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ORIGINAL ARTICLE

# Surgical treatment of head and neck chondrosarcomas

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**KEYWORDS**
Chondrosarcoma;
Head and neck;
Larynx;
Nasal cavity;
Skull base

**Abstract**
*Introduction:* Head and neck chondrosarcomas may adopt different locations and biological behaviour.
*Material and method:* We present a retrospective clinical series of 17 chondrosarcomas surgically treated in our Department from 1977 until 2006.
*Results:* Chondrosarcomas were located in the nasosinusal area (n=6), larynx (n=5), petrous bone (n=3), atlas (n=1), parapharyngeal space (n=1) and trachea (n=1). All patients except for one underwent surgery with radical intention. The mean follow-up period was 84 months (median, 71 months). Six patients developed recurrent disease with a mean latency of 10 months. Two patients died due to the disease and two remained alive with evidence of tumour. Patients with grade I chondrosarcomas presented less recurrent disease than those with grade II or III chondrosarcomas (17% vs 80%, P=.029). The estimated 5-year survival was 88%, with the better survival of patients with grade I chondrosarcomas reaching statistical significance (P=.023). In 2 patients with cricoid chondrosarcomas, the reconstruction was carried out using the Rethi-Ward technique, and they were without evidence of disease at 71 months (with no cannula) and 145 months (with cannula). Chondrosarcomas of the jugular foramen were treated using a modified type A infratemporal approach.
*Conclusion:* Low grade head and neck chondrosarcomas have a good prognosis, while high grade chondrosarcomas tend to recur, despite radical surgical treatment.


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**PALABRAS CLAVE**
Condrosarcoma;
Cabeza y cuello;
Laringe;
Cavidad nasal;
Base de cráneo

**Tratamiento quirúrgico de los condrosarcomas de cabeza y cuello**

**Resumen**
*Introducción:* Los condrosarcomas de cabeza y cuello adoptan una gran variedad de localizaciones y comportamientos biológicos.
*Material y método:* Se presenta una serie retrospectiva de 17 casos de condrosarcomas de cabeza y cuello tratados quirúrgicamente en nuestro servicio desde 1977 hasta 2006.
*Resultados:* Los condrosarcomas se localizaron en el área nasosinusal (n = 6), laringe (n = 5), peñasco (n = 3), atlas (n = 1), espacio parafaríngeo (n = 1) y tráquea (n = 1). Todos excepto una paciente se sometieron a cirugía con intención radical. El periodo de seguimiento medio fue de 84 meses (mediana, 71 meses). Se produjo recidiva en 6 pacientes con una latencia media de 10 meses. Dos pacientes fallecieron a causa de la enfermedad y dos permanecieron vivos con enfermedad. Los pacientes con condrosarcomas de grado I presentaron menos recidivas que los grados II y III (17% frente a 80%, p = 0,029). La supervivencia media estimada a los 5 años fue del 88% siendo estadísticamente significativa la mayor supervivencia en los pacientes con tumores de grado I (p = 0,023). En 2 pacientes con condrosarcomas cricoideos la reconstrucción se llevó a cabo mediante la técnica de Rethi-Ward, encontrándose sin evidencia de la enfermedad a los 71 (decanulado) y 145 meses (no decanulado). Los condrosarcomas de la fosa yugular fueron tratados mediante el abordaje infratemporal tipo A modificado.
*Conclusiones:* Los condrosarcomas de cabeza y cuello de bajo grado presentan un buen pronóstico vital. Los de alto grado, pese al tratamiento radical, tienden a la recidiva.


## Introduction

Chondrosarcomas are malignant tumours whose common feature is the formation of neoplastic cartilage, which may adopt a wide range of histological features and locations.[1] Between 6%-12% of chondrosarcomas are located in the head and neck region and in 48% of them, the source is located in bone structures.[2-5] The larynx and the sinonasal tract are the most frequent settlements,[4-7] followed in frequency by the base of the skull, specifically the middle fossa and originating from the petroclival suture.[8-10] Other less common sites are the oral cavity, orbit, pharynx, middle ear, parotid gland, thyroid gland and trachea.[5,11]

Head and neck chondrosarcomas (HNCS) appear between 10 and 20 years earlier than those in other locations, with a peak incidence around the 4th decade of life and with a slight predominance in males.[3-5,12-14] Unlike other locations, laryngeal chondrosarcomas appear around the age of 60 years with a clear predominance in males.[5,11,15]

Chondrosarcomas can be divided into primary, when they settle on previously healthy tissue, or secondary, when they settle on chondromas or previously existing cartilaginous exostosis.[16] Diseases involving the appearance of multiple enchondromatosis, such as Mafucci syndrome or Ollier disease, are associated with chondrosarcoma in up to 15% of cases.[10] It has been suggested that in locations that lack cartilage, such as the base of the skull or the upper maxillary, the origin of the HNCS depends on the persistence of embryonic cartilage remnants.[12,17-19]

Evans classified chondrosarcomas into three histological grades according to their cellularity, number of mitosis per field and size of cell nuclei, this classification having prognostic implications.[20] Mesenchymal chondrosarcomas, which are rare, have a worse prognosis. Their course is characterised by rapid recurrence and a tendency to metastasize, as well as by undifferentiated variants and clear cell chondrosarcoma.[21] Low grade HNCS (type I and type II) are slow-growing tumours with little tendency to metastasize, whose lethality derives from their tendency towards local recurrence and intra-axial invasion,[4,9,13] and which can occur with many years of latency.[5] Lymph node involvement is unusual (5%) and distant metastases only occur between 7%-18% of cases,[4,5,22] while high-grade chondrosarcomas may present metastases in up to 71% of cases.[19,23] Along with the histological subtype, other prognostic factors have been identified in the literature, such as tumour location and complete surgical excision, both features being closely related.[4,15,17,21]

The treatment of choice for chondrosarcoma is radical resection. They have traditionally been considered as radioresistant tumours,[14,24,25] although in recent times this concept has gradually changed. Responses to radiotherapy have been published in HNCS[3,26,27] and new radiation modalities have proven useful in those lesions where resection with free margins could not be obtained, especially at the base of the skull.[28-30] Complementary treatment with radiotherapy is accepted in high-grade tumours, those with lymph node involvement, incomplete resection and recurrence. It is proposed as the main treatment when the tumour cannot be resected or when intervention is rejected.[31] Chemotherapy is reserved for tumours with a high risk of metastasis, such as mesenchymal, undifferentiated or high-grade tumours. Anecdotal partial responses have been published.[21] The combination of chemotherapy and radiotherapy has not obtained cures.[14]

To date, a very small number of HNCS series covering more than 15 cases have been published.[4,5,7,14,21,32-34] There have also been some that focus on the laryngeal location[15,35-37] and others on the base of the skull.[9,13,38,39] The purpose of our study is to report our accumulated experience in the diagnosis and treatment of these uncommon lesions.

## Material and methods

We performed a retrospective descriptive study that included patients with histological diagnosis of chondrosarcoma located in the region of the head and neck and who had undergone surgery with curative intent at our service. The study population consisted of 17 patients treated between the years 1977 and 2006.

Data collection was based on a review of their medical histories, recording data on age, gender, tumour site, histological grade, staging, relevant medical history, clinical presentation, surgical procedures, complications and follow-up. The extent of disease was analysed according to the 6th edition of AJCC for sarcomas derived from bone, applying the classification of soft tissue sarcomas for the HNCS that had not settled on bone.[40] The histological classification was based on the criteria proposed by Evans.[20] Total resection was considered when no surgical or radiological remnants of the disease were found. For the data analysis, the SPSS 15.0® program was used. Comparisons between qualitative parameters were carried out through the design of contingency tables and Fisher's exact test. Survival analysis was carried out using the design of Kaplan-Meier curves. The level of statistical significance between survival curves was calculated using the Log-Rank test. The significance level was set at $P=.05$ and all comparisons were considered bilateral.

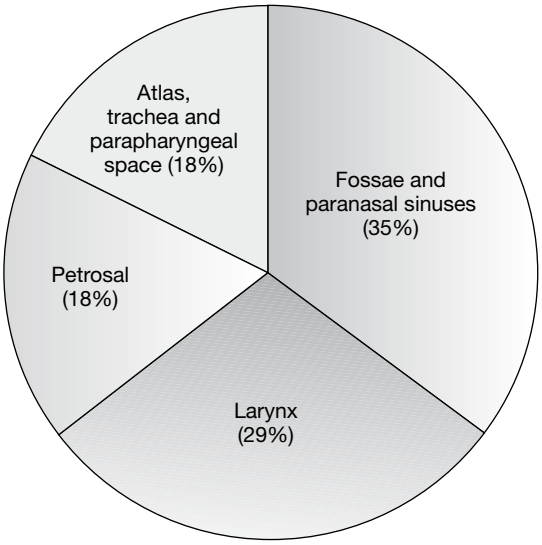


**Figure1** Prevalence of the different primary sites of HNCS (n=17).

## Results

The sample consisted of 6 women and 11 men, with an average age at diagnosis of 54 years (median 58 and range 29-88 years). Five patients had undergone previous surgery at other centres before being operated in our department. The anatomical location of the primary tumour involvement is illustrated in Figure 1.

Thirteen patients presented grade I chondrosarcomas, 3 patients grade II chondrosarcomas and one patient suffered from a grade III chondrosarcoma. During follow up, 2 patients with grade II chondrosarcomas progressed to grade III and one patient with grade I chondrosarcoma passed to grade II. Eleven patients were included within stage IA (65%), four in stage IB (23%), one in stage IIA (6%) and one in stage III (6%).

Complete tumour resection was achieved in all cases. Four patients (23%) received complementary conventional external radiation therapy, in 2 cases due to high-grade tumours and in the other 2 due to having undergone prior surgery.

There were recurrences in 6 patients (35%), consisting of local recurrence in 5 and in the form of implants along the previous surgical approach in the remaining case. Relapse took place with a median latency of 10 months. One patient with high-grade chondrosarcoma developed a distant metastasis, along with local recurrence. Excluding this last patient, the rest underwent rescue surgery, achieving complete resection in all cases (5).

The mean follow-up period ranged from 8 to 198 months, with a mean of 84 months and a median of 71 months. At the end of the follow-up period, 13 patients (76%) were alive without disease, 2 patients (12%) remained alive with evidence of disease and another 2 patients (12%) died due to local progression at 8 and 41 months, both with grade III tumours. Table summarises the patient characteristics and monitoring. Mean patient survival estimated by the Kaplan-Meier method was 176 months and cumulative survival at 5 years was 88%.

Patients who presented grade I HNCS both at diagnosis and during follow-up suffered recurrence in 17% of cases, compared to 80% of those with grades other than grade I. These differences were statistically significant ($P=.029$).

The cumulative survival at 5 years in the group of patients with grade I chondrosarcomas was 100%, compared to 60% in the group of patients with grade II or III chondrosarcoma. These differences were statistically significant ($P=.023$).

### Sinonasal chondrosarcomas

The primary site included the ethmoid sinuses (n=2), the nasal septum (n=2), the maxillary sinus (n=1) and the sphenoid sinus (n=1). However, in 2 cases, there was a secondary invasion of the anterior cranial fossa. In 5 of the 6 patients, the initial presentation symptom was nasal respiratory failure and in all patients, physical examination showed the presence of an endonasal mass. There were 3 paralateronasal approaches, one subcranial, one subtemporal-infratemporal and one endoscopic approach. The only noteworthy complication was the rejection of the osteosynthesis material by a patient who required review surgery. Four patients were free of disease at the end of follow-up. One patient died as a consequence of the disease and the remaining one remains alive with residual disease.

### Laryngeal chondrosarcomas

These were located in the back plate of the cricoid cartilage (n=3) and in the thyroid cartilage (n=2). Dysphonia was the

**Table** Summary of the key features in patient management and monitoring

| Age/gender | Grade/stage | Approach | Relapse | Grade of increase | Monitoring, months | Location |
|---|---|---|---|---|---|---|
| 29/M | GI/IA | Subtemporal-IFT | No | No | 77 | AWE |
| 70/M | GII/IA | Paralateronasal | Yes (5) | Yes | 18 | DD |
| 30/M | GI/IB | Paralateronasal | Yes (10) | No | 13 | AWE |
| 70/F | GI/IA | Paralateronasal | No | No | 90 | AWE |
| 34/F | GII/IA | Subcranial | Yes (12) | Yes | 49 | AWE[a] |
| 88/F | GI/IB | CENS | No | No | 114 | AWD[b] |
| 56/M | GI/IA | Middle thyrotomy | Yes (186) | No | 198 | AWE |
| 63/M | GIII/III | Total laryngectomy | Yes (1) | No | 8 | DD |
| 49/M | GI/IA | Total laryngectomy | No | No | 148 | AWE |
| 59/M | GII/IA | Cricoid resection | No | No | 71 | AWE |
| 64/M | GI/IA | Cricoid resection | No | No | 145 | AWE |
| 26/M | GI/IA | Modified type A IFT | No | No | 48 | AWE |
| 51/F | GI/IA | Modified type A IFT | No | No | 48 | AWE |
| 58/F | GI/IA | Transtemporal approach | No | No | 133 | AWE |
| 62/M | GI/IB | Lateral external | Yes (11) | Yes | 41 | AWD[c] |
| 70/F | GI/IA | Resection and thyrotomy | No | No | 192 | AWE |
| 32/M | GI/IIA | Transcervical resection | No | No | 36 | AWE |

AWD indicates alive with disease; AWE, alive without evidence of disease; DD, died from disease; F, female; IFT, infratemporal approach; M, male.
Figures in brackets refer to the months passed until diagnosis of recurrence.
[a]This patient presented 3 recurrences which were treated surgically.
[b]The initial resection was carried out without obtaining adequate surgical margins.
[c]Presented 3 relapses and the last interventions were palliative.

initial presentation symptom in all patients. All patients were male. Four of the 5 patients were habitual smokers. Upon physical examination, it was possible to observe the presence of an endolaryngeal submucosal mass in all cases, with fixation of the ipsilateral vocal cord in 4 cases. Two cases showed the presence of a cervical mass initially interpreted as a thyroid nodule. In 2 patients, the extent of the disease led to the need for total laryngectomy to be performed. Of these patients, one progressed satisfactorily, while the other, with a high-grade chondrosarcoma and neoplastic vascular embolisms, died immediately after finishing the treatment, despite concomitant radiotherapy and chemotherapy. In 2 patients, much of the cricoid was resected and the subglottic area was reconstructed with a hyoid bone flap pedicled to the prelaryngeal musculature. Figure 2 illustrates this surgical technique using a CT scan. The remaining patient suffered from disease located in the thyroid cartilage; the lesion was removed through a middle thyrotomy, with reconstruction using clavicular periosteum pedicled to the sternocleidomastoid muscle. This last patient developed a late relapse, which was treated by laser laryngeal microsurgery. As post-operative complications, one patient developed a cervical infection and another, an episode of severe bronchoaspiration.

Of the three cases where the larynx was preserved, the patient with primary disease of the thyroid cartilage was decannulated after one month, while the 2 patients with disease at the cricoid level showed significant subglottic scarring reactions. One of these patients was decannulated one year of surgery, after laser cordectomy. The remaining patient could not be decannulated despite repeated attempts over 5 years.

## Skull base chondrosarcomas

Two patients suffered chondrosarcoma at the level of the jugular fossa, both referring symptoms in the neuro-otological area and presenting an unremarkable physical examination. Figure 3 presents the radiographic appearance of this tumour location through nuclear magnetic response (NMR) imaging. They were treated with a modified type A infratemporal approach, without facial re-routing and with middle ear obliteration. There were no complications and the sequela was transmissive hearing loss attributable to the intervention, while facial function was normal. The evolution presented no recurrence.

A third patient developed chondrosarcoma in the petrous apex, which was manifested in the clinical form of hemifacial algia with normal physical examination. This patient had been diagnosed with rheumatoid arthritis. She was treated using a transtemporal approach and showed no complications or sequelae. During follow-up, she presented a radiation lesion in the surgical field that was initially considered as a recurrence, so it was excised through a preauricular subtemporal approach. However, the histological result was of inflammatory reaction against a foreign body and the patient has spent more than 10 years without recurrence.

A fourth chondrosarcoma far exceeded 5 cm in diameter and affected the parapharyngeal space, its upper edge

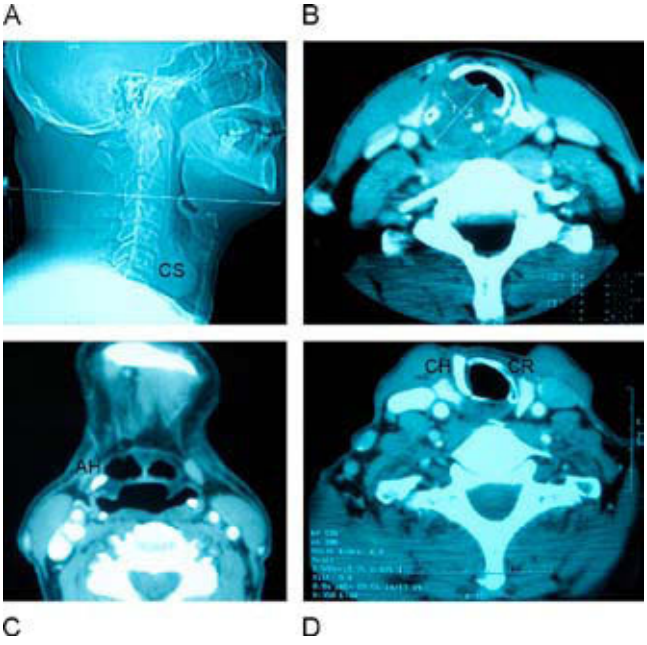


**Figure 2** CT images corresponding to a patient diagnosed and treated for a cricoid chondrosarcoma. A) Lateral radiograph of the neck showing the presence of a soft tissue mass (CS) at the C6-C7 level. B) Heterogeneous mass with a major diameter of 4 cm originating from the right side of the posterior plate of the cricoid, destroying half of the cricoid ring and the subglottic lumen. This corresponds to a cricoid chondrosarcoma. C) Absence of the hyoid except for the right horn, which remained in situ. D) Postoperative control after 10 years of follow-up. The patient underwent a cricoid resection and reconstruction with a pedicled flap from the hyoid body. The image illustrates the cricoid remnant (CR) and the hyoid flap (CH).

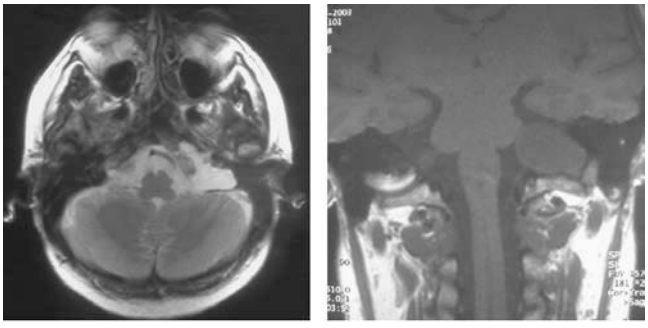


**Figure 3** MRI images showing a jugular fossa chondrosarcoma. A) Axial section and T1-weighted sequence with contrast which shows the presence of a mass of 3 cm in diameter, centered in the left jugular fossa. B) A slight compression of the middle cerebellar peduncle caused by chondrosarcoma is evident in the coronal plane and T1, along with a subarachnoid cleavage plane between the two structures. Note the independence and indemnity of the ipsilateral sigmoid sinus.

contacting the skull base. It was treated with total excision through a cervical-transparotid approach. No signs of relapse have appeared in 3 years.

## Other locations

One patient presented a tracheal chondrosarcoma extended to the cricoid cartilage, which manifested under the clinical form of a cervical mass. It was treated by tracheal resection and middle thyrotomy, with termino-terminal reconstruction of the trachea. She presented postoperative cervical infection and preferred not to be decannulated, despite an evidently correct air passage and the absence of long-term relapse.

One patient presented grade I chondrosarcoma at the level of the atlas, which was treated by an extreme lateral approach. The subsequent recurrence along the surgical approach was treated by the same type of approach with complementary radiotherapy. In the following 23 months, the patient underwent various palliative resections due to a recurrence that affected the vertebral artery and extended in the intra-axial direction. He is currently alive with evidence of disease.

## Discussion

Head and neck chondrosarcomas are heterogeneous tumours in terms of their location and biological behaviour. While low-grade tumours generally present a torpid evolution in the space of years, high-grade chondrosarcomas can have a fulminating evolution.[4,5,20,21] as occurred in one of the cases in our series. Moreover, the wide variety of locations where they can appear causes the range of indicated surgical techniques to be very heterogeneous as well. It also means the possibility of achieving complete tumour resection, a fundamental prognostic factor. Most HNCS cases are low-grade tumours[4,5] and in the absence of metastasis, all low-grade HNCS belong to stage I of the AJCC, except for those chondrosarcomas under 5 cm arising from soft tissues. This is why the degree of histological differentiation is vital in establishing prognosis, the size of the tumour being less important.

In our series, of the 3 patients presenting grade III chondrosarcomas, 2 died and the remaining patient presented 3 relapses in the space of 49 months, for which she was reoperated. As to the 2 patients with grade II HNCS, one of them remains alive without evidence of disease after 71 months' follow-up. The remaining patient has presented 3 recurrences, which were treated with curative intent on 2 occasions and 3 palliative debulkings were carried out due to locally uncontrolled disease. Of the 12 patients who at the time of diagnosis and during follow-up showed histological grade I, two of them suffered a relapse that was successfully treated without evidence of disease at the end of the follow-up period. Considering that tumour resection was complete in all cases, it appears that high-grade tumours often present relapses despite radical treatment.[10,21] The association between histological grade and the presence of recurrence is so obvious that even with the limited sample size available, the lower frequency of relapses in patients with grade I HNCS (17%) is statistically significant compared to that of other patients (80%). There were no deaths in the group of patients with grade I HNCS, while 40% of the remaining patients died as a consequence of local recurrence.

These findings are consistent with other series,[4,5] with an approximate survival rate of 80% in low-grade tumours and of 40% in high-grade ones. Moreover, in a multicentre study that collected 146 anterior fossa sarcomas, the only independent predictive factor of survival was the presence of disease-free surgical margins.[41] However, this last study did not include chondrosarcomas.

The recurrence rate of 35% found in our series was consistent with the existing results in the literature, where it ranges between 29% and 71%.[4,5,7,14,33] Survival was 88% at the end of the follow-up period. In the literature, survival at 5 years is estimated at around 80%-87%, while it is between 65% and 70% at 10 years.[5,7] Series with fewer patients treated surgically and those not including laryngeal chondrosarcomas present worse results.[4,14]

The period of patient inclusion was 29 years, which is justified by the low incidence of this disease. This feature is common to the largest published series, ranging between 20 and 49 years.[3,4,5,11,14,15,21] Most of our patients treated before 1990 presented laryngotracheal chondrosarcomas, so the only therapeutic innovation was the introduction of the laser. It is likely that both sinonasal chondrosarcomas extended to the base of the skull and the primaries at this location were considered unresectable. Some authors have reported that recent cases have better prognosis than older ones.[4,15] We believe that aside from the obvious advances in surgery of the skull base, the main difference with respect to older cases is the availability of modern diagnostic radiology methods that facilitate diagnosis and monitoring. In CT scans, chondrosarcoma appears as a soft tissue mass that often has internal calcifications, especially if they have been irradiated. Bone destruction also appears, although with less intensity than in the case of chordomas. The typical image obtained by NMR is that of a low intensity mass on T1 weighted sequences and with average intensity on T2 sequences, taking up contrast in a heterogeneous manner, although it is possible that they do not capture contrast.[42]

One problem attributable to the series with older cases is the difficulty of distinguishing a chondroma from a low-grade chondrosarcoma. It is estimated that up to 62% of chondrosarcomas present images consistent with chondroma in their histological analysis (which were excluded in this review).[15] Moreover, this diagnostic peculiarity makes it recommendable to carry out extensive biopsies. Up to 32% of patients are previously diagnosed with a different histology of chondrosarcoma[4] and the head and neck are an unusual location for chondromas.

## Sinonasal chondrosarcomas

The most commonly used surgical approach was the paralateronasal, which allows extensive control of the nasal cavity, the maxillary sinuses, the ethmoid sinuses, the medial part of the ipsilateral orbit and even the sphenoid sinus. The cosmetic result is excellent and complications are rare. Furthermore, the gelatinous consistency of the tumour and its pseudocapsule facilitate dissection through the paralateronasal approach. The subcranial approach is indicated when the tumour extends bilaterally towards the orbits, as was the case in one patient in our series. One patient with sphenoid chondrosarcoma presented extension to the superior clivus and the anterior part of the middle fossa. In the latter case, we used a subtemporal-infratemporal approach associated with a subcranial approach.[43] We preferred this approach to the infratemporal B as it also respected the middle ear and the 3rd trigeminal branch.[44] Undoubtedly, in the coming years the surgical treatment of neoplasms affecting these locations will be modified, in parallel with the development and generalisation of extended endoscopic approaches.

The only patient treated by endoscopic sinonasal surgery was a patient who underwent surgical resection without free surgical margins and who had presented a breast adenocarcinoma 2 years before that was being treated with Tamoxifen. In a state-wide study, Odink et al published the association between chondrosarcomas and breast adenocarcinomas, with an odds ratio of 7.62, suggesting the presence of a syndrome involving both pathologies.[45,46] Other authors have published case reports on patients who associated both neoplastic diseases.[47-50] However, there have been no published cases to date that refer to the present situation, in which a HNCS appears in a patient suffering from a breast adenocarcinoma. According to the study by Grifone et al, 61% of chondrosarcomas express α-type oestrogen receptors and 89% β-type, with the expression being significantly higher in lesser-grade tumours.[51] In a sample of 35 chondrosarcomas, Cleton-Jensen et al demonstrated the presence of elevated levels of m-RNA involved in the transcription of oestrogen receptors.[52] This same author and his working group found that chondrosarcoma cell cultures stimulated their growth in the presence of oestrogen and were inhibited by exemestane (an aromatase inhibitor).[52] Consequently, we think it likely that the unusual evolution of this patient, who remained almost 10 years without disease progression despite the absence of wide surgical margins, can be explained by the anti-oestrogen therapy that she received. There are no *in vivo* trials to assess the treatment of chondrosarcoma with oestrogen.

## Laryngeal chondrosarcomas

For many authors, laryngeal chondrosarcomas are a separate entity within HNCS, as they affect older people, are usually highly differentiated tumours and their prognosis is more favourable.[4,21] All our patients were male, which was in accordance with previous results showing a male predominance in 78%-100% of cases.[11,15] In addition to its degree of differentiation, the relative remoteness from central nervous structures facilitates complete resection. Moreover, dysphonia as a sign of alarm, present in all patients in our series, facilitates early diagnosis. However, patient examination in the early stages usually offers little striking information, because the tumour does not produce mucosal ulceration and can remain hidden in the subglottic area, with apparently idiopathic paralysis of the vocal cord being the earliest sign. In many cases, there is a history of vocal cord medialization with Teflon.[11,53] However, we believe that there is no pathophysiological relationship with chondrosarcoma and it is a consequence

of the treatment of vocal fold paralysis. In our series, 4 of the 5 patients were smokers; the more conclusive data from the literature report a history of smoking in one third of patients.[15]

In 2002, Thompson et al conducted a review that included 146 patients with laryngeal chondrosarcomas, from a series in English.[15] In that series, 77% of the tumours originated in the cricoid cartilage, 19% of them in the thyroid cartilage and 3% in the arytenoid. The primary location at the posterior cricoid lamina and the frequent involvement of the cricoarytenoid joint make total laryngectomy the standard surgical option. Between 35%-54% of patients underwent total laryngectomy,[5,15] with 77%-95% obtaining a cure.[11,15] Faced with this aggressive treatment, the current treatment proposal calls for the use of conservative surgery without losing a radical oncological effect.[11,53,54] The conservative choice used in our series was hemicricoidectomy and reconstruction with a hyoid flap pedicled to the sternohyoid. Many authors have published their results using this technique, called the Rethi-Ward, in subglottic reconstruction, with success in decannulation in 60%-90%.[55-59] The 2 patients intervened by this technique have preserved the larynx and remained disease-free for a long period (71-145 months). Other alternative techniques for conservative treatment of cricoid chondrosarcomas are total resection and thyrotracheal anastomosis[54,60] or extramucosal resection of the cricoid.[61] Endoscopic laser resection has recently been introduced in the therapeutic arsenal, both for recurrence and for the primary disease. In 13 patients with cricoid cartilage tumours, Merrot et al obtained one recurrence in 5 years of average follow-up.[62] In our series, one patient was treated for a recurrence using $CO_2$ laser with good results.

### Petrosal chondrosarcomas

Most chondrosarcomas of the skull base settle in the petroclival suture.[9] Chondrosarcomas of the jugular fossa are extremely infrequent, the most prominent series being of the 5 cases of Sanna et al.[10,63] Survival at 5 years of skull base chondrosarcomas ranges between 85%-100% and at 10 years between 77%-95%.[9,12,13,39,64,65] In our cases, the clinical expression was not remarkable, with no associated signs and the symptoms dominated by hearing loss, vertigo and tinnitus.

The approach used was the type A infratemporal.[44] The facial nerve was maintained in the Fallopian channel and skeletonised, in the manner suggested by Pensak under the term "Fallopian Bridge". This technique achieves normal facial function in 92% of patients.[66,67] With this management of the facial nerve, it is possible to obtain better results in terms of preserving facial function than with the Brackmann technique,[68] the short transposition proposed by Farrior[69] and the closely related transmastoid-infralabyrinthine approach proposed by Fournier.[70] Despite maintaining excellent facial function, in patients in our series it was necessary to obliterate the middle ear, because skull base surgery requires a closure that is as tight as possible to prevent a cerebrospinal fluid leak. Other approaches that can be used for the removal of these injuries are the transigmoidal petro-occipital or the transottic approaches[63] and the more recent extended endoscopic approach.[71] Given the proximity to neurovascular structures, it is sometimes not possible to achieve total resection. Under these circumstances, new radiotherapy modalities, such as radiosurgery[72,73] and proton therapy,[74] may come into play.

Our third patient had a chondrosarcoma that had settled in the petrous apex and was treated through a transtemporal approach. This patient presented a foreign body reaction in the surgical field and was reoperated one year later through a preauricular subtemporal approach. It so happened that this patient suffered from rheumatoid arthritis, which may have had an influence both in the difficulties that she presented for histological diagnosis and in her abnormal scarring reaction. At 10 years of the initial treatment, the patient was diagnosed and treated for an invasive lobular breast carcinoma, representing the 2nd of the 6 women in our series with this pathology.

### Other locations

The trachea is an unusual location for chondrosarcomas, with only 16 cases reported to date.[31,75] The simplest surgical option is resection and termino-terminal anastomosis, which in our case was combined with a middle thyrotomy for subglottic extension.

In the patient suffering chondrosarcoma of the cervical spine, evolution has not been good. The extreme lateral transcondylar approach makes it possible to control the vertebral artery, so it is the approach of choice for C1 or C2 lateral lesions. As a result of the extensive drilling of the condyle, it was necessary to conduct an occipito-vertebral fixation. This patient suffered a recurrence along the surgical path, which presented one unresectable intra-axial component and another cervical one that was treated with palliative resection in up to 3 occasions.

Considering publications in English and French, only 8 patients with chondrosarcoma of the parapharyngeal space have been described[76-83] and only one was a grade I case.[83] Unlike other sarcomas, grade I chondrosarcomas do not usually manifest invasive characteristics of the soft parts. Consequently, in the rare location in the parapharyngeal space, it was not necessary to carry out a mandibulotomy, and the tumour could be detached through a cervical approach, as in benign parapharyngeal lesions.

## Conclusions

Since the majority of HNCS are tumours with a low grade of malignancy, the prognosis is usually favourable. High-grade tumours or those located in anatomic areas with difficult management have a worse vital prognosis. Based on our experience, we believe that it is possible to achieve total tumour resection using conservative approaches such as hemicricoidectomy, type A infratemporal approach without facial transposition, endoscopic laser resection or endoscopic sinonasal surgery. Advances in neuroimaging have greatly improved the clinical management of these patients.

## Conflict of interests

The authors declare no conflict of interests.

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