CHAPTER 4

Postoperative elective nodal irradiation for squamous cell carcinoma of the head and neck: Outcome and prognostic factors for regional recurrence

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Ann Oncol. 2011 Nov;22(11):2489-94

Abstract

Background: This study describes the results of elective irradiation in the N0 neck and tries to identify prognostic factors for regional recurrence.

Materials and methods: Between 1985 and 2000, 785 cN0 or pN0 necks were treated with elective nodal irradiation in 619 head and neck squamous cell carcinoma (HNSCC) patients.

Results: Regional control at 3 years was 94% in the cN0 (non-dissected) neck compared to 97% the pN0 (dissected) neck and 90% in the ipsilateral compared to 96% in the contralateral neck (p=0.08 and p= 0.006, respectively). Regional control in the ipsilateral cN0 neck was 78% compared to 96% in the contralateral cN0 neck. Surgical margin of the primary tumor was an additional prognostic factor in all N0 and pN0 necks.

Conclusions: Neck control rates in electively irradiated N0 necks were excellent. Regional control was worse in the cN0 neck compared to the pN0 neck and in the ipsilateral neck compared to the contralateral side. Additionally, in case of positive surgical margins of the primary tumor, elective nodal irradiation should be applied, even in case of a pN0 neck.

Introduction

Head and neck squamous cell carcinoma includes a large group of relatively rare cancers at different sites, which all together amounts for 5% of all new cancer patients in the Netherlands (1). Many patients are primarily treated with surgery, followed by postoperative radiotherapy with or without chemotherapy in case of adverse prognostic factors, such as close or positive surgical margins and lymph node metastases with extranodal spread (ENS) (2-6).

In the majority of patients, both the operated and surgically uninvolved necks are included in the clinical target volumes (CTV) of radiation. The general policy in many centers is to electively treat the neck if the risk of nodal metastases exceeds 20% (7). Many patients who underwent surgical resection of the primary site with or without neck dissection will also receive elective nodal irradiation of the clinical N0 (cN0) neck. In case of composite resections (primary tumor with *en bloc* neck dissection), the operated pathological N0 (pN0) neck will also be irradiated if an indication for postoperative radiotherapy is present for the primary site.

In the postoperative setting, it has been generally recognized that the presence of 2 or more pathological nodes and/or the presence of ENS are the most important adverse prognostic factors for control of the neck (2,3). Studies concerning the outcome of elective irradiation of the N0 neck are scarce and prognostic factors for regional recurrence in the cN0 and pN0 neck are still unknown.

Therefore, the main purpose of the current study was to describe the results of elective irradiation in N0 necks in a large consecutive single institutional series and, in addition, to identify prognostic factors for regional recurrence in the N0 neck.

Materials and methods

The population reviewed for this retrospective study was composed of a consecutive series of 619 postoperatively irradiated patients with either unilateral or bilateral cN0 and pN0 necks. Patients were treated at VU University Medical Center from January 1985 to December 2000 for squamous cell carcinoma of the mucosa of the oral cavity (excluding the lip), oropharynx, hypopharynx or larynx. The majority of patients (66%) were male. The median age was 60 years, ranging from 20 to 90 years. Pre-treatment evaluation included a medical history, palpation of the neck, examination under general anesthesia with panendoscopy and a chest radiograph in all cases. Additional diagnostic radiological evaluation of the neck was performed in 235 patients (38%). An ultrasound of the neck with or without fine needle aspiration cytology (USgFNAC) depending on site criteria was carried out 184 cases (30%). Computed tomography (CT) of the involved head and neck region was performed in 57 patients (9%) and magnetic resonance imaging (MRI) in 113 cases (18%). Additional diagnostic procedures for distant metastases, including CT of the chest, liver ultrasound, bone scintigraphy and/or, more recently, positron emission tomography (PET-scan) were only performed if clinically indicated. Patients with distant metastases were excluded from the analysis. T- and N-classifications were assigned according to the staging system of the UICC 1997 (8). The pre-treatment patient neck characteristics are listed in Table 1.

Surgery

All 619 patients underwent surgery of the primary tumor. The primary tumor was treated by local excision (n=187; 30%), composite resection with or without a marginal or segmental mandibulectomy (n=301; 49%) or laryngectomy with partial or total pharyngectomy (n=131; 21%).

The patient population consisted of 1238 necks, of which 785 necks were treated with elective nodal irradiation in case of a cN0 or pN0 neck. From these 785 necks, 227 necks had undergone surgery and were pN0 (29%). A radical neck dissection was performed in 9 necks (1%) of which seven were ipsilateral necks and two were contralateral. A modified radical neck dissection was performed in 136 necks (17%), of which 112 were ipsilateral and 24 were contralateral necks. In 82 necks, a selective neck dissection (SND) was performed, including a SND(I-III) (6%) in 49 necks (4 ipsilateral necks and 45 contralateral necks) and a SND(II-IV) in 33 (4%) necks (22 ipsilateral and 11 contralateral).

Table 1: Pre-treatment characteristics of all N0, all cN0 and all pN0 necks.

Variable	All N0 necks		cN0 necks		pN0 necks		Chi-square
Total number	785		558		227		
pT-classification							P<0.001
T1	84	(10.7%)	80	(14.3%)	4	(1.8%)	
T2	172	(21.9%)	147	(26.3%)	25	(11.0%)	
T3	269	(34.3%)	180	(32.3%)	89	(39.2%)	
T4	260	(33.1%)	151	(27.1%)	109	(48.0%)	
Primary site							p=0.019
Oral cavity	372	(47.4%)	265	(47.5%)	107	(47.1%)	
Oropharynx	232	(29.6%)	175	(31.4%)	57	(25.1%)	
Larynx	126	(16.1%)	76	(13.6%)	50	(22.0%)	
Hypopharynx	55	(7.0%)	42	(7.5%)	13	(5.7%)	
Grade of differentation							p=0.239
Poorly differentiated	140	(17.8%)	107	(19.2%)	33	(14.5%)	
Moderately differentiated	527	(67.1%)	365	(65.4%)	162	(71.4%)	
Well differentiated	118	(15.0%)	86	(15.4%)	32	(14.1%)	
Surgical margins primary site							p=0.132
Free surgical margins	511	(65.1%)	354	(63.4%)	157	(69.2%)	
Close surgical margins (1-5 mm)	114	(14.5%)	84	(15.1%)	30	(13.2%)	
Positive surgical margins (< 1 mm)	160	(20.4%)	120	(21.5%)	40	(17.6%)	
Perineural invasion							p=0.805
No	667	(85%)	473	(84.8%)	194	(85.5%)	
Yes	118	(15%)	85	(15.2%)	33	(14.5%)	
Angioinvasive growth							p=0.737
No	648	(82.5%)	459	(82.3%)	189	(83.3%)	
Yes	137	(17.5%)	99	(17.7%)	38	(16.7%)	
Interval surgery-radiotherapy							p=0.756
<43 days	263	(43%)	236	(42%)	100	(44%)	
43-49 days	149	(24%)	133	(24%)	59	(26%)	
49-56 days	93	(15%)	82	(15%)	29	(13%)	
>56 days	114	(18%)	107	(19%)	39	(17%)	

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Radiotherapy

All patients received postoperative radiotherapy and elective nodal irradiation with curative intent. The interval between surgery and onset of irradiation was less than 43 days in 263 patients (43%), 43 to 49 days in 149 patients (24%), 49 to 56 days in 93 patients (15%) and >56 days in 114 patients (18%). Radiotherapy was delivered using megavoltage equipment (6 MV linear accelerator) using isocentric techniques. All patients were immobilized in supine position by the use of individually designed facial masks for reproducible positioning. Generally, the initial clinical target volume (CTV) consisted of the area of the resected primary tumor, the pathological lymph nodes plus at least 1 to 1.5 cm margin and the elective nodal areas of the unilateral or bilateral neck. For the planning target volume (PTV), a 0.5 cm margin was applied. The nodal areas were irradiated using 2 opposing lateral fields for the upper neck nodes with an anterior field for the low jugular and supraclavicular lymph nodes.

In all patients, the elective nodal target volume consisted of the nodal areas of the operated neck. In the vast majority of patients, both necks were irradiated.

In case of oropharyngeal carcinoma, the elective nodal target volume of the N0 neck consisted at least of level II, level III and level IV on both necks. In case of tumours extending or originating in the posterior pharyngeal wall, the retropharyngeal lymph nodes were also included. In case of tumour extension beyond the faucal arches, level Ib was also included in the elective nodal target volume.

In case of hypopharyngeal carcinoma, level Ib, II, III, IV and V, as well as the retropharyngeal lymph nodes up to the level of the base of skull were included in the elective nodal area.

In case of oral cavity carcinomas, level Ia, Ib, II, III and IV were generally included in the elective nodal target volume. Only in case of early stage (limited T-stage) oral cavity tumors originating in the anterior floor of mouth, elective irradiation of the neck was confined to level I to III.

In case of laryngeal carcinoma, the elective nodal areas of the N0 neck included level II, III and IV.

Twenty-one patients underwent unilateral irradiation as the probability of contralateral lymph node metastases (depending on the site and stage of the primary tumor) was considered very low. In these cases the initial CTV included the primary site with the same margins and the surgical bed. In these cases, only the ipsilateral neck was included in the CTV.

The elective nodal areas were irradiated to a total dose of 46-50 Gy. In case of elective nodal irradiation up to 46 Gy, the PTV received 23 fractions of 2 Gy. In case of elective nodal irradiation up to 50 Gy, the PTV was irradiated in 25 fractions of 2 Gy with shielding of the spinal cord after 40 Gy. The anterior part of the neck was irradiated with a dose per fraction of 2 Gy up to 50 Gy using photons while the posterior triangle was irradiated using electrons (6 to 12 MeV) with a dose per fraction of 3 Gy up to a total dose of 49 Gy. The dose of the electrons was specified at the 100% isodose and the energy of the electrons was determined in such a way that the maximum dose to the spinal cord was ≤ 20% of the prescribed dose.

To correct for set up errors, an extra margin of 0.5 centimeter was taken for the PTV. In general, two opposing anterior-posterior and posterior-anterior fields were used for the cranial part of the PTV and an additional single anterior field to cover the ipsilateral low jugular and supraclavicular nodal regions. In some cases, for the cranial part an additional low weighted lateral field was used in order to spare a larger amount of the anterior part of the oral cavity.

Elective irradiation was defined as (i) the prophylactic irradiation of the pN0 neck (in case a neck dissection was carried out), and/or (ii) the prophylactic irradiation of the cN0 neck [in case of a clinical N0 neck (without neck dissection) and surgical treatment of the primary tumor]. Necks that received a total dose < 40 Gy were excluded from the analysis.

Follow up strategy

All patients were followed every 2 months in the first year after treatment, every 3 months in the second year, and every 4-6 months thereafter. Generally, follow-up consisted of clinical examination of the neck while additional investigations were only performed in case of suspicious findings.

Statistics

The analysis was performed for neck recurrence for each neck separately. Neck recurrence was defined as a new pathological cervical node or a new cervical mass confirmed by cytology in a formerly irradiated neck. A univariate analysis with the Kaplan-Meier method was performed to assess the neck control rate in the different groups. The analysis was performed based on each separate neck and not on a patient basis. Differences between curves were compared with the log rank test for statistical significance. A multivariate analysis was performed using the Cox proportional hazards model to identify independent prognostic factors and potential confounders.

All analyses were carried out by using SPSS for WINDOWS (version 11.0; SPSS Inc, Chicago, IL).

Table 2: Results of the univariate analysis with regard to neck control in all N0 necks, cN0 necks and pN0 necks

Variable	All N0 necks				All cN0 necks				All pN0 necks			
	Number	**3-years regional control**	**Hazard ratio (95% CI)**	**Log Rank**	**Number**	**3-years regional control**	**Hazard ratio (95% CI)**	**Log Rank**	**Number**	**3-years regional control**	**Hazard ratio (95% CI)**	**Log Rank**
Neck side				p=0.006				p<0.001				p=0.046
Contralateral	598	95.6%	1.00		506	95.9%	1.00		92	100%	no events in reference category	
Ipsilateral	187	89.9%	2.48 (1.28-4.82)		52	78.2%	4.69 (2.18-10.1)		135	94.8%		
Primary tumour site				p=0.181				p=0.189				p=0.541
Oral cavity	372	94.9%	1.00		265	94.6%	1.00		107	100%	no events in reference category	
Oropharynx	232	93.9%	1.30 (0.63-2.71)		175	93.1%	1.38 (0.61-3.12)		57	96.1%		
Larynx	126	98.4%	0.48 (0.08-1.54)		76	96.7%	0.51 (0.11-2.27)		50	95.6%		
Hypopharynx	55	90.8%	1.95 (0.65-5.85)		42	87.3%	2.58 (0.83-8.03)		13	100%		
Surgical margins primary site				p=0.001				p=0.010				p<0.001
Free	511	97.5%	1.00		354	96.6%	1.00		157	99.3%	1.00	
Close (1-5 mm)	114	90.3%	3.62 (1.53-8.60)		84	86.7%	3.70 (1.53-8.94)		30	100%	no events	
Positive (< 1 mm)	160	88.8%	4.11 (1.90-8.88)		120	90.5%	2.61 (1.08-6.30)		40	84.1%	21.4 (2.50-183)	
Imaging				p=0.806				p=0.727				p=0.671
Yes	297	94.9%	1.00		200	94.3%	1.00		97	97.7%	1.00	
No	488	94.7%	1.09 (0.54-2.20)		358	93.6%	1.15 (0.53-2.53)		130	96.9%	1.41 (0.29-7.00)	
Neck dissection				p=0.079								
Yes (pN0)	227	96.9%	1.00		*Not applicable*				*Not applicable*			
No (cN0)	558	93.9%	2.16 (0.90-5.19)									
Interval surgery - radiotherapy				p=0.055				p=0.174				p=0.396
0-42 days	336	95%	1.00		236	95%	1.00		100	96%	1.00	
43-49 days	192	99%	0.52 (0.17-1.59)		133	98%	0.70 (0.22-2.23)		59	100%	no events	
49-56 days	111	93%	1.69 (0.67-4.23)		82	91%	1.80 (0.65-4.94)		29	96%	1.18 (0.12-11.3)	
>56 days	146	91%	2.04 (0.91-4.56)		107	89%	2.05 (0.83-5.04)		39	94%	1.88 (0.31-11.3)	

Results

All N0 necks

The pre-treatment characteristics of all N0 necks are listed in Table 1. The 3-year neck control rate of all irradiated N0 necks was 95%. In the univariate analysis (Table 2), neck control was significantly associated with neck side (ipsilateral versus contralateral). In the ipsilateral neck, the 3-year neck control rate was 90%, compared to 96% in the contralateral neck (p=0.006). Neck control was also significantly associated with surgical margins of the primary site. Among patients with free surgical margins, the 3-year neck control rate was 98%, compared to 90% and 89% in case of close or microscopically positive surgical margins, respectively (p=0.001). Borderline significance was found for neck dissection (yes versus no) (p=0.079) (Table 2). No significant association with neck control was found for adequate imaging of the neck (yes versus no). Imaging of the neck was considered adequate in case at least one modality (USgFNAC, CT and/or MRI) was used.

In the multivariate analysis, neck side, neck dissection and surgical margins were identified as independent prognostic factors for neck control (Table 3).

Table 3: Results of the multivariate analysis with regard to neck control in all N0 necks.

	B	SE (B)	HR (95% CI)	P-value
Neck side				p<0.001
Ipsilateral (reference to contralateral)	1.603	0.413	4.97 (2.12-11.2)	
Neck dissection				p=0.003
No (reference to yes)	1.571	0.536	4.81 (1.68-13.8)	
Surgical margins				p=0.018
Close (reference to free surgical margins)	0.970	0.463	2.64 (1.07-6.53)	
Positive (reference to free surgical margins)	1.107	0.413	3.02 (1.35-6.79)	
T-classification				p=0.223
T2 (reference to T1)	0.217	0.617	1.24 (0.37-4.16)	
T3 (reference to T1)	0.627	0.602	1.87 (0.58-2.54)	
T4 (reference to T1)	-0.515	0.738	0.60 (0.14-2.54)	
Primary tumour site				p=0.298
Hypopharynx (reference to oral cavity)	0.609	2.296	2.52 (0.76-8.31)	
Oropharynx (reference to oral cavity)	0.039	0.405	1.04 (0.47-2.30)	
Larynx (reference to oral cavity)	-0.659	0.826	0.52 (0.10-2.61)	
Imaging				p=0.708
No (reference to yes)	0.137	0.366	1.15 (0.56-2.35)	

Clinically N0 (cN0) non-dissected necks

A separate analysis was carried out for the cN0 necks. In the univariate analysis, the 3-year neck control rate was significantly better in the contralateral neck compared with the ipsilateral neck (96% and 78%, respectively) (p<0.001). Furthermore, the 3-year neck control rate was significantly associated with surgical margins. Neck control was 97% in case of free surgical margins, compared to 87% and 91% in case of close and microscopically positive surgical margins, respectively (p=0.010). However, neck control in the ipsilateral cN0 neck did not depend on surgical margins. In the multivariate analysis, only neck side was identified as an independent prognostic factor for neck control in the cN0 necks (Table 4).

Table 4: Results of the multivariate analysis with regard to neck control in the cN0 necks.

	B	SE (B)	HR (95% CI)	P-value
Neck side				p<0.001
Ipsilateral (reference to contralateral)	1.660	0.450	5.26 (2.18-12.7)	
Surgical margins				p=0.067
Close (reference to free surgical margins)	0.662	0.473	1.94 (0.77-4.90)	
Positive (reference to free surgical margins)	1.100	0.480	3.00 (1.17-7.69)	
T-classification				p=0.216
T2 (reference to T1)	0.044	0.638	1.05 (-.30-3.65)	
T3 (reference to T1)	0.655	0.628	1.92 (0.56-6.59)	
T4 (reference to T1)	-0.633	0.785	0.42 (0.53-2.47)	
Primary tumour site				p=0.298
Hypopharynx (reference to oral cavity)	1.365	0.655	3.92 (1.08-14.1)	
Oropharynx (reference to oral cavity)	0.246	0.462	1.28 (0.52-3.16)	
Larynx (reference to oral cavity)	-0.247	0.856	0.78 (0.15-4.18)	
Imaging				p=0.773
No (reference to yes)	0.178	0.412	1.20 (0.53-2.68)	

Pathologically N0 (pN0) dissected necks

In the univariate analysis of the pN0 necks, the 3-year neck control rate was significantly associated with neck side and surgical margins. Neck control was significantly better in the contralateral neck (100%) compared to the ipsilateral neck (95%) (p=0.046). In case of free surgical margins, the 3-year neck control was 99%, compared to 100% and 84% in case of close and microscopically positive margins, respectively (p<0.001) (Table 2). In the subset of patients with pN0 necks with positive surgical margins, 3-years neck control was 100% in the contralateral (CL) necks (n=11), compared to 78% in the ipsilateral (IL) necks (n=29)(p=0.15).

Because of the absence of events in the reference categories, no details regarding the multivariate analysis are shown.

Discussion

The main purpose of the present analysis was to describe the results of elective irradiation in N0 necks and to identify prognostic factors for regional recurrence in the N0 neck. First, it should be noticed that the neck control rate in N0 necks was very high (95%), with a significantly higher probability of neck recurrence in the ipsilateral neck.

Several investigators reported similar regional control rates (9-11). In a prospective randomized study, Peters et al (10) irradiated cN0 and pN0 necks in the postoperative setting, using 1.8 Gy per fraction (5 times per week) up to a total dose of 54 Gy and 57.6 Gy, respectively and observed a 2-year regional control rate of 90% in low risk necks. Although Peters et al (10) applied higher elective doses of 54 and 57.6 Gy (EQD_{2Gy} = 53 Gy and EQD_{2Gy} = 56 Gy, respectively) compared to the 50 or 46 Gy in the present study, it is generally accepted that elective doses of 45 to 50 Gy are sufficient to treat subclinical nodal disease (10, 12-14). However, it should be pointed out that the 54 Gy in the study of Peters et al (10) was delivered to areas at risk for subclinical microscopic disease not operated upon and 57.6 Gy was eventually delivered to areas of subclinical microscopic disease in areas operated upon and found not to have pathologic evidence of disease. An increased risk of local relapse was observed on interim analysis when the early study design delivered 52.2 Gy - 54 Gy to pathologic negative regions. While the Peters paper reported a 89% 2 year actuarial neck control rate for patients receiving less than or equal to 54 Gy, this was only in nine patients. So these results should be interpreted with caution.

In the present study, we analyzed the cN0 necks separately from the pN0 necks to minimize variability in residual tumor burden, since cN0 necks theoretically may contain tumor load up to the clinical detection threshold (= 7 logs of tumor clonogens (13)). This hypothesis was supported by the fact that the hazard ratio for neck control was 2.2 in favor of the pN0 necks. However, it should be noted that the absolute difference was only 3.0% (i.e., 3-year neck control: 96.9% versus 93.9%) and that this difference will be less relevant from a clinical point of view.

The present study shows that neck control in electively irradiated necks is generally excellent and, from that point of view, the question arises as to whether elective nodal irradiation could be omitted in well-defined subgroups. As far as we know, no other studies have been carried out to investigate prognostic factors for outcome after elective nodal irradiation. The results of the present study revealed two important risk factors associated with a higher rate of neck failure, including the ipsilateral neck and positive surgical margins (of the primary site). In particular, neck control in the ipsilateral dissected pN0 necks with positive surgical margins was 78%, compared to 100% in the contralateral dissected pN0 necks with positive margins. Therefore, one could argue to withhold elective irradiation from the contralateral pN0 neck, even in case of positive surgical margins. However, caution should be made with tumors abutting or crossing the midline, as these could carry a higher potential risk of regional recurrence. In one of our earlier studies on unilateral postoperative irradiation, we demonstrated that the risk on failures in the contralateral non-irradiated neck in patients with lateralized oral cavity and oropharyngeal tumors mainly depended on the pathological nodal status of the ipsilateral neck, with 99% regional control in case of a pN0 ipsilateral neck (15). Therefore, we would argue to withhold elective irradiation from the contralateral pN0 neck only in selected patients with well lateralized tumors and an ipsilateral pN0 neck.

Some argue that elective nodal irradiation of the ipsilateral neck can be omitted in case of a pN0 dissected neck based on the assumption that there is pathological evidence that the neck is not at risk. However, based on the results of the present study, we would strongly advise elective nodal irradiation of the pN0 ipsilateral neck in case of positive surgical margins as there is no doubt that neck control will deteriorate below the 78% achieved with elective postoperative radiotherapy as observed in the current study. On the contrary, given the relatively low neck control rate, one could argue to apply a more aggressive strategy (i.e. increase the dose to the ipsilateral pN0 neck to 60-66 Gy), which is stressed by the fact that successful salvage treatment in case of a regional recurrence in an operated neck is generally not possible.

It should be emphasized that in the present series no postoperative chemoradiation was applied, which is now considered gold standard for patients with positive surgical margins and/or lymph node metatases with ENS (2-6). It is not unlikely that the addition of concurrent chemotherapy to postoperative radiotherapy will result in a further reduction of regional recurrences in this specific subset. In one of our earlier studies including patients treated with primary radiotherapy or chemoradiation, the addition of chemotherapy indeed resulted in a significantly lower incidence of regional recurrences (16). However, as this study concerned patients treated with primary (chemo) radiation, this remains to be determined in the postoperative setting.

The question arises why the ipsilateral pN0 neck is at risk in case of positive surgical margins of the primary site. Two possible hypotheses could be generated for this finding. First, in case of positive surgical margins, the tumor will be cut per definition during the surgical procedure leading to tumor spill in the complete surgical area, in particular when resection of the primary tumor and the neck is performed continuously. Another explanation could be that positive surgical margins are referring to a more aggressive tumor behavior and that neck failure results from residual tumor causing reseeding in the neck during the interval between surgery and radiotherapy. In this case, one would expect that surgical margin was also a significant factor in the cN0 necks, which was however not the case. Therefore, the first hypothesis, i.e., tumor spill during the surgical procedure, might be a likely explanation for this finding.

In the current series, approximately 10% of the cases developed a local recurrence. Some argued that these patients should be excluded from the analysis, as it cannot be excluded that a possible regional recurrence develops from the recurrence of the primary tumor and not from residual tumor in the neck. Although this is virtually true, we considered it methodically incorrect to exclude patients with local recurrences for two reasons. First, as it will always remain unclear whether a regional failure in case of a local recurrence is either due to reseeding of this local recurrence or a real failure from residual tumor in the neck, the results will always be biased when these patients are excluded. Second, this analysis was based on prognostic factors available prior to postoperative radiotherapy. The results of these kind of analyses can only be used for determining future treatment policies when all patients remain included in the analysis, irrespective of outcome (intention-to-treat principle). Moreover, an additional analysis (not shown) showed that local recurrence was not significantly associated with neck control and the results of the current analysis would not have changed any of the conclusions presented.

As only 36% of all cN0 necks and 37% of all ipsilateral cN0 necks had imaging of the neck, one could argue that non-palpable disease that might require higher doses for regional control could be missed. However, we could not confirm this by the findings of the current series.

In conclusion, the current analysis showed that elective irradiation of the neck in surgically treated patients result in excellent neck control rates. Prognostic factors for neck control are neck side and surgical margins of the primary site. Given the relatively high recurrence rate in the ipsilateral pN0 neck in case of positive surgical margins, more aggressive treatment approaches could be considered and clinically validated.

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