

# Adjuvant Radiotherapy and Chemoradiation in Elderly Patients with Squamous Cell Carcinoma of the Head and Neck

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## Research article

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# Abstract

## Background:

Radiotherapy and chemoradiation are well-established therapies for patients with squamous cell carcinoma of the head and neck (SCCHN). In aging societies, also the incidence of SCCHN in elderly patients is rising. Because of the underrepresentation of elderly patients in scientific trials, we evaluated the feasibility of adjuvant radiotherapy and chemoradiation in patients with SCCHN aged >70 years.

## Methods:

All patients had been >70 years at the time of diagnosis and received adjuvant radiotherapy or, if feasible, chemoradiation at the University Medical Centre Regensburg between 2004 and 2018.

71 patients -most with SCCHN UICC stage IVa- with a median age of 75 years were included; 9 patients received concomitant chemoradiation. Median follow-up was 27 months (IQR 18 – 62 months).

## Results:

Radiotherapy and chemoradiation was well tolerated. 62 patients (87.3%) underwent treatment without interruption, and 65 patients (91.5%) completed radiotherapy with 95% of the initially prescribed dose. Median dose for all patients was 64 Gy (IQR: 60 – 66 Gy). 6/9 patients received at least 75 % of the planned chemotherapy dose. 37 patients (52.1%) developed acute toxicity CTC grade III or IV.

Overall survival was 87 % after 12 months, 67 % after 24 months and 41 % after 60 months. Median overall survival was 51 months (IQR: 19 - 99 months). Local tumour control was 99 % after 12 months, 88 % after 24 months and 76 % after 5 years.

## Conclusion:

Feasibility of adjuvant radiotherapy and chemoradiation in our collective of elderly patients with SCCHN was good. Particularly local tumour control was satisfactory. Overall survival does not seem to differ between elderly and younger patients or patients unselected for age. De-intensification of treatment because of age does not seem justified.

## Background:

Squamous cell carcinoma of the head and neck (SCCHN) is a common type of malignant tumours worldwide. In 2019, 53,000 cases of cancer of the oral cavity and pharynx and 12,410 cases of laryngeal cancer were projected for the United States (US), 3.7% of all new cancer cases in the US are SCCHN. (National Comprehensive Cancer Network 2019b) (Siegel et al. 2019). The worldwide proposed incidence of SCCHN for 2018 was 834,860 cases (4.6% of all newly diagnosed malignancies) (Bray et al. 2018).

In Germany, the Robert Koch Institute (RKI) in cooperation with the “Gesellschaft der epidemiologischen Krebsregister in Deutschland e.V.” (Society of Epidemiological Cancer Registries in Germany) publishes German cancer statistics every two years. In 2014, 12,830 new cases of tumours of the oral cavity and pharynx (9,130 in men, 3,700 in women) were diagnosed as well as 3,500 new cases of malignant tumours of the larynx (2,980 in men and 520 in women) (Robert-Koch-Institut 2017).

The aetiology of head and neck cancer is multifactorial. The main risk factors are smoking, alcohol consumption, human papilloma virus (HPV), premalignant lesions (for example, leukoplakia) and premalignant conditions (inherited conditions or acquired immunodeficiency)(Shaw und Beasley 2016) (Blot et al. 1988) (Sankaranarayanan et al. 1998).

Cancer of the head and neck occur heterogeneously, and locally advanced SCCHN are frequent (Magnes et al. 2017). One therapeutic option for locally advanced SCCHN is multimodal treatment consisting of resection followed by postoperative or adjuvant radiotherapy or chemoradiation (Marur und Forastiere 2016; National Comprehensive Cancer Network 2020) (Bernier et al. 2004) (Bernier et al. 2005; Gregoire et al. 2010).

According to national and cross-national guidelines, the decision on SCCHN treatments with adjuvant radiotherapy or chemoradiation depends on TNM Classification of Malignant Tumours, tumour site, general state of health, comorbidities and risk factors of the individual patient (National Comprehensive Cancer Network 2020) (National Comprehensive Cancer Network 2019b)(ESMO 2010) (Bernier et al. 2005).

The demographic change in aging societies is one reason for the rising number of patients with SCCHN (Sikora et al. 2004), so that radiooncologists face an increasing rate of elderly or frail patients (Jelinek et al. 2018) (VanderWalde et al. 2013). The definition of frailty has been discussed in several studies (Clegg et al. 2013), and numerous screening tools have been developed (National Comprehensive Cancer Network 2019a) (Pottel et al. 2012) (Biganzoli et al. 2013) (Bellera et al. 2012). Nevertheless elderly or frail patients are often underrepresented in clinical trials (VanderWalde et al. 2013) (Metges et al. 2000) (Dietz et al. 2018) (Fietkau et al. 2020) (Kuhnt et al. 2017).

Therefore, the aim of the present analysis was to evaluate the results and the feasibility of adjuvant radiotherapy or chemoradiation in a collective of elderly patients with SCCHN who were aged 70 years and older.

## Methods:

This survey included patients with SCCHN who had been 70 years and older at the time of diagnosis and received adjuvant radiotherapy or chemoradiation at the University Medical Centre Regensburg between 2004 and 2018. The study adhered to the Declaration of Helsinki and was approved by the Ethics Committee of the University of Regensburg. Overall, 71 patients (16 women and 55 men) were included in this retrospective survey. Median age of the patients was 75 years (IQR 72–79 years). 42 patients had a

head and neck tumour UICC stage IVa. 20 patients were treated with adjuvant radiotherapy because of tumour recurrence, but none of the patients had previously received radiotherapy of the head and neck. 62 patients received adjuvant radiotherapy and 9 patients concomitant adjuvant chemoradiation. Median follow-up was 27 months (IQR: 18–72 months) [Table 1].

Table 1

Patients characteristics	Percentage	
Patients [n]	71	
Gender [n]		
♣ female	16	22.5%
♣ male	55	77.5%
Age [years] at diagnosis		
♣ median	74	
♣ first Quartile	71	
♣ third Quartile	78	
Tumor entity [n]		
♣ oropharynx	19	26,7%
♣ oral cavity	29	40.8%
♣ hypopharynx	7	9.9%
♣ larynx	16	22.5%
UICC classification [n]		
I	5	7.0%
II	3	4.2%
III	18	25.4%
IVa	42	59.2%
IVb	3	4.2%
Karnofsky performance status initially [n]		
30–40%	2	2.8%
50–60%	12	16.9%
70–80%	42	59.2%
90–100%	10	14.1%
Not specified	5	7.0%
Karnofsky performance status minimal during therapy [n]		
30–40%	3	4.2%

Patients characteristics		Percentage	
50–60%	21	29.5%	
70–80%	35	49.3%	
90–100%	4	5.6%	
Not specified	8	11.3%	
Follow-up [months]			
♣ median	27		
♣ first quartile	18		
♣ third quartile	62		

In this objective head and neck tumours were categorised as tumours of the oral cavity, larynx, oropharynx and hypopharynx (= Squamous Cell Carcinoma of the Head and Neck, SCCHN). The main purpose of this survey was to evaluate the feasibility of radiotherapy and chemoradiation.

Overall survival was defined as the period between the date of diagnosis and the date of death or of the last known contact with a health facility. The general condition was classified in accordance to the Karnofsky performance status.

Data were collected by means of patient files and documentation programmes of the department and the University Medical Centre Regensburg (Mosaik [IMPAC Medical Systems, Elekta, Stockholm, Sweden], SAP [SAP, Walldorf, Germany], Onkodat [University of Regensburg, MedicDAT GmbH, Poikam Germany], CATO [Becton Dickinson, Franklin Lakes, USA]). Treatment-related side effects were classified according to the Common Terminology Criteria for Adverse Events (CTCAE) Version 3.0. (National Cancer Institute - Division of Cancer Treatment and Diagnosis). Toxicity was evaluated before, during and directly after therapy as well 6 weeks, 6 months and 12 months after therapy.

Survival data were completed with the help of the registration office and Tumour Centre of Regensburg.

Statistical analysis and diagrammes were done with IBM SPSS Statistics 25 (IBM, Armonk, NY, USA). A significance level of  $p = 0.05$  was considered significant. Significance tests were carried out with the T-Test for metric variables and the Chi<sup>2</sup>-test for nominal variables. The Mann-Whitney- U -test was used for ordinal scaled variables.

Survival curves for 60 months were created with Kaplan-Meier-plots and analysed with log-rank-tests.

An univariate as well as a multivariate analysis were conducted. Positive and negative predictive factors were identified by means of the Cox regression model.

## Results:

### Feasibility

Radiotherapy was well tolerated by the patients. In this survey, 62 (87.3%) patients underwent radiotherapy and chemoradiation as planned without interruption. Treatment had only to be interrupted for 2 or more days for 9 (12.7%) of 71 patients. 65 (91.5%) patients could complete radiotherapy with a dose of 95% of the initially prescribed radiation dose. Because of premature discontinuation of radiotherapy, 6 (8.5%) patients received less than 95% and 4 (5.6%) patients less than 80% of the prescribed dose. Median dose for all patients was 64 Gy (IQR: 60–66 Gy).

Of 71 patients, 9 (12.7%) received simultaneous adjuvant or postoperative chemoradiation. 6 (66.6%) of the 9 patients received 75% or more and 8 (88.8%) of the 9 patients 50% or more of the initially planned dose. 1 patient received less than 25% of the prescribed chemotherapy dose because of the premature termination of chemoradiation. Most of the postponed cycles were shifted due to temporary bone marrow toxicity, especially leukopenia and neutropenia.

### Acute Toxicity

In this survey, we also evaluated the side effects of radiotherapy and chemoradiation, such as enoral mucositis, dysphagia, dermatitis caused by radiation, loss of weight, leukopenia, thrombopenia, anaemia, renal failure and xerostomia. Side effects were analysed after 6 weeks and after 3, 6 and 12 months according to the dates of follow-up examination. 37 patients (52.1%) developed acute toxicity CTC grade III or IV after radiotherapy or chemoradiation. Analysis by means of the Chi<sup>2</sup>-test showed that simultaneous chemoradiation did not result in any significantly higher degree of acute toxicity than radiotherapy alone.

The most frequent acute side effect of radiation was enoral mucositis. 24 (33.8%) patients developed therapy-induced toxicity CTC grade III or higher. After 6 weeks, 3 (4.2%) patients were still affected by mucositis. [Table 2]

Table 2

Therapy characteristics	Percentage	
Patients [n]	71	
Postoperative or adjuvant radiotherapy	62	87.3%
Postoperative or adjuvant chemoradiation	9	12.7%
Boost [n]		
♣ sequential	56	78.9%
♣ concomitant	5	7.0%
♣ without	10	14.1%
Radiation technique [n]		
♣ IMRT	42	59.2%
♣ IMAT	13	18.3%
♣ VMAT	7	9.9%
♣ Isocentric multi-pattern technique	7	9.9%
♣ Isocentric opposing fields	2	2.8%
Dose [Gy]		
♣ median	64	
♣ first quartile	60	
♣ third quartile	66	
Acute toxicity according to CTCAE Version 3.0 [n]		
♣ Mucositis Grade $\leq$ II	46	65.7%
♣ Mucositis Grade $\geq$ III	24	34.3%
♣ Dermatitis Grade $\leq$ II	61	85.9%
♣ Dermatitis Grade $\geq$ III	10	14.1%
♣ Dysphagia Grade $\leq$ II	42	60.9%
♣ Dysphagia Grade $\geq$ III	27	39.1%
Late toxicity according to CTCAE Version 3.0 [n]		
♣ 6 months after RTx		
o Mucositis Grade $\leq$ II	50	96.2%



Therapy characteristics	Percentage	
o Mucositis Grade $\geq$ III	2	3.8%
o Xerostomia Grade $\leq$ II	47	95.9%
o Xerostomia Grade $\geq$ III	2	4.1%
o Dysphagia Grade $\leq$ II	40	90.9%
o Dysphagia Grade $\geq$ III	4	9.1%
♣ 12 months after RTx		
o Mucositis Grade $\leq$ II	39	100.0%
o Mucositis Grade $\geq$ III	0	0.0%
o Xerostomia Grade $\leq$ II	39	97.5%
o Xerostomia Grade $\geq$ III	1	2.5%
o Dysphagia Grade $\leq$ II	33	91.7%
o Dysphagia Grade $\geq$ III	3	8.3%
weight 6–12 weeks after compared to weight before start of therapy [n]	1	1,6%
♣ 80–84%		
♣ 85–89%	3	4,8%
♣ 90–94%	15	24,2%
♣ 95–100%	26	41,9%
♣ > 100%	16	25,8%

27 (38.0%) patients had dysphagia (CTC grade III or more), which was still present in 9 (12.7%) after 6 weeks. 10 (14.1%) patients had already developed dysphagia CTC grade III before the start of radiotherapy, so that these cases were not clearly classified as therapy-induced dysphagia.

Dermatitis CTC grade III or more caused by radiotherapy was seen in 10 (14.1%) patients. 4 (5.6%) patients were affected by weight loss > 10% of body weight.

## Late Toxicity

Dysphagia CTC grade III persisted for more than 6 months in 4 (5.6%) patients and for more than 12 months in 3 (4.2%) patients. 4 (5.6%) patients treated with radiotherapy showed Xerostomia CTC grade III after 6 weeks, 2 (2.8%) patients after 6 months and 1 (1.4%) patient after 12 months. The Karnofsky

performance status (KPS) was stable in most patients, only 5 (7.0%) patients experienced a decrease in KPS of 20% or more.

## Survival And Response

Our study population of 71 patients showed an overall survival rate of 87% after 12 months, 67% after 24 months and 41% after 60 months [Figure 1]. Median overall survival was 51 months (IQR: 19.0–99.0 months). All patients were primarily treated with curative intent.

Age had no significant impact on overall survival. Median survival of the patients was classified according to the following age groups: 70–74 years (34 patients, median survival: 37 months), 75–79 years (24 patients, median survival: 54 months), 80–84 years (10 patients, median survival: 51 months), and 85 years and more (3 patients, median survival: 24 months).

During follow-up, 17 (23.9%) of the 71 patients developed tumour recurrence (median after 12 months, IQR: 10.0–21.5 months). 13 patients showed metastatic spread during follow-up (median after 11 months, IQR: 9–20). Median relapse-free survival was 25 months (IQR: 12–57 months), median local-relapse-free survival 25 months (IQR: 15–65 months) and median metastasis-free survival 26 months (IQR: 14–65 months).

Median overall survival for patients with tumour recurrence (local relapse or metastatic spread) during follow-up was 21 months (IQR: 18–54 months). Median survival of patients without relapse was 65 months (IQR: 23–120 months) and thus significantly longer than for patients with tumour recurrence (log rank-test:  $p = 0.001$ ).

Local tumour was 99% after 12 months, 88% after 24 months and 76% after 60 months. 13 of the 71 patients had local tumour recurrence (median after 25 months (IQR: 15.0–65.0). [Figure 2]

A subgroup analysis showed a median overall survival rate of 24 months during follow-up for both patients with local relapse (IQR: 18–54 months) as well as for patients with metastatic spread (IQR: 14–25 months). According to the log rank-test for both subgroups this result is significant in comparison to the remaining patients (local relapse:  $p = 0.039$ ; metastatic spread:  $p = 0.002$ ).

## Univariate And Multivariate Analysis

In view of the overall survival rate, these results were significant with regard to the KPS. First, patients with a KPS of 60% or less before, during or after radiotherapy had significantly worse overall survival ( $p = 0.019$ ) than patients with a KPS of 70–100%. This fact was confirmed in the univariate analysis of KPS after radiotherapy, in which especially a KPS of 50% or less was associated with significantly worse overall survival (KPS 30%:  $p = 0.000$ , KPS 40%:  $p = 0.000$ , KPS 50%:  $p = 0.001$ ). Furthermore, univariate analysis yielded a significantly worse overall survival rate during follow-up for patients with tumour

recurrence (local recurrence or metastatic spread) ( $p = 0.002$ ) and for patients with metastatic spread ( $p = 0.001$ ).

Univariate evaluation showed a trend towards an association between dysphagia after radiotherapy, especially dysphagia CTC grade III 6 months after the end of radiotherapy ( $p = 0.071$ ), and slightly worse overall survival. A tendency was also apparent for an association of low haemoglobin values (anaemia CTC III or higher) before radiotherapy ( $p = 0.067$ ), tumour recurrence at the beginning of radiotherapy ( $p = 0.101$ ) and an increased UICC-status (UICC IVb:  $p = 0.084$ ) with worse overall survival.

Multivariate analysis yielded a significant association of tumour recurrence (local recurrence or metastatic spread) during follow-up ( $p = 0.02$ ) and dysphagia CTC grade III 6 months after the end of radiotherapy ( $p = 0.036$ ) with overall survival.

## **Conclusion:**

Malignancies of the head and neck area are among the most frequent malignant tumours, but elderly patients have been underrepresented in scientific surveys so far. The aim of the present examination was to evaluate the feasibility and results of radiotherapy or chemoradiation in patients aged  $> 70$  years with head and neck tumours.

The feasibility of radiotherapy and chemoradiation in our collective of elderly patients was good. Especially local tumour control was satisfactory.

Careful patient selection regarding comorbidities and the Karnofsky performance status is essential. But continuous progress in radiation techniques over the past few years has significantly reduced the frequency of toxicities. The factor age does not seem to influence overall survival because there was no obvious difference between elderly patients and younger or unselected patients.

Our results suggest that de-intensification of treatment just because of age has to be reconsidered critically.

Further research is needed to better assess cancer therapy, particularly in elderly and frail patients.

## **Discussion:**

In this survey, we consciously decided to focus on elderly patients aged  $> 70$  years with head and neck cancer who had been treated with radiotherapy or chemoradiation at the University Medical Centre Regensburg. Our aim was to investigate this heterogenous patient collective under therapy to analyse how these patients tolerated treatment and how to deal with the demands and challenges of real world data. Many other studies have focused on pre-selected patient collectives. Such (pre-)selection of patients may falsify the results of surveys and overlook the special requirements in treating elderly or frail patients, which is one reason for the lack of sufficient data on such patients.

For elderly patients with head and neck tumours radiotherapy and chemoradiation represent important and effective treatment options (National Comprehensive Cancer Network 2020). Elderly patients should not be deprived of radiotherapy or chemoradiation just because of their age (Metges et al. 2000; Kunkler et al. 2014; Wasil et al. 2000). We underline this assumption because of the good feasibility of radiotherapy and chemoradiation in our patient collective.

However, it is necessary to take a closer look at the collective of elderly patients with SCCHN.

Comparison of subgroups is difficult, because postoperative patients with intermediate risk tumours usually only receive radiotherapy (National Comprehensive Cancer Network 2020). Nearly all high-risk patients in our collective would have received simultaneous chemoradiation if they had been younger. In reality only fit patients in our collective received simultaneous chemoradiation pursuant to present guidelines, since some elderly and frail patients were not intended to be able to tolerate simultaneous chemotherapy according to the data of "Meta-analysis of chemotherapy in head and neck cancer (MACH-NC)". (Blanchard et al. 2016). In accordance to the data of the MACH-NC meta-analysis elderly patients in our collective who had risk factors (ECS, more than 3 lymph nodes affected, less than 5 mm margin), comorbidities or a low Karnofsky performance status received radiotherapy alone although -according to oncological guidelines - simultaneous chemoradiation should also be conducted – at least theoretically. (Blanchard et al. 2016; National Comprehensive Cancer Network 2020). However, some of the elderly patients with risk factors in our collective received simultaneous chemoradiation because of their good general condition and their high Karnofsky performance status, although the data of the MACH-NC meta-analysis recommend radiotherapy alone for this group of patients aged > 70 years of age. The patients' general condition was classified in accordance to the Karnofsky performance status and comorbidities. Thus therapeutic decisions had to be made individually for each patient.

As already mentioned feasibility of radiotherapy and chemoradiation in our collective was good, consequently treatment had only to be interrupted for 2 or more days in 9 (12.7%) patients. Reasons for the interruption of radiotherapy were mostly acute toxicity or other medical complications such as infections. Some interruptions were due to patient incompliance or organisational problems. 65 patients were able to complete radiotherapy with 95% of the initially prescribed radiation dose (91.5%). 4 patients (5.6%) received less than 80% of the prescribed dose due to the premature termination of 1 of these 4 patients died of respiratory insufficiency because of pulmonary metastases newly developed under radiotherapy (16 Gy). Another patient died of cardiovascular disease under chemoradiation (16.2 Gy and less than 25% of the prescribed chemotherapeutic dose). 2 of the 4 patients terminated radiotherapy at their own request.

Elderly patients are often deprived of radiotherapy or chemoradiation only because of their age. Metges et al. observed that elderly patients were frequently treated less aggressively because of their assumed limited life expectancy. Physicians automatically presume that the treatment procedure would impair quality of life. In their survey Metges et al. did not find any difference in treatment response among the various age groups (Metges et al. 2000).

We also cannot confirm the hypothesis that elderly patients generally have a worse prognosis than collectives of younger patients or patients of different age groups. Data on elderly patient collectives are generally still insufficient (Wasil et al. 2000).

Our patients treated with simultaneous chemoradiation generally had worse outcome than the patients only treated with radiotherapy. Median survival of patients undergoing simultaneous chemotherapy was 21 months. Patients without simultaneous chemotherapy had a median survival rate of 51 months. In the log rank-test this result was not significant ( $p = 0.219$ ). This result is due to the fact that patients who qualify for simultaneous chemotherapy have a poor prognosis and considerable risk factors (ECS, more than 3 lymph nodes affected, less than 5 mm margin). The majority of our patients had locally advanced tumour (UICC stadium IVa), hence the poor overall survival rate was not surprising.

For these reasons, comparison of these patient groups is difficult. On the one hand, simultaneous chemotherapy and radiotherapy is more effective (Forastiere et al. 2013) (Bourhis et al. 2012) (Adelstein et al. 2003).

On the other hand, only patients with risk factors qualify for simultaneous chemotherapy. Thus, patients with risk factors are faced with poor prognosis. Furthermore, not all patients in this survey who qualified for chemotherapy also received chemotherapy, often because of comorbidities or severe secondary diagnoses.

Our univariate and multivariate analysis (COX regression) resulted in a significant value for dysphagia, particularly after 6 months. This value seems to be an important parameter for overall survival because of the following underlying factors: A limitation caused by the tumour itself could (already) exist at the beginning of therapy. Furthermore, dysphagia could be related to therapy. Consequently, appropriate nutrition may prevent patients from losing weight or from significant deterioration of the general condition. Dysphagia and limitation of swallowing are very complex clinical pathologies. Moreover, detection of dysphagia may be difficult in small patient collectives. Because patients often develop aspiration pneumonia, good phoniatric and logopaedic accessibility is essential (Patterson 2019) (Pedersen et al. 2016) (Brodsky et al. 2016 Jul) (Hey et al. 2013). For this reason, treatment in specialised centres is desirable. Patients in this survey were treated at the University Medical Centre Regensburg for the entire duration of therapy.

In our collective, patients with poor prognosis and a low KPS usually had worse overall survival. Our univariate analysis showed significant results for overall survival for patients with a KPS of 60% or less before, during or after radiotherapy and tumour recurrence (local recurrence or metastatic spread) or metastatic spread during follow-up.

The subgroup analysis yielded a median overall survival rate of 24 months for patients with local tumour recurrence (IQR: 18–54 months) or metastatic spread (IQR: 14–25 months) during follow-up. The log rank-test of both subgroups yielded significant results (local relapse:  $p = 0.039$ ; metastatic spread:  $p =$

0.002). Consequently, prognosis is determined, inter alia, by tumour recurrence, which emphasizes the importance of local control.

Patients without relapse showed a median survival rate of 65 months (IQR: 23–120 months) and thus lived significantly longer than patients with tumour recurrence (log rank-test:  $p = 0.001$ ). Only 13 out of the 71 patients were affected by local tumour recurrence. Overall, local tumour control in this survey was good (99% after 12 months, 88% after 24 months and 76% after 60 months).

Furthermore, our univariate evaluation showed a trend towards an association of dysphagia after radiotherapy, especially dysphagia CTC grade III 6 months after the end of radiotherapy, a low haemoglobin value (anaemia CTC III or higher) before radiotherapy ( $p = 0.067$ ), tumour recurrence at the beginning of radiotherapy and an increased UICC-status with poor overall survival. The haemoglobin value is also known as a negative predictive marker in unselected non-elderly patients (Dietl et al. 2005).

The purpose of this survey was to evaluate the treatment feasibility of radiotherapy or chemoradiation in an unselected patient collective. To assess the reality and authenticity of the treatment of elderly patients as closely as possible, we decided to include the patients in the described unselected manner. Consequently conclusions could be drawn with regard to feasibility and toleration of radiotherapy and chemoradiation.

The feasibility of radiotherapy and chemoradiation in our collective of elderly patients was good. We focused on the question of how patients aged > 70 years and particularly frail patients may tolerate cancer therapy. Our patients were retrospectively classified according to the Karnofsky Performance Index. The results of this survey imply that elderly (and frail) patients benefit from radiotherapy and chemoradiation just like any other patients with head and neck cancer. The benefits have also been proven in other studies (Metges et al. 2000) (Wasil et al. 2000; Kunkler et al. 2014). Straube and Pigorsch et al. also described the good results of radiotherapy in elderly and frail patients (Straube et al. 2016). However, their patient collective was smaller than ours. The implementation of intensity-modulated radiation and the subsequent dose reduction and thus protection of organs at risk has increased the compatibility of radiotherapy in the head and neck area (Kunkler et al. 2014).

Our patient collective was larger and less heterogenous than those in other surveys. Each of our patients received adjuvant radiotherapy or chemoradiation, and our patient collective is representative because it resembles clinical reality.

Chemoradiation was not significantly less well tolerated by our elderly patients than by younger patients, and this result has been confirmed in other surveys (Giovanazzi-Bannon et al. 1994; Lichtman et al. 2007; Newcomb und Carbone 1993).

Nevertheless, careful patient selection regarding comorbidities and the Karnofsky performance status is necessary (Sanabria et al. 2007). Our next prospective studies on radiotherapy and chemoradiation of elderly patients with head and neck cancer will particularly focus on frail patients.

# Declarations

## **-Ethics approval and consent to participate**

The study adhered to the Declaration of Helsinki and was approved by the Ethics Committee of the University of Regensburg.

## **-Consent for publication**

Not applicable

## **-Availability of data and material**

The datasets generated and analysed during the current study are not publicly available due to data protection regulations for the personal and confidential patient data but are available anonymised from the corresponding author on reasonable request.

## **-Competing interests**

The authors declare that they have no competing interests.

## **-Funding**

None

## **-Authors' contributions**

All authors read and approved the final manuscript. C.S., M.G.H, O.K., M.H. and A.R. developed the protocol and contributed to the study design. C.S. and M.G.H. contributed to manuscript's writing and statistical analysis. All authors participated in data collection, C.S., A.R., M.H., M.G.H, F.S. and O.K. in patient recruitment respectively treatment and R.K. as well as K.E. in histopathological examination.

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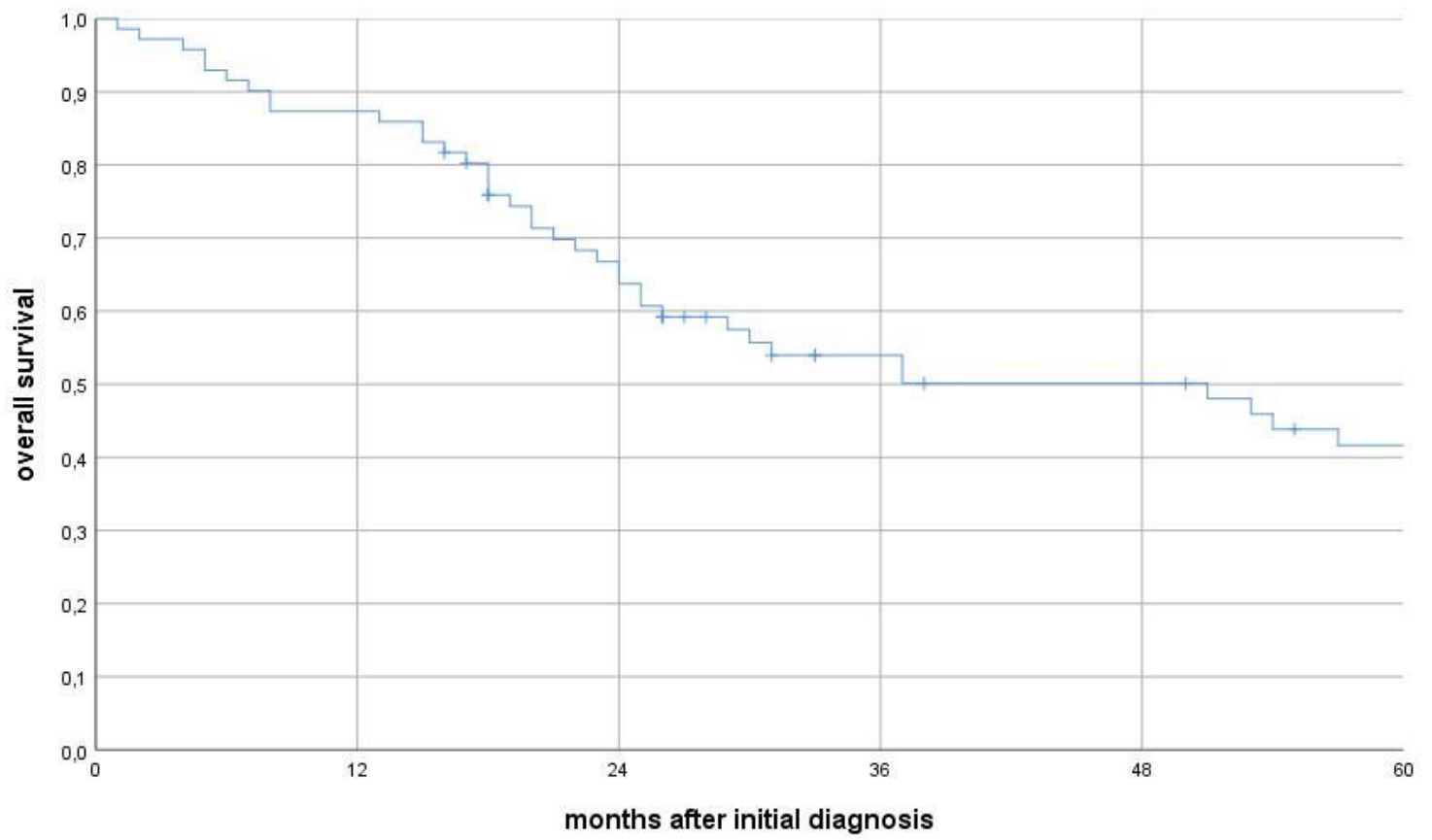


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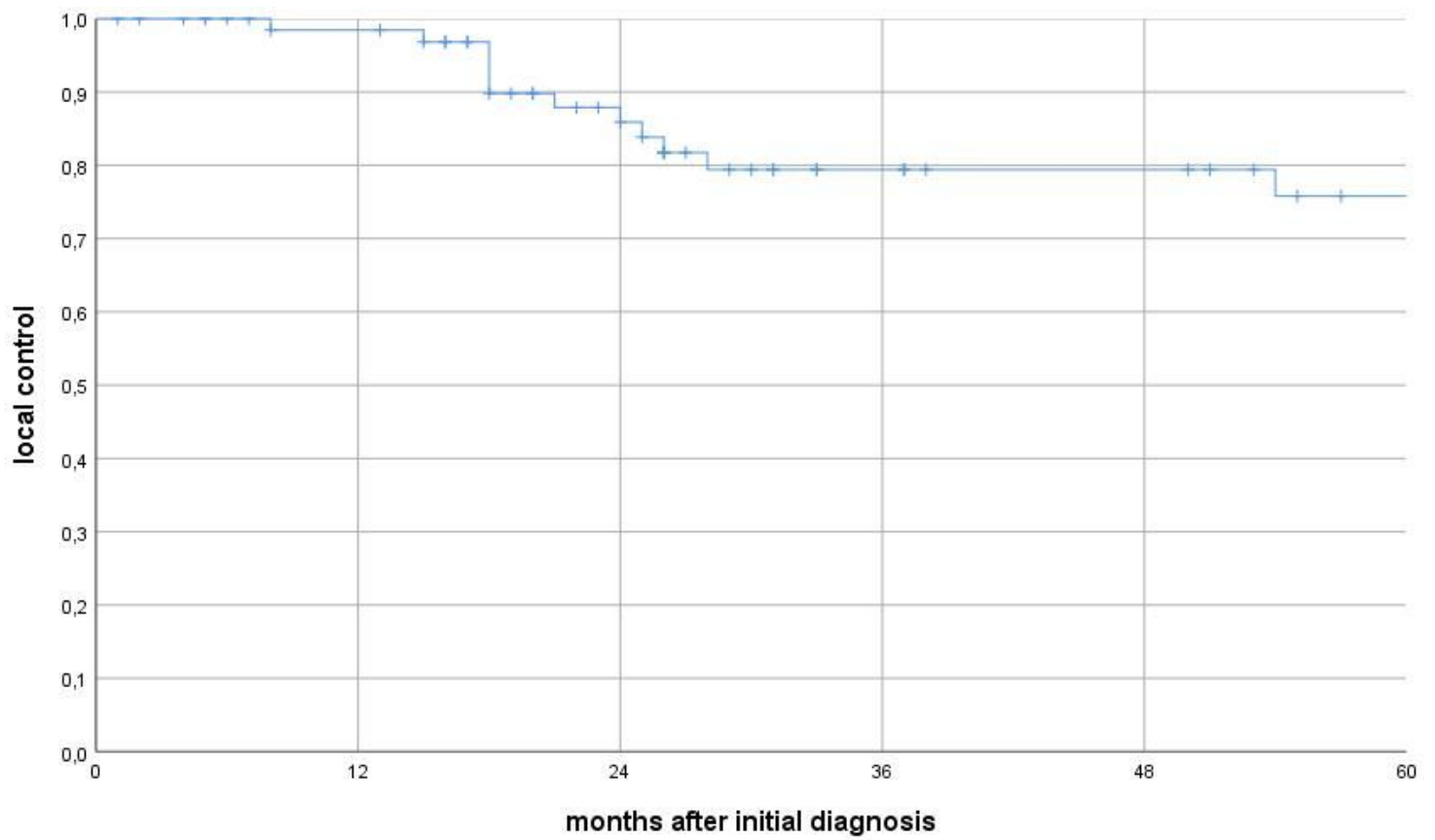
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## Figures



**Figure 1**

Overall survival of the whole sample



**Figure 2**

Local tumour control after adjuvant radiotherapy / chemoradiation