Scholars Journal of Medical Case Reports
Abbreviated Key Title: Sch J Med Case Rep
ISSN 2347-9507 (Print) | ISSN 2347-6559 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Radiotherapy

Definitive Volumetric Modulated Arc Therapy for Locally Advanced Grade 2 Sinonasal Chondrosarcoma Following Endoscopic Debulking Surgery: A Case Report and Literature Review

Sara Harbaj[1*], Rania Chakir[1], Amina Majdi[1], Boutaina Agdi[1], Amine Lachgar[1], Karima Nouni[1], Hanan El Kacemi[1], Tayeb Kebdani[1], Khalid Hassouni[1]

[1]Department of Radiotherapy, National Institute of Oncology, Faculty of Medicine and Pharmacy, University Mohammed V, Rabat, Morocco

DOI: https://doi.org/10.36347/sjmcr.2026.v14i07.001 | **Received:** 14.05.2026 | **Accepted:** 27.06.2026 | **Published:** 03.07.2026

***Corresponding author:** Sara Harbaj
Department of Radiotherapy, National Institute of Oncology, Faculty of Medicine and Pharmacy, University Mohammed V, Rabat, Morocco

Abstract **Case Report**

Sinonasal chondrosarcoma is a rare malignant cartilaginous neoplasm accounting for a small proportion of head and neck sarcomas. Owing to its indolent growth and nonspecific clinical presentation, diagnosis is frequently delayed. Complete surgical excision remains the cornerstone of treatment; however, radical resection may be challenging in locally advanced tumors involving critical anatomical structures. We report the case of a 54-year-old woman presenting with progressive bilateral nasal obstruction, facial pain, and epiphora. Imaging revealed a locally advanced destructive tumor centered on the nasal septum with extension to the sphenoid sinus, hard palate, and nasopharynx. Endoscopic decompressive surgery was performed, and histopathological examination confirmed a grade 2 chondrosarcoma. Following multidisciplinary discussion, the patient underwent definitive radiotherapy using volumetric modulated arc therapy (VMAT) to a total dose of 70 Gy delivered in 35 fractions. Treatment was well tolerated, with only grade 1 mucositis. Post-treatment magnetic resonance imaging demonstrated radiological stability of the residual tumor, accompanied by significant clinical improvement. One year after completion of radiotherapy, the patient remained clinically stable with sustained symptomatic improvement and no evidence of clinical disease progression. This case highlights the potential role of definitive high-dose radiotherapy in achieving durable disease stabilization and clinical control of locally advanced sinonasal chondrosarcoma following non-radical surgery.

Keywords: Sinonasal chondrosarcoma, nasal cavity, radiotherapy, VMAT, head and neck sarcoma, local control.

INTRODUCTION

Chondrosarcoma is a malignant mesenchymal tumor characterized by the production of cartilaginous matrix and represents the second most common primary malignant bone tumor after osteosarcoma [1]. Head and neck involvement is uncommon, accounting for approximately 5–10% of all chondrosarcomas, while sinonasal localization remains exceptionally rare [2,3].

The clinical presentation of sinonasal chondrosarcoma is often nonspecific and largely depends on tumor size and local extension. The most frequently reported symptoms include progressive nasal obstruction, rhinorrhea, facial pain, epistaxis, headache, visual disturbances, and cranial nerve dysfunction in advanced cases [2,4]. Because of its slow-growing nature, diagnosis is often delayed, and patients commonly present with locally advanced disease.

Cross-sectional imaging plays a crucial role in evaluating tumor extension. Computed tomography is particularly useful for assessing bone destruction and calcified chondroid matrix, whereas magnetic resonance imaging provides superior delineation of soft tissue involvement and skull base extension [5]. Histopathological examination remains essential for definitive diagnosis and grading.

Complete surgical excision with negative margins is generally considered the standard treatment for sinonasal chondrosarcoma [2,6]. However, obtaining adequate margins may be difficult because of the proximity of critical structures such as the orbit, skull

base, optic pathways, and internal carotid arteries. Consequently, postoperative or definitive radiotherapy is increasingly employed in cases of residual disease, subtotal resection, unresectable tumors, or tumors involving anatomically complex regions [7–10].

Although conventional chondrosarcomas have historically been regarded as relatively radioresistant tumors, advances in radiation delivery techniques, including intensity-modulated radiotherapy (IMRT), volumetric modulated arc therapy (VMAT), proton therapy, and carbon-ion therapy, have improved dose conformity and local control outcomes while reducing treatment-related toxicity [8–11].

We report the case of a locally advanced grade 2 sinonasal chondrosarcoma treated with definitive VMAT radiotherapy following endoscopic decompressive surgery, resulting in durable radiological stability and a favorable clinical outcome at one year of follow-up.

Case Presentation

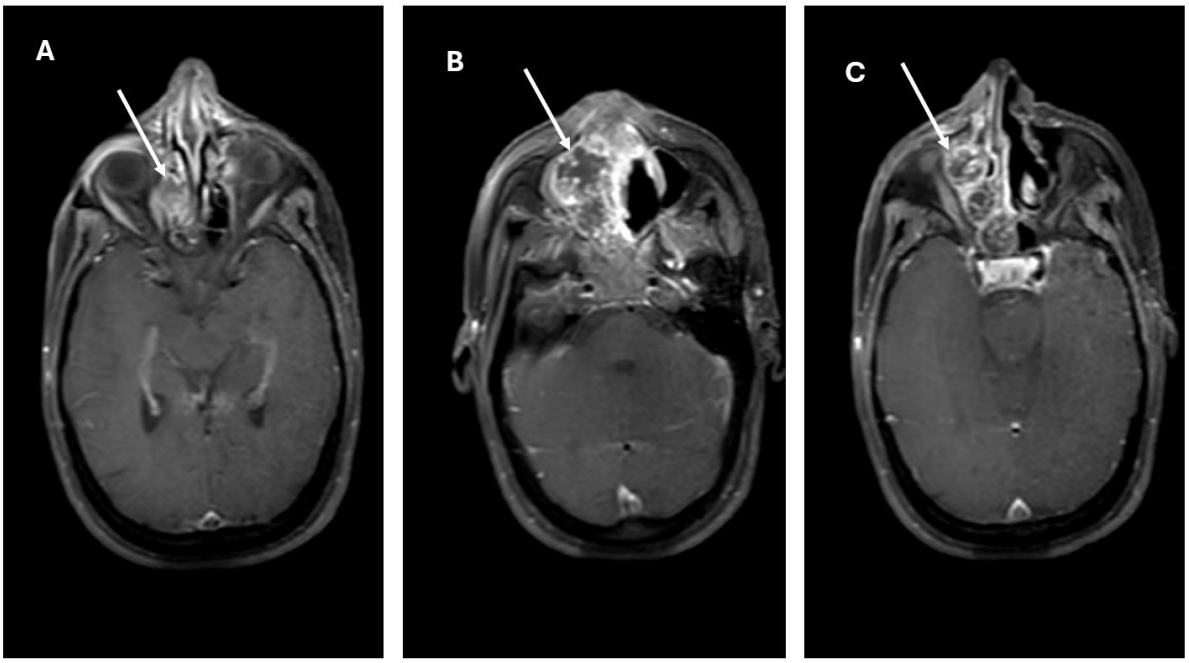
A 54-year-old Moroccan woman with a medical history of type 2 diabetes mellitus presented with a two-year history of progressive bilateral nasal obstruction associated with right-sided facial pain and epiphora. The gradual worsening of symptoms prompted medical consultation in January 2023.

Computed tomography (CT) of the paranasal sinuses performed on January 24, 2023, revealed a locally aggressive osteolytic lesion centered on the nasal septum measuring 49 × 49 × 38 mm. The mass occupied both nasal cavities and demonstrated extensive local extension. Laterally, it exerted a mass effect on the medial walls of the maxillary sinuses. Superiorly, the lesion extended toward the ethmoidal air cells. Posteriorly, it protruded into the sphenoid sinus and nasopharynx. Inferiorly, destruction of the hard palate was observed with extension toward the oral cavity.

The patient underwent endoscopic endonasal decompressive surgery on February 16, 2023, with the primary objective of relieving nasal obstruction. Histopathological examination of the surgical specimen confirmed the diagnosis of grade 2 conventional chondrosarcoma.

Following referral to the National Institute of Oncology, additional staging investigations were performed. Magnetic resonance imaging (MRI) of the facial massif conducted on March 23, 2023, demonstrated a locally advanced right nasal tumor extending to the sphenoid sinus and classified as T4aN0M0 (Figure 1). Thoracic CT performed during the same period showed no evidence of distant metastatic disease.

Figure 1. Baseline radiological appearance of locally advanced sinonasal chondrosarcoma.



Legend: Baseline gadolinium-enhanced MRI demonstrating a locally advanced sinonasal chondrosarcoma. (A-C) Representative axial sections showing a heterogeneous enhancing lesion centered on the nasal septum with extension to adjacent sinonasal structures (arrows)

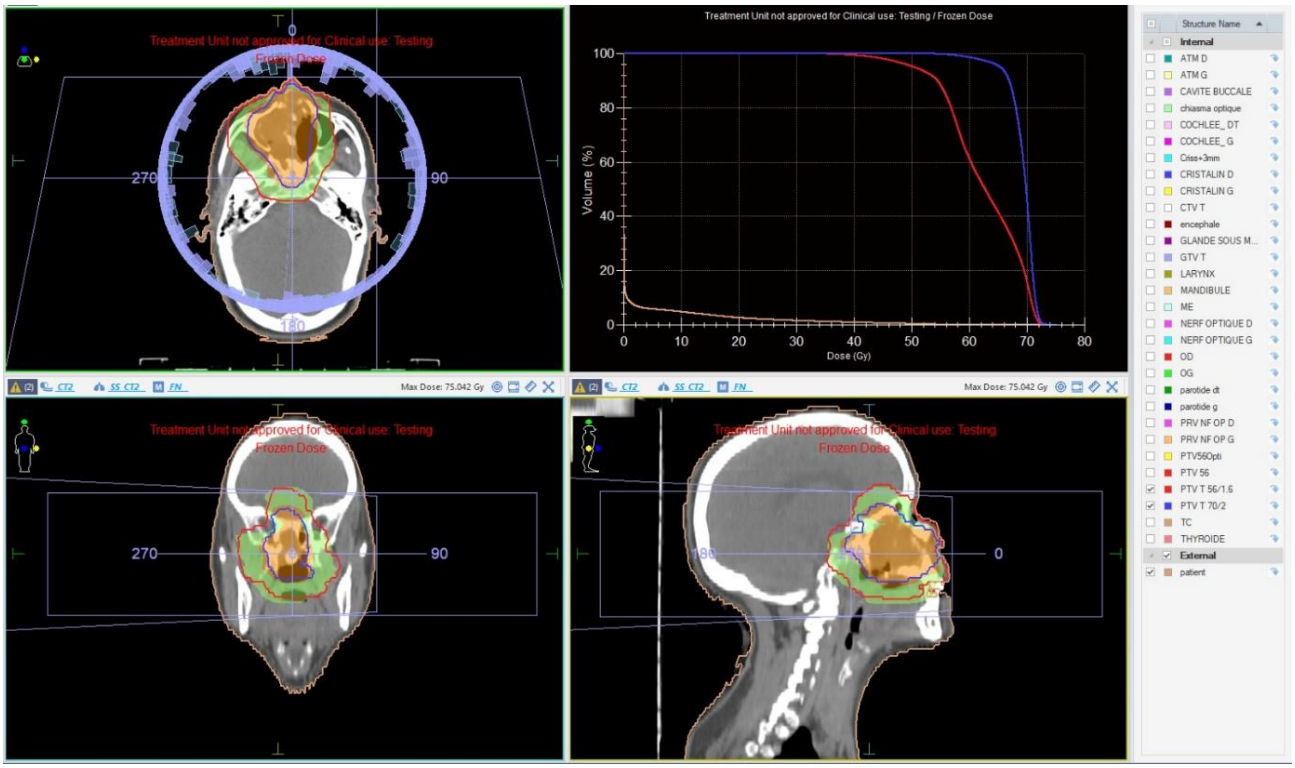
At presentation to our department, the patient reported persistent right-sided facial pain and rhinorrhea, more pronounced on the right side. Physical examination revealed right nasal swelling without cervical or

supraclavicular lymphadenopathy. Oral examination showed satisfactory dentition and no visible mucosal abnormalities. The patient's Eastern Cooperative Oncology Group (ECOG) performance status was 0.

The case was reviewed during a multidisciplinary tumor board meeting. Given the presence of locally advanced residual disease following decompressive surgery and the anatomical complexity of the tumor location, definitive radiotherapy was recommended.

Radiotherapy was delivered using volumetric modulated arc therapy (VMAT) to a total dose of 70 Gy in 35 fractions of 2 Gy each, administered once daily, five fractions per week. Treatment planning was based on simulation CT imaging with appropriate target volume delineation. Particular attention was paid to sparing critical organs at risk, including the optic apparatus, eyes, brainstem, temporal lobes, and spinal cord (Figure 2).

Figure 2. VMAT treatment plan and dose-volume histogram for locally advanced sinonasal chondrosarcoma.



Legend: Treatment planning images demonstrating volumetric modulated arc therapy (VMAT) for a locally advanced grade 2 sinonasal chondrosarcoma. The axial (upper left), coronal (lower left), and sagittal (lower right) views illustrate target volume delineation and dose distribution. The dose-volume histogram (DVH) (upper right) shows adequate target coverage while respecting dose constraints to surrounding organs at risk. A total dose of 70 Gy in 35 fractions was prescribed to the planning target volume (PTV)

Treatment was well tolerated. The only acute adverse event observed during radiotherapy was grade 1 radiation-induced mucositis, which was managed conservatively.

Clinical assessment after treatment demonstrated a marked improvement in nasal obstruction and facial discomfort. Follow-up MRI performed on November 14, 2023, showed radiological stability of the sinonasal tumor compared with baseline imaging, without evidence of local progression. According to RECIST 1.1 criteria, the radiological evaluation was consistent with stable disease. No cervical lymphadenopathy was identified on clinical examination.

The patient had an Eastern Cooperative Oncology Group (ECOG) performance status of 0. At 1 year following completion of radiotherapy, the patient remained clinically stable, with sustained symptomatic improvement and no evidence of clinical disease progression.

DISCUSSION

Sinonasal chondrosarcoma is an exceptionally rare malignant cartilaginous neoplasm representing only a small fraction of head and neck sarcomas. Chondrosarcomas account for approximately 0.1% of all head and neck malignancies, and only a minority arise within the nasal cavity and paranasal sinuses [1,2].

Because of their slow-growing nature, sinonasal chondrosarcomas frequently remain asymptomatic for prolonged periods. Consequently, diagnosis is often delayed until tumors reach a considerable size or invade adjacent anatomical structures. Nasal obstruction is the most commonly reported presenting symptom, followed by facial pain, rhinorrhea, epistaxis, headache, visual disturbances, and cranial nerve deficits in advanced disease [1,3]. Our patient presented with progressive bilateral nasal obstruction associated with facial pain and epiphora, a clinical presentation consistent with previously reported cases.

Imaging plays a pivotal role in diagnosis, staging, and treatment planning. Computed tomography is particularly useful for evaluating bone destruction and identifying calcified chondroid matrix, whereas magnetic resonance imaging provides superior delineation of soft tissue extension and skull-base involvement [4,5]. In the present case, CT demonstrated a destructive lesion involving the nasal septum with extension to the sphenoid sinus, hard palate, and nasopharynx, while MRI confirmed a locally advanced T4a lesion.

Histologically, conventional chondrosarcoma remains the most common subtype encountered in the sinonasal region [1,8]. Histological grade is one of the strongest prognostic factors. While grade 1 tumors generally exhibit indolent behavior and favorable outcomes, grade 2 lesions are associated with a higher risk of local recurrence and disease progression, thereby justifying aggressive local treatment approaches [2,6]. The diagnosis of grade 2 chondrosarcoma in our patient, therefore, supported the decision to pursue definitive local therapy despite the absence of distant metastatic disease.

Complete surgical excision with negative margins remains the cornerstone of treatment and is associated with the best oncological outcomes [1,7]. However, obtaining adequate margins may be challenging in tumors involving anatomically complex regions such as the skull base, sphenoid sinus, orbit, or major neurovascular structures. As a result, subtotal resections or debulking procedures are frequently performed in selected patients, with additional treatment modalities required to improve local control.

Historically, chondrosarcomas have been regarded as relatively radioresistant tumors because of their low mitotic activity, low vascularity, and abundant extracellular matrix [2,9]. Consequently, radiotherapy was traditionally reserved for patients with unresectable tumors, residual disease, positive margins, or contraindications to surgery. However, significant technological advances have expanded the role of radiotherapy in recent decades.

Modern techniques such as IMRT and VMAT enable highly conformal dose distributions while minimizing irradiation of surrounding organs at risk. This is particularly relevant in sinonasal malignancies, where target volumes are frequently located in proximity to critical structures, including the optic nerves, optic chiasm, retinae, temporal lobes, and brainstem [9,10]. Furthermore, proton therapy and carbon-ion therapy have demonstrated excellent local control rates in skull-base chondrosarcomas, supporting the efficacy of high-dose radiation treatment in selected patients [10,11].

Current evidence suggests that doses ranging from 60 to 70 Gy are generally required to achieve meaningful tumor control in conventional chondrosarcoma [10–12]. In our patient, definitive VMAT was delivered to a total dose of 70 Gy in 35 fractions, corresponding to the upper range of conventionally fractionated schedules reported in the literature.

One of the most noteworthy findings in our case was the achievement of durable radiological stability following treatment. Although objective tumor shrinkage is frequently used as a marker of treatment efficacy in solid tumors, stable disease should not be regarded as treatment failure in conventional chondrosarcoma. Given the slow-growing biological behavior of these tumors, prolonged disease stabilization may represent a favorable therapeutic outcome, particularly when accompanied by significant symptomatic improvement and preservation of quality of life [2,10].

In the present case, MRI performed seven months after completion of radiotherapy demonstrated stable disease according to RECIST 1.1 criteria, without evidence of local progression. This radiological result was accompanied by substantial clinical improvement, including relief of nasal obstruction and facial pain. The patient also maintained an ECOG performance status of 0 throughout follow-up.

Another important observation was the excellent tolerance of treatment. Only grade 1 mucositis was observed during radiotherapy, and no severe acute toxicity was recorded. This favorable toxicity profile is likely related to the use of VMAT, which allows improved sparing of adjacent organs at risk while maintaining adequate target coverage [9,10].

Although surgery remains the preferred treatment whenever complete resection can be achieved, our observation contributes to the growing body of evidence supporting the role of definitive high-dose radiotherapy in selected patients with locally advanced sinonasal chondrosarcoma, particularly in the presence of residual disease following non-radical surgery [7,10-12].

The main limitations of this report include its single-case design, the relatively limited radiological follow-up period, and the absence of volumetric assessment of tumor response. Nevertheless, the rarity of sinonasal chondrosarcoma and the favorable outcome observed after definitive VMAT radiotherapy contribute valuable information to the existing literature.

CONCLUSIONS

Sinonasal chondrosarcoma is a rare malignant tumor for which management remains challenging. While complete surgical resection remains the standard treatment whenever feasible, definitive radiotherapy may provide durable clinical control in selected patients with locally advanced residual disease.

In the present case, VMAT-based radiotherapy delivered to a total dose of 70 Gy in 35 fractions resulted in sustained radiological stability according to RECIST 1.1 criteria, significant clinical improvement, and minimal toxicity. These findings support the use of modern high-dose radiotherapy as an effective treatment option for selected patients with sinonasal chondrosarcoma following non-radical surgery.
Further studies and additional case reports are needed to define better the role of definitive radiotherapy in this rare disease.

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