Postmastectomy Radiation Therapy in

Patients With One to Three Positive Axillary Lymph Nodes. *J Clin Oncol* 35:1256-1258. doi: 10.1200/JCO.2016.71.0764

9. Poortmans P (2014) Postmastectomy radiation in breast cancer with one to three involved lymph nodes: ending the debate. *Lancet* 383:2104–2106. doi: 10.1016/S0140-6736(14)60192-6
10. Fowble BL, Einck JP, Kim DN, et al (2012) Role of postmastectomy radiation after neoadjuvant chemotherapy in stage II-III breast cancer. *Int J Radiat Oncol Biol Phys* 83:494–503. doi: 10.1016/j.ijrobp.2012.01.068
11. White J, Mamounas E (2014) Locoregional Radiotherapy in Patients With Breast Cancer Responding to Neoadjuvant Chemotherapy: A Paradigm for Treatment Individualization. *J Clin Oncol* 32:494–495. doi: 10.1200/JCO.2013.53.4974
12. Rusthoven CG, Rabinovitch RA, Jones BL, et al (2016) The impact of postmastectomy and regional nodal radiation after neoadjuvant chemotherapy for clinically lymph node-positive breast cancer: a National Cancer Database (NCDB) analysis. *Ann Oncol* 27:818–827. doi: 10.1093/annonc/mdw046
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14. Bae SH, Park W, Huh SJ, et al (2012) Radiation Treatment in Pathologic N0-N1 Patients Treated with Neoadjuvant Chemotherapy Followed by Surgery for Locally Advanced Breast Cancer. *J Breast Cancer* 15:329–8. doi: 10.4048/jbc.2012.15.3.329
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## Molekulare Prädiktion für die Radiotherapie

- Ergebnisse von Genexpressionsprofilen sollen nicht für die Indikationsstellung der Radiotherapie herangezogen werden

Oxford

LoE	GR	AGO
2b	B	++

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## Simultane Applikation von systemischen Therapien mit adjuvanter lokoregionärer Radiotherapie

	Oxford		
	LoE	GR	AGO
▪ Trastuzumab / Pertuzumab*	1a	A	++
▪ T-DM1	1b	A	+
▪ Tamoxifen	2b	B	+
▪ Aromatasehemmer	2b	B	+
▪ Checkpointinhibitoren	2b	C	+
▪ Capecitabin**	2b	B	+
▪ CDK4/6-Inhibitoren***	4	C	+/-
▪ Olaparib****	2b	C	+/-

\* Bei HER2-positiven Tumoren sollte eine simultane parasternale RT generell vermieden werden; keine simultane Trastuzumab- / Pertuzumabtherapie bei parasternaler RT.

\*\* bei hypofraktionierter RT bis ca. 40 Gy, Dosisreduktion von Capecitabin erwägen, Pat. mit hohem Rezidivrisiko

\*\*\* In bisherigen Phase III-Studien (monarchE, PALLAS, Penelope-B) Gabe erst nach Abschluss der RT, in der Palliativsituation bisher kein Anhalt für deutlich erhöhte Toxizität

\*\*\*\* In bisherigen Phase III-Studien nur sequentielle Gabe

Trastuzumab\* concurrent with radiotherapy (\*in HER2 pos tumors parasternal RT should generally be avoided;  
no concurrent trastuzumab in parasternal RT)

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## Simultane Gabe von Capecitabin zur lokoregionären Radiotherapie

**Woodward et al. Int J Radiat Oncol Biol Phys. 2017 Nov 15;99(4):777-783**

- Prospective phase trial, 32 pat. with LABC, sim. def. / neoadj. chemoradiotherapy, median total dose 66 Gy
- "The first 9 patients analyzed [...] received CAP 825 mg/m<sup>2</sup> twice daily continuously beginning on the first day of RT. **Because of observed excess grade 3 toxicity the protocol was amended,** and subsequent patients received CAP only on RT days (5 days per week)."
- "Noncontinuous CAP dosing was much better tolerated than continuous dosing. **Thirteen of 26 patients (50%) had grade ≥ 3 and higher treatment-related dermatologic toxicity.**"

**Alhanafy et al. Menoufia Medical Journal 2015, 28:325-332**

- Randomised phase II-trial, 100 pat., adj. radiotherapy 40 Gy / 15 fr. +/- CAP 825 mg/m<sup>2</sup> Mo-Fr, LABC
- " [...] **concurrent capecitabine was feasible with a high percent of patients (96%),** [...] only two out of 50 (4%) patients had capecitabine dose modification ...".
- "All early toxicities were GI/GII. Radiation dermatitis had a peak incidence in the last few fractions of the radiation therapy and the week after radiotherapy; no treatment interruption was needed and the incidence was close in both groups".
- Radiation dermatitis grade I 14% vs. 18%; grade 2 4% vs. 4%

