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Nasal packing does not affect the dosimetry of sinonasal cancers treated with intensity-modulated radiotherapy or volumetric-modulated arc therapy

Abstract

Introduction: To investigate the impact of nasal packing on radiotherapy dosimetry for nasal and paranasal sinus cancers treated with intensity modulate radiotherapy (IMRT) or volumetric modulated arc therapy (VMAT) technique.

Methods: A prospective database identified all patients with primary nasal and paranasal sinus cancers treated with adjuvant radiotherapy. All patients were simulated using CT scanning with packing in the nasal cavity. For this study the nasal packing was contoured and assigned an electron density equivalent to air. The dose to the pre-operative gross tumour volume (GTV), planned tumour volume (PTV) and organs-at-risk (OAR) were re-calculated and compared to those with nasal packing, using both the Pinnacle (Collapsing Cone Convolution) and Monaco (Monte Carlo) planning systems.

Results: 24 patients were identified, predominantly ethmoid (14) or maxillary (4) primaries. The predominant histology was SCC (12/24). The majority (22/24) were treated with curative intent. Using Collapsing Cone Convolution calculation, the median [range] coverage of 95% of prescribed dose to high-dose PTV (95.5% [92.2-98.5%] vs 95.2% [92.1-98.5%]; packing vs no packing, P=1.00) and low-dose PTV (95.8% [90.0-99.4%] vs 95.9% [91.1-99.7%]; packing vs no packing, P=1.00) were not impacted by packing the nasal cavity. There was also no impact by no packing on the maximal dose to the brainstem, optic nerves, optic chiasm nor lens.

Conclusions: Packing of nasal cavity does not change the dose to the PTVs or critical OARs in patients with nasal and paranasal sinus cancers treated with adjuvant IMRT or VMAT radiotherapy and can be safely omitted.

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Abbreviations: OAR; organs at risk, PTV; planned target volume, IMRT; intensity modulated radiotherapy, VMAT; volumetric modulated arc therapy

Introduction

Intensity modulated radiotherapy (IMRT) has been one of the major technological advances in our field in recent times. It has facilitated fewer late treatment toxicities in our patients[1] and improved local control and disease specific survival in diseases such as nasopharyngeal carcinoma.[2,3] IMRT has also impacted on fractionation schedules, with less common use of hyperfractionated radiotherapy regimens[4] and near universal use of the simultaneous integrated boost (SIB) regimen.

Another pre-IMRT standard practice that has come into question is that of routine packing of the nasal cavity for nasal cavity cancers and paranasal sinus cancers. Historically this has been standard recommendation within our radiation oncology head and neck teaching, in order to reduce the air cavity and improve dosimetry.[5] However, it is time consuming for treatment staff to complete on a daily basis over 6 weeks, it is uncomfortable for the patient, and the reproducibility is questionable.

In order to change clinical practice, one needs data. A literature search revealed no published clinical data regarding the safety or otherwise of omitting nasal packing for patients undergoing adjuvant therapy for cancers of the nasal and paranasal sinuses.

The primary aim of this study was to review the impact of nasal packing on the radiotherapy dosimetry in all patients with nasal and paranasal sinus cancers treated with adjuvant radiotherapy. The secondary aim was to document the clinical outcomes of this patient cohort.

Methods

Patients

This is a retrospective dosimetry study. Patients were identified from a prospective database and included all consecutive patients treated at GenesisCare, St Vincent Hospital Melbourne from August 2016 to June 2020 who received adjuvant radiotherapy for a primary malignancy of the nasal cavity or paranasal sinuses. All patients were discussed at the multidisciplinary tumour board, and all had magnetic resonance imaging (MRI) and positron emission tomography computerised tomography (PET/CT) included in their staging investigations. Post treatment follow-up was performed 3 monthly for the first 2 years, 4 monthly for the third year, then 6 monthly until 5 years. The study was approved by institutional ethics board.

Radiotherapy Technique

Patients were simulated in a supine position and thermoplastic mask to immobilize the head, neck and shoulders. The nasal cavity was packed with Vasgauze. Patients were simulated with 2mm CT scan slices. An oral spacer was used in all patients to separate the oral tongue from the hard palate. The pre-surgical imaging was fused with the planning CT scan and the presurgical gross tumour volume (GTV) and high, intermediate, and low dose planning target volumes delineated. All the patients were planned and treated with intensity modulated radiotherapy (IMRT) or volumetric modulated arc therapy (VMAT) technique with prescription point to cover the 98% of the planning target volume (PTV) (i.e., D98). The dose constraints to the

organs at risk (OAR) were standardized as per institutional policy. All patients were treated with nasal cavity packing in-situ. These plans were generated on v.9.8.0.6 of the Pinnacle (Philips WI, USA) treatment planning system. They were optimised as per departmental protocol and calculated using the planning system's Collapsed Cone Convolution algorithm. For the post-hoc analysis, the Vasgauze packings were delineated on the planning CT dataset, and then their electron density was assigned to be equivalent to that of air in the planning system. A new plan was generated and optimized for dosimetry comparison (i.e., non-packing of nasal cavity). Further, both plans (packing and no packing) were exported from Pinnacle to the Monaco (Elekta, Stockholm, Sweden) treatment planning system v. 6.00.01 and re-calculated using the Monte Carlo algorithm. It was thought that re-calculating with the Monte Carlo algorithm would give us a more accurate representation of what was happening dosimetrically in the air cavities as the limitations of the Collapsed Cone Convolution algorithm in the presence of inhomogeneities are well established.

Data-analysis

We compared 100% prescribed dose and mean dose to the pre-operative GTV, 98% prescribed dose and 95% prescribed dose coverage of the high dose level PTV (i.e., PTVHD98% and PTVHD95%) and the 95% prescribed dose coverage of the low dose level PTV (i.e., PTVLD95%). The maximal dose to the brainstem, optic nerve, optic chiasm, and lens were used to compare the dose to the OARs. For the Monaco calculations the maximum dose reported is actually the dose to 0.035cm of the OAR due to the problems associated with reporting point doses from a Monte Carlo calculation because of statistical noise.

We also reviewed the clinical outcomes in terms of overall survival (calculated from the date of the last day of radiotherapy to the date of last contact or death) and major (Grade 3-5) treatment related side-effects.

Statistical Analysis

Baseline characteristics were summarised using descriptive statistics including counts and frequencies for categorical variables and mean, standard error of mean (S.E.M.), median and range for continuous variables. It is reported that the variation of dose coverage is minimal in head and neck cancer radiotherapy planning.[6] Therefore, Steel-Dwass test for non-parametric paired data was used to analyse the comparative results. $P<0.05$ was considered significant. Statistical analyses were performed using JMP software (version 14.0, 2018, SAS Institute Inc, Cary, NC).

Results

Patient characteristics

There were 24 patients identified. Patient's clinical characteristics are summarized in Table 1. The majority of the patients had primary cancer arising from the ethmoid sinus (n=14). Most of the patients (21/24) had locally advanced disease (i.e., T3 or T4). Only one patient presented with nodal disease (T4N2bM0 squamous cell carcinoma of maxilla). Histology in the majority of patients was either squamous cell carcinoma (SCC) or adenocarcinoma (17/24,71%). There was a variety of other histologies as denoted in Table 1. The recommended treatment of the multidisciplinary tumour board was received in all patients. Sixteen patients received adjuvant radiotherapy and a further 8 received concurrent chemoradiotherapy. Of these 8 patients, 6 received weekly cisplatin (SCC=5, esthesioneuroblastoma=1) and 2 received weekly carboplatin and etoposide (neuroendocrine/small cell carcinoma).

Nearly all the patients (n=22) were treated with 60Gy or higher in 2Gy per fraction daily. One patient with a very large T4 glomangiopericytoma was treated as an in-patient with 2 fractions of 1.8Gy per day to a total dose 50.4Gy in 30 fractions. One patient had additional medical co-morbidities and received moderately hypofractionated (2.5Gy per fraction) radiotherapy to a total dose of 50Gy. All patients completed the prescribed course of treatment. One patient (pT4N2bM0 SCC maxilla) developed progressive disease in week 1 of radiotherapy and was replanned with an increase in RT dose (66Gy but in 2.25Gy per fraction) and intensification of weekly cisplatin to high dose cisplatin for the remaining weeks of RT.

Target coverage

Using Collapsing Cone Convolution calculation, there was no difference of median coverage to the high-dose level PTV (PTVHD98% median [range]: 93.0% [88.8-97.8%] vs. 92.4% [88.8-97.7%]; packing vs. no packing, P=1.0; PTVHD95%: 95.5% [92.2-98.5%] vs. 95.2% [92.1-98.5%]; packing vs. no packing, P=1.0) or low-dose level PTV (PTVLD95%: 95.8% [90.0-99.4%] vs. 95.9% [91.1-99.7%]; packing vs. no packing, P=1.0, Figure 1). There was no difference of median mean dose to the pre-operative GTV (GTV median [range]: 60.6Gy [49.9-67.0] vs. 60.8Gy [49.9-67.1]; packing vs. no packing, P=1.0; or 100% prescribed dose coverage (GTV D100%: 92.0% [3.0-97.1%] vs. 90.8% [0-98.6%]; packing versus no packing, P=1.0). There was no statistical difference of median of PTVHD98%, PTVHD95% and PTVLD95% in the sub-site analysis (ethmoid sinus [n=14], maxillary sinus [n=4] and nasal cavity [n=6]; Table 2; Figure 1). Similar results were found when using Monte Carlo calculation (Supplement Table 1).

Dose to Organs at Risk (OAR)

Using Collapsing Cone Convolution calculation, there was no impact of the maximal dose to the brainstem (44.2±2.6 vs 43.8±2.7Gy, mean ± S.E.M.; packing vs. no packing), optic nerve (Left: 51.1±1.8 vs. 51.2±1.8Gy; Right: 52.8±1.5 vs. 53.2±1.3Gy), optic chiasm (52.3±1.1 vs. 52.4±1.1Gy) and lens (Left: 9.2±0.7 vs. 9.2±0.7Gy; Right: 10.1±1.6 vs. 10.2±1.6Gy, Table 3). Similar results were found when using Monte Carlo calculation (Supplement Table 2).

Clinical outcomes

One patient was lost to follow-up, the median follow-up for the remaining 23 patients was 24.5 months, range 2 to 53 months. The overall survival for the whole cohort was 72.8% at 2-years and 66.2% at 3-years (Figure 2A). For the patients with either SCC or adenocarcinoma treated with 60Gy or more (n=16), their overall survival was 73.7% at 2-years and 64.5% at 3-years (Figure 2B). In this group of patients 11 are alive with no evidence of disease, 3 died of disease (all local recurrences), 1 died with no evidence of disease and 1 is alive with local recurrence. There was only one patient who post completion of treatment developed nodal recurrence. This patient had a pT4N0M0 SCC nasal cavity and re-presented with a parotid nodal mass 8 weeks post completion of treatment. He had surgery and post operative radiotherapy and remains alive with no evidence of disease.

Regarding CTCAE Grade 3 or 4, there was only one Grade 3 radiotherapy toxicity – symptomatic frontal lobe necrosis that responded well to dexamethasone. This 77-year-old man with a pT4N0M0 nasal adenocarcinoma was prescribed 60Gy, the maximal point dose to the frontal lobe was 63.7Gy. There were 2 cases of nasal adhesions and 1 patient who required surgery for a stenosed nasolacrimal duct.

Table 1 Patient and tumor characteristics

Variable	Level	Result (n=24)
Gender	Female	7 (29.2%)
	Male	17 (70.8%)
Age	Mean (SD)	65 (15)
	Median [range]	69 [34 - 87]
Subsite	Ethmoid	14 (58.3%)
	Maxilla	4 (16.7%)
	Nasal cavity	6 (25.0%)
Histology	Squamous cell carcinoma	12 (50.0%)
	Adenocarcinoma	5 (20.8%)
	Esthesioneuroblastoma	2 (8.3%)
	Neuroendocrine carcinoma	2 (8.3%)
	Glomangiopericytoma	1 (4.2%)
	Mucosal melanoma	1 (4.2%)
	Sarcoma	1 (4.2%)
T Classification	1*	1 (4.2%)
	2	2 (8.3%)
	3	4 (16.7%)
	4	17 (70.8%)
N Classification	0	23 (95.8%)
	2b	1 (4.2%)
Radiotherapy technique	IMRT	8 (33.3%)
	VMAT	16 (66.7%)
Concurrent chemotherapy	No	16 (66.7%)
	Yes	8 (33.3%)
	Weekly cisplatin 40mg/m^2	6
	Carboplatin/Etoposide	2
EQD2 (Gy)	66 (66Gy/33f, 1 fraction/day)	9 (37.5%)
	64 (64Gy/32f, 1 fraction/day)	2 (8.3%)
	60 (60Gy/30f, 1 fraction/day)	11 (45.8%)
	50.4 (50.4Gy/30f, 2 fractions/day) Ω	1 (4.2%)
	52.08 (50Gy/20f, 1 fraction/day)	1 (4.2%)

* Sarcoma

Ω patient with glomangiopericytoma, treated as inpatient

Table 2 100% prescribed dose to the pre-operative GTV (GTV D100%), 98% coverage of high dose PTV (PTVHD98%), 95% coverage of high dose PTV (PTVHD95%) and 95% coverage of low dose PTV (PTVLD95%) using Collapsing Cone Convolution algorithm

		Packing (%, median [range])	No packing (%, median [range])	n
All	GTV D100%	92.0 (3.0-97.1)	90.8 (0-98.6)	24
	PTVHD98%	93.0 (88.8 – 97.8)	92.4 (88.8 – 97.7)	24
	PTVHD95%	95.5 (92.2 – 98.5)	95.2 (92.1 – 98.5)	24
	PTVLD95%	95.8 (90 – 99.4)	95.9 (91.1 – 99.7)	22
Ethmoid	GTV D100%	91.4 (73.0 – 95.6)	91.4 (3.5 – 98.6)	14
	PTVHD98%	92.9 (89.2 – 97.8)	92.4 (89.0 – 97.7)	14
	PTVHD95%	95.4 (92.2 – 98.5)	95.1 (92.1 – 98.5)	14
	PTVLD95%	95.9 (90.0 – 99.4)	95.9 (91.5 – 99.7)	13
Maxillary	GTV D100%	49.9 (3.0 – 94.5)	49.9 (0.0 – 94.5)	4
	PTVHD98%	95.3 (89.9 – 96.1)	94.5 (90.7 – 95.4)	4
	PTVHD95%	96.6 (93.7 – 97.8)	96.5 (93.5 – 97.4)	4
	PTVLD95%	97.7 (96.1 – 98.7)	97.6 (96.1 – 98.1)	4
Nasal	GTV 100%	91.1 (84.2 – 97.0)	90.5 (84.2 – 97.4)	6
	PTVHD98%	92.5 (88.8 – 94.9)	91.2 (88.8 – 95.8)	6
	PTVHD95%	95.5 (94.3 – 97.6)	94.9 (94.3 – 97.5)	6
	PTVLD95%	95.4 (91.4 – 95.7)	95.4 (91.1 – 95.9)	5

Citation: Paula F, June C, Sweet PN, et al. Nasal packing does not affect the dosimetry of sinonasal cancers treated with intensity-modulated radiotherapy or volumetric-modulated arc therapy. *Int J Radiol Radiat Ther.* 2023;10(2):32–38. DOI: 10.15406/ijrrt.2023.10.00351

Table 3 Max dose to the organ at risk (OAR) using Collapsing Cone Convolution algorithm

	OAR	Packing (Gy, mean ± SEM)	No packing (Gy, mean ± SEM)	n	*P*
All	Brain stem	44.2±2.6	43.8±2.7	24	NS
	Left optic nerve	51.1±1.8	51.2±1.8	20	NS
	Right optic nerve	52.8±1.5	53.2±1.3	21	NS
	Optic chiasm	52.3±1.1	52.4±1.1	23	NS
	Left lens	9.2±0.7	9.2±0.7	20	NS
	Right Lens	10.1±1.6	10.2±1.6	21	NS
Ethmoid	Brain stem	43.1±3.4	42.8±3.4	14	NS
	Left optic nerve	54.1±0.8	54.0±0.8	13	NS
	Right optic nerve	53.9±1.0	53.9±1.0	12	NS
	Optic chiasm	53.4±0.9	53.4±0.9	13	NS
	Left lens	9.8±0.9	9.7±0.9	13	NS
	Right Lens	8.7±0.8	8.7±0.9	12	NS
Maxilla	Brain stem	43.2±7.7	41.9±7.6	4	NS
	Left optic nerve	39.0±9.6	39.1±9.6	3	NS
	Right optic nerve	46.1±8.1	48.8±7.4	3	NS
	Optic chiasm	51.2±1.6	51.5±1.6	4	NS
	Left lens	6.3±1.4	6.4±1.4	3	NS
	Right Lens	17.8±10.9	18.5±10.5	3	NS
Nose	Brain stem	47.3±5.7	47.4±5.7	6	NS
	Left optic nerve	50.8±1.1	51.0±1.1	4	NS
	Right optic nerve	53.9±2.7	54.0±2.7	6	NS
	Optic chiasm	50.8±4.0	50.9±4.0	6	NS
	Left lens	9.3±0.8	9.5±0.8	4	NS
	Right Lens	9.0±1.4	9.2±1.5	6	NS

Supplementary Table 1 Monaco Calculation of 100% prescribed dose to the pre-operative GTV (GTV D100%), 98% coverage of high dose PTV (PTVHD98%), 95% coverage of high dose PTV (PTVHD95%) and 95% coverage of low dose PTV (PTVLD95%) using Monte Carlo algorithm.

		Packing (%, median [range])	No packing (%, median [range])	n
All	GTV D100%	84.5 (18.1 – 93.0)	84.8 (18.1 – 93.7)	24
	PTVHD98%	88.9 (82.6 – 95.7)	88.8 (82.0 – 95.74)	24
	PTVHD95%	92.0 (88.0 – 96.8)	91.9 (87.3 – 96.8)	24
	PTVLD95%	93.1 (89.8 – 97.2)	93.4 (89.7 – 97.2)	22
Ethmoid	GTV D100%	91.4 (73.0 – 95.6)	91.4 (3.5 – 98.6)	14
	PTVHD98%	89.2 (86.4 – 95.7)	88.9 (86.2 – 95.7)	14
	PTVHD95%	92.0 (89.0 – 96.8)	91.1 (89.0 – 96.8)	14
	PTVLD95%	94.7 (89.8 – 96.5)	94.8 (89.7 – 96.5)	13
Maxillary	GTV D100%	49.9 (3.0 – 94.5)	49.8 (0.0 – 94.5)	4
	PTVHD98%	90.1 (86.9 – 92.5)	89.9 (86.9 – 92.2)	4
	PTVHD95%	92.4 (90.7 – 95.9)	92.3 (90.7 – 95.8)	4
	PTVLD95%	92.9 (92.4 – 97.2)	93.4 (92.4 – 97.2)	4
Nasal	GTV D100%	85.2 (81.0 – 93.0)	85.9 (80.0 – 93.7)	6
	PTVHD98%	87.6 (82.6 – 92.5)	87.6 (82.0 – 92.5)	6
	PTVHD95%	90.9 (88.0 – 94.5)	90.9 (87.3 – 94.5)	6
	PTVLD95%	92.5 (91.2 – 94.0)	92.4 (91.1 – 93.8)	5

Supplementary Table 2 Monaco calculations of max dose to the organ at risk (OAR) using Monte Carlo algorithm

	OAR	Packing (Gy, mean ± SEM)	No packing (Gy, mean ± SEM)	n	*P*
All	Brain stem	41.0±2.6	41.0±2.6	24	NS
	Left optic nerve	49.1±1.7	49.1±1.7	20	NS
	Right optic nerve	51.1±1.4	51.1±1.4	21	NS
	Optic chiasm	49.5±1.2	49.4±1.2	23	NS
	Left lens	8.2±0.5	8.1±0.5	20	NS
	Right Lens	9.0±1.3	9.0±1.4	21	NS

Citation: Paula F, June C, Sweet PN, et al. Nasal packing does not affect the dosimetry of sinonasal cancers treated with intensity-modulated radiotherapy or volumetric-modulated arc therapy. *Int J Radiol Radiat Ther.* 2023;10(2):32–38. DOI: 10.15406/ijrrt.2023.10.00351

Supplement Table 2 Continued...

	OAR	Packing (Gy, mean ± SEM)	No packing (Gy, mean ± SEM)	n	*P*
Ethmoid	Brain stem	39.8±3.4	39.9±3.4	14	NS
	Left optic nerve	52.0±0.9	52.0±0.9	13	NS
	Right optic nerve	52.2±1.0	52.2±1.0	12	NS
	Optic chiasm	50.1±1.2	50.1±1.2	13	NS
	Left lens	8.4±0.7	8.3±0.7	13	NS
	Right Lens	7.6±0.6	7.5±06	12	NS
Maxilla	Brain stem	40.3±7.8	40.4±7.8	4	NS
	Left optic nerve	38.1±9.0	38.1±9.0	3	NS
	Right optic nerve	46.0±7.5	46.0±7.4	3	NS
	Optic chiasm	48.2±1.5	48.6±1.6	4	NS
	Left lens	6.8±0.7	6.6±0.7	3	NS
	Right Lens	16.2±8.9	16.4±8.9	3	NS
Nose	Brain stem	44.2±5.4	44.3±5.4	6	NS
	Left optic nerve	47.9±1.6	47.9±1.6	4	NS
	Right optic nerve	51.5±2.8	51.5±2.8	6	NS
	Optic chiasm	49.1±3.8	48.7±3.8	6	NS
	Left lens	8.6±1.0	8.6±1.0	4	NS
	Right Lens	8.2±1.4	8.1±1.4	6	NS

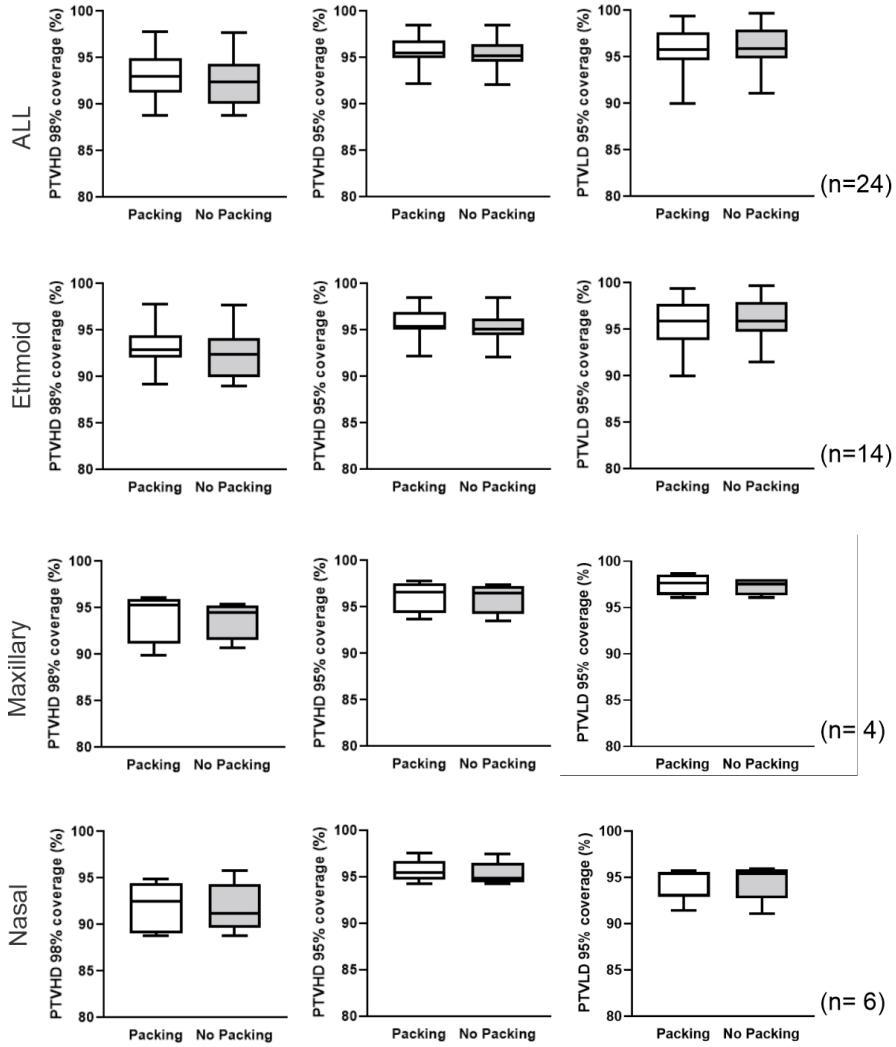
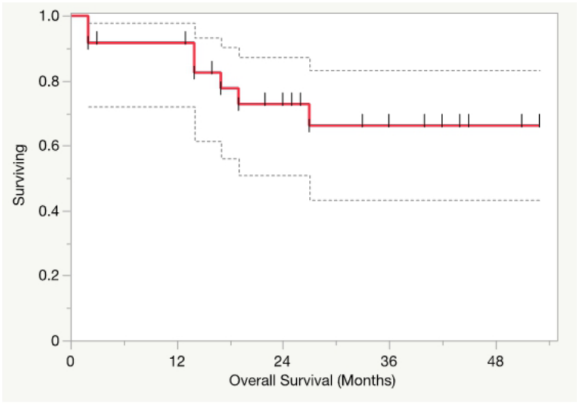


Figure 1 Boxplot of high does and low dose PTV coverage with and without nasal packing using Collapsing Cone Convolution algorithm. PTVHD98%, 98% coverage of high dose. PTV; PTVHD95%, 95% coverage of high dose PTV; PTVLD95%, 95% coverage of low dose PTV.

A) Kaplan-Meier curve of overall survival for the whole cohort (n=-24)



B) Kaplan-Meier curve of overall survival of patients with either SCC or adenocarcinoma treated with 60Gy or more (n=-16)

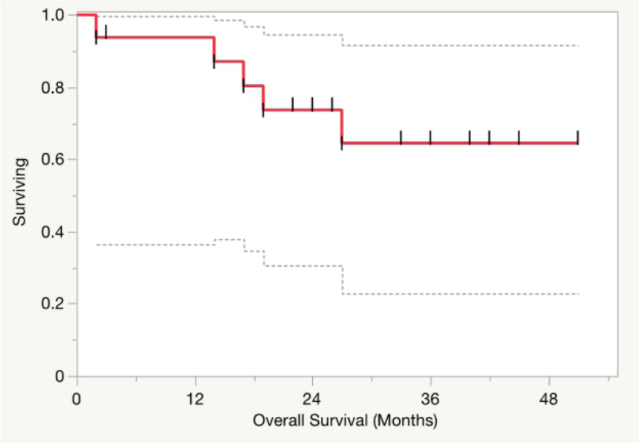


Figure 2 Overall survival: n=24; Overall survival for SCC / adenocarcinoma only: n=16.

Discussion

To our knowledge this is the first clinical cohort comparing dosimetry in patients with nasal and paranasal sinuses cancers with and without nasal packing. This study conclusively demonstrates that there is no benefit to the patient to undergo the daily discomfort of nasal packing as it doesn't generate superior dosimetry nor reduced dose to OARs. This also means that these patients treatment set-up time can be substantially reduced on a daily basis.

Prior teaching in the 2/3D RT era that nasal packing reduced the air spaces and improved deposition of dose to the remaining soft tissues of the nasal and paranasal tissues is not supported by our data using IMRT/VMAT. The only clinical scenario where nasal packing would still be recommended is when treating nasal skin with electrons and when treating nasal vestibule SCC.

The clinical outcomes of this patient cohort were comparable to those of other series.[7,8] In the entire cohort of mixed histologies the local failure rate was 4/24(17%). In the adenocarcinoma/SCC cohort the local failure rate was 4/16 (25%) and the nodal recurrence rate was only 1/24 (4%) for the entire cohort and 1/16 (6%) for the adenocarcinoma/SCC cohort. The incidence of nodal disease in our adenocarcinoma and SCC patient cohort was low, only 1/16 (6%) at presentation, and only 1 patient experienced nodal failure. This low incidence justifies no elective treatment of the N0 neck in our population.

Evolving clinical practice is informed by clinical research and there are many key randomised controlled trials in head and neck cancer that have changed clinical practice.[9]

Interestingly, we are perhaps not as diligent in obtaining data to justify ceasing a clinical practice, for example, the de-utilisation of hyperfractionation schedules or the practice of nasal packing. The meta-analyses of concurrent chemotherapy have firmly established its use in the definitive treatment of locally advanced head and neck cancer (HNC)[10], and as adjuvant treatment in high risk HNC patients treated surgically.[11] Less attention has been paid to the similar survival benefit generated by hyper-fractionated RT in the meta-analysis of altered fractionated RT[12]. One of the few down sides of IMRT and its variations has been the loss of hyperfractionation as a treatment regimen. The different doses per fraction in the published regimens means that two physics plans needed to be calculated and then summed. This was not as convenient as the simultaneous integrated boost regimen, which was also easier (and less toxic) to combine with concurrent chemotherapy.[13] Hence overall the relative benefit of hyperfractionation lost out in the complex field of HNC treatment regimens.

Similarly, the use of nasal packing as a RT planning standard has become more the exception than the rule due to the extra time required to perform it daily prior to each fraction, the discomfort to the patient and the clinical suspicion that packing the lower nasal cavity should really have minimal impact on air cavities in the ethmoid sinuses. In our study we found nasal packing had no impact on any subsite, ethmoid/maxilla or nasal, although the numbers of patients in the latter 2 subsites was small (4 and 6, respectively). Nevertheless, we found the data consistent in both the Pinnacle and Monaco planning systems, and sufficient to clinically justify omission of this practice.

Conclusion

Packing of the nasal cavity does not change the dose to the GTV, PTVs or critical OARs (i.e. optic nerve, optic chiasm, lens and brain stem) in patients with nasal and paranasal sinus cancers treated with adjuvant IMRT or VMAT radiotherapy and can be safely omitted.

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None.

Conflicts of interest

Authors declare that there is no conflicts of interest.

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