Surgical therapy in advanced sinonasal carcinomas – retrospective study

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Background and Aim. Sinonasal tumors are a rare and heterogeneous group of malignant tumors with different histopathological characteristics and clinical presentation. These tumors are usually treated through surgery. The aim of this study is to present our results of surgical therapy in patients with an advanced sinonasal tumor.
Methods. This retrospective study included patients with an advanced sinonasal tumor who were surgically treated. The surgical technique combined both a frontal transbasal approach together with an endoscopic endonasal approach. The parameters used for evaluation were the histological type of tumor, the radicality of resection (complete vs. incomplete), the frequency of recurrence, the surgical and postoperative complications, the type of subsequent oncological therapy and the overall survival.
Results. The group consisted of ten patients seven were men and three were women. Complete resection (defined as R0) was achieved in 8 (80%) of the cases, subcomplete resection was achieved in 2 (20%) of the cases. The overall survival period was 28.7 months (95% confidence interval 15.9–41.6).
Conclusion. The combination of the frontal transbasal approach with the endoscopic endonasal approach is a suitable surgical strategy that enables easier achievement of complete tumor resection, reconstruction of the anterior skull base and reduces the need for extensive surgical approaches.

Key words: sinonasal tumors, transbasal approach, endoscopic surgery, skull base

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INTRODUCTION

Sinonasal tumors are a rare and heterogenic group of malignant tumors with diverse histopathological characteristics and clinical presentation. Sinonasal tumors compose less than 1% of all malignant tumors and less than 3% of all head and neck tumors. They occur mostly between 5. and 7. decennium and affect men twice as much as women[1,2].

Sinonasal tumors can be of epithelial origin (carcinomas) and mesenchymal origin (sarcomas).

The most common is spinocellular carcinoma followed by lymphoepithelial carcinoma, undifferentiated sinonasal carcinoma, adenocarcinoma and neuroendocrine tumors[1]. These tumors mostly arise from maxillar and ethmoidal sinus and finally very rarely from frontal and sphenoidal sinus[2,3]. Five-year mortality mainly depends on the histopathological type of tumor and the oncological stage at the time of diagnosis. In early stages (T1–2) five-year survival approaches 60%, in advanced stages (T3–4) it falls to only 20% (ref.[1]). Depending on the histopathologic type, the prognosis can be divided into three groups: tumors with a good prognosis (esthesioneuroblastoma, adenoid-cystic carcinoma) where the five-year survival rate approaches 70%, tumors with a moderate prognosis (spinocellular carcinoma, adenocarcinoma) with a 53%–63% five-year survival rate and tumors with a poor prognosis (undifferentiated sinonasal carcinoma, malignant melanoma) with a five-year survival rate of 35% (ref.[4]). Depending on anatomic localization, tumors originating in the maxillary sinus have a poorer prognosis than those originating from the nasal cavity[3,5]. Etiological risk factors include occupational exposure to wood dust, leatherwork, flour, glue, formaldehyde, and organic solutions. Others include cigarette smoking, chronic sinus infection, radiotherapy, and the presence of inverted papilloma[1,6,7].

Clinical presentation is mostly nonspecific and rarely leads to early diagnosis. It is characterized by nasal congestion, nostril obstruction, persistent epistaxis, anosmia, cephalea or neck lymphadenopathy. In advanced stages with orbital involvement there is sometimes proptosis, diplopia or amaurosis[2,8,9]. The main modality of treatment remains surgical resection. Localized tumors (T1–2) may be cured through surgical therapy with gross complete resection. In other cases, adjuvant radiotherapy follows. In advanced tumors (T3–4) a combined surgical, radiotherapeutic and chemotherapeutic approach remains the chosen standard of treatment[1,10,11]. Proton therapy leads to a better overall survival rate than conventional radiotherapy[12,13]. In this paper we review our experience with combined surgical technique (endonasal and transbasal) in patients with advanced sinonasal tumors.

METHODS

This retrospective study took place between 2014–2022 at the Neurosurgery clinic Teaching hospital in Olomouc. It consisted of patients with advanced sinonasal tumors, who were treated surgically with a combined endonasal endoscopic and open transbasal approach.

All patients were evaluated by an ENT (ear, nose, and throat) specialist and neurosurgeon. They all underwent a planned endoscopic procedure and a bioptic sample was obtained for histological grading. The main diagnostic imaging tool was MRI (magnetic resonance imaging) with gadolinium contrast (Fig. 2). Planning skull base CT (computed tomography scan) was obtained before surgery as well. All patients were well informed of the expected benefit and the risks of the surgery, including the possibility of smell and vision loss. All patients supplied both verbal and written consent before surgery. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the latest Helsinki declaration.

Surgical Technique

Whole body anesthesia with orotracheal intubation preceded all surgical treatment. Patients were placed in the supine position with their head fixed in a Mayfield clamp. All surgical procedures were aided with intraoperative optical navigation systems StealthStation S7 or S8 Medtronic Navigation Inc., Littleton, MA, USA. The surgery field was prepared to be accessible to both endoscopic endonasal and the open frontobasal approach (Fig. 3).

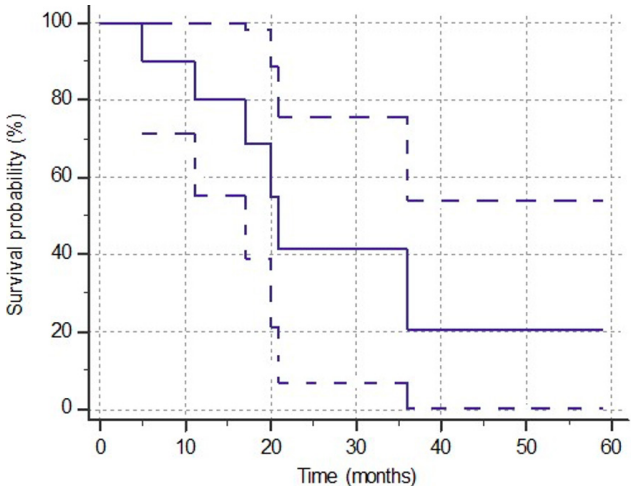

Fig. 1. Kaplan-Meier curve of overall survival including 95% CI.

Frontal transbasal approach

Bicoronal incision extending from the preauricular crease is made bilaterally. The skin flap is prepared and separated from pericranium and elevated dorsally. Vascular pericranium is then prepared separately from glabella and supraorbital ridge sparing the supraorbital and supratrochlear nerves.

The temporal muscle and fascia were elevated in their ventroapical aspect to expose sphenofrontal suture and pterion. Bicoronal craniotomy was then made using three burr holes placed above the orbitotemporal aspect and coronal suture as usual. Craniotomy was made to extend as frontally as possible. The dura mater was separated

Table 1. Table comprehensively showing our patient cohort, showing age, sex, histological type, TNM classification, extent of resection, adjuvant therapy, follow-up.

Age	Sex	Diagnosis	TNM classification	Extent of resection	Adjuvant therapy	Repeated surgery	Follow-up (months)
68	Male	Spinocellular carcinoma	T4N0M0	GTR	Radiotherapy – LINAC	NO	17†
55	Male	Small cell neuroendocrine tumour	T4N0M0	NTR	Chemotherapy, radiotherapy – LINAC	NO	36†
62	Male	Spinocellular carcinoma	T4N0M0	GTR	Radiotherapy – proton	NO	59
42	Male	Undifferentiated sinonasal carcinoma	T4N0M0	GTR	NO	NO	5†
39	Male	Undifferentiated sinonasal carcinoma	T4N0M0	GTR	Chemotherapy, radiotherapy – proton	Yes – recurrent disease	21†
34	Male	Undifferentiated sinonasal carcinoma	T4N0M0	GTR	Chemotherapy, radiotherapy – proton	Yes – recurrent disease	20†
58	Female	Spinocellular carcinoma	T4N0M0	GTR	NO	NO	18
59	Female	Undifferentiated sinonasal carcinoma	T4N0M0	NTR	Radiotherapy – proton	NO	11†
55	Male	Adenoid cystic carcinoma	T4N0M0	GTR	Radiotherapy – proton	Yes – recurrent disease	33
57	Female	Spinocellular carcinoma	T4N0M0	GTR	Radiotherapy – proton	NO	12

† denotes length of follow up until death.

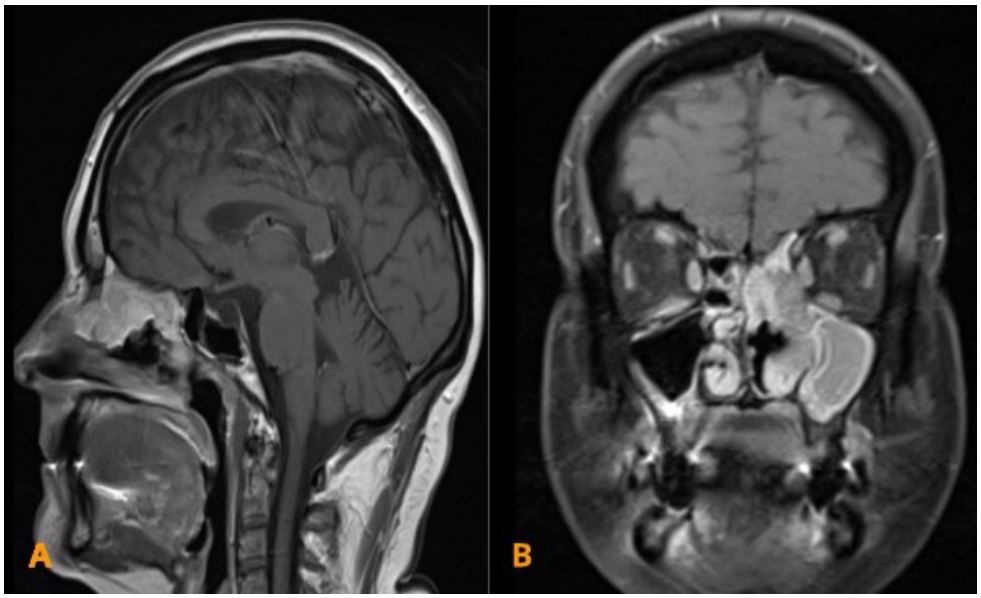

Fig. 2. Contrast enhanced brain MRI, T1 weighted scans sagittal (A) and coronal (B) showing an anterior skull base tumor growing into the sinonasal cavity.

Fig. 3. Patient positioned in supine position with head in a Mayfield's clamp, bicoronal incision site noted with a marker (A). Surgical field prepared for a combined transnasal and open transbasal surgical approach (B).

carefully before bone extraction. The posterior wall of the frontal sinus was removed, and the frontal sinus opened widely. Cranialization was achieved with the removal of the mucosal lining. Depending on the size of the tumor, the frontal skull base was made available from crista galli to stripping of the fila olfactoria to eventually resect sinus sagitalis superior in its rostral part and falx resection. In the case of dural involvement, the intradural resection of the tumor precedes the dural resection and watertight duraplasty by the means of fascia lata follows with the intention of sterile intradural surgical field. The amount of exposure of anatomical structures depended on the extent of tumor infiltration. Usually, a wide ethmoidectomy enables inspection of the nasal cavity. In the case of sphenoidal or maxillar involvement, sphenoidectomy or antrostomy was performed. In orbital involvement, the medial or superior aspect of the orbit was drilled away, and the tumor was completely resected with infiltrated periorbital tissue. Tumor resection was made to achieve a resection margin of R0. The skull base defect was reconstructed using a titanium plate (Fig. 4). The periostal flap was then placed epidurally subfrontally, and sutured to the dura mater secured with tissue glue (Tisseeel). The craniotomy was then reconstructed with the bone and secured with titanium plates to the cranium.

Endoscopic endonasal approach

An endoscopic approach followed the intracranial open surgery. After anemization of the nasal cavity, an endoscopic approach was created with a 30° optic (Storz). Both the nasal cavity and the paranasal sinus were inspected ("blind spots") and in the case of any tumor residue,

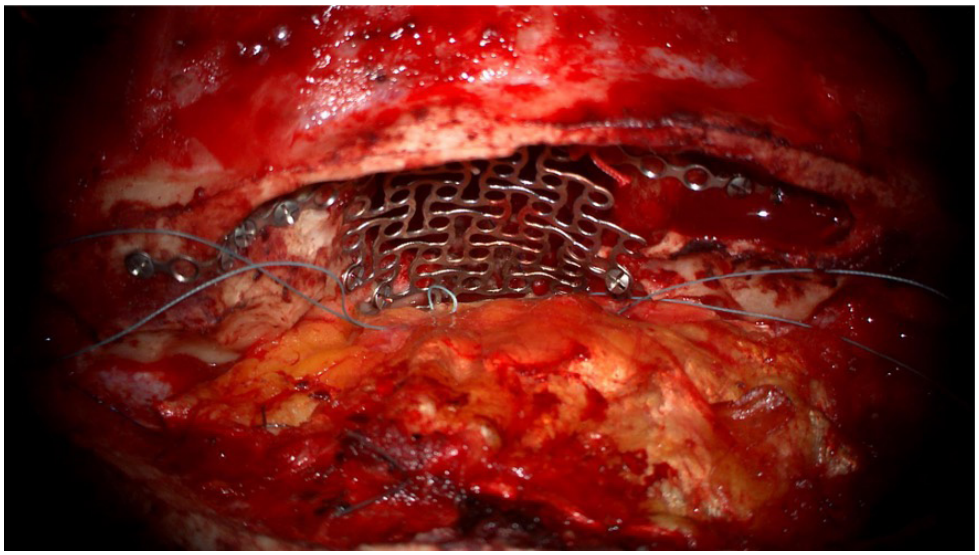

Fig. 4. Anterior skull base fossa reconstruction using titanium plate, fascia lata grafting apparent in duraplasty superiorly.

an excision was attempted. Next the skull base plasty was explored and fatty tissue with tissue glue was placed underneath. At the end of the surgery two nasal tamponades (Merocel) were left in place for up to five days. In all patients, a lumbar drain was placed to prevent postoperative liquorrhea and left in place for three to five days.

After surgery, oncological therapy at an oncological clinic followed. Patients were also routinely examined by an ENT doctor who endoscopically inspected the nasal cavity until it had completely healed. After that, every three months an endoscopic review of the nasal cavity took place in all patients as well as an MRI with gadolinium contrast.

We assessed histopathological grade, resection radicality (gross total resection to incomplete resection) and tumor recurrence, peri and postoperative complication rate, type of oncological therapy, and overall survival. The results were statistically analyzed. The statistical software MedCalc v18.2 (MedCalc Software, Ostend, Belgium) was used for statistical processing. The overall survival time was evaluated using the Kaplan-Meier method, and the comparison of survival in individual groups was evaluated using the log-rank test.

RESULTS

Our cohort consisted of ten patients between the ages of 34 and 68 (average age 52.9), made up of seven males and three females. Four patients were diagnosed with undifferentiated sinonasal carcinoma, in three patients the histopathological finding was spinocellular carcinoma, two patients were diagnosed with sarcoma, and in one patient small cell neuroendocrine carcinoma was found. This can be seen in Table 1. All patients presented with advanced disease. Complete resection (R0) was achieved in 8 cases (80%) and subcomplete resection in two cases (20%). The average overall survival for patients with complete resection was 32.1 months (95% CI 15.5–48.7), for patients with subcomplete resection it was 23.5 months (95% CI 1.0–48.0), the result was not statistically significant (P=0.637). In patients without repeated surgery, the average overall survival was 30.8 months (95% CI 14.2–47.3), and for patients with repeated surgery the average overall survival was 24.7 months (95% CI 18.0–31.4), the result was not statistically significant (P=0.881). The average overall survival time for women was 15.6 months (95% CI 11.9–19.4), and for men the average survival time was 29.4 months (95% CI 15.4–41.5), the result was not statistically significant (P=0.764).

The overall survival averaged 28.7 months (95% CI 15.9–41.6) (Fig. 1). In surviving patients, the average length of the follow up was 30.5 months (12–59). In total there were three complications, two nasal CSF (cerebrospinal fluid) leaks and one infection, brain abscess with osteomyelitis, all resolved satisfactorily.

DISCUSSION

The frontal transbasal approach was first described by Dandy in 1936 in the large frontal meningioma invading ethmoidal sinus[14]. Unterberger used this approach in the treatment of frontobasal injury in 1958. At that time this approach was innovative, as it reduced the craniofacial scarring connected to then mostly used extracranial approaches[15]. The term itself "frontobasal approach" was first used by Derome in 1972 and he used it for midline frontal skull base tumors[16]. The approach was then refined by a series of authors. Kawakami described en block bilateral osteotomy of orbital roof and frontal sinus and termed this approach as the "extensive transbasal approach"[17]. Sekhar described an orbitalfrontoethmoidal osteotomy variation based on the localization of the tumor and named this approach the "extended frontal approach"[18]. Fukushima popularized this approach and further refined the necessary anatomy, surgical technique and indication[19].

Varying classifications of the transbasal approach arose over time. The most complex one seems to be proposed by Feiz-Erfan et al. This classification sorts the transbasal approach into four categories. Basic transbasal approach is termed TBA – level 0 and consists of a bicoronal incision with bifrontal craniotomy. Level I TBA adds osteotomy of the orbit or nasal bone. Level II TBA further extends the approach with the separation of the medial canthal ligament and osteotomy of medial aspect of the orbit. Finally Level III TBA extended the approach further by resecting the lateral wall of the orbit to the point of inferior orbital fissure[20].

The endoscopic endonasal approach is considered adjunctive to the open transbasal approach, allowing for a better visualization of the surgical field, skull base and eventually makes obscured parts of the tumor available for resection. This leads to increased radicality in both surgical and oncological therapy, as well as better cosmetic results. An undeniable advantage of this combined approach is the option to review the skull base reconstruction endoscopically and identify any eventual CSF leak. Gabriel et. al describes the double flap technique in skull base reconstruction in patients who had undergone the combined transbasal and endoscopic approaches for sinonasal tumor. This technique uses a vascularized epicranial flap placed on the bifrontal skull base and an endoscopically prepared nasoseptal flap. Furthermore, a lumbar drain is placed to aid healing.

This cohort was composed of nine patients, with the average follow-up of 35.7 months and all underwent adjuvant radiotherapy. No CSF leak was apparent in this cohort[21]. This technique was used in our cohort as well. We used the vascularized epicranial flap, fascia lata and fatty tissue endonasaly combined with muscle and tissue glue. Using a nasoseptal flap in complete tumor resection remains controversial. Further advantages of the endoscopic endonasal approach lie in the option of wide opening of the paranasal sinuses drainage, reduction in dead space and lower incidence of sinusitis and other infections. This finding is similar to that of Morioka et al., who had no perioperative infections in 16 patients treated with this combined approach[22]. We encountered one infection and that of brain abscess associated with osteomyelitis. This occurred in a patient with poor compliance.

Sinonasal tumors are a rare and heterogenic entity. The literature describes only case reports or small cohorts of patients[23,24]. Therefore, we find it difficult to appropriately assess the outcome as it is not only dependent on the histopathological type, but on the extent of the disease as well. This leads to inconsistencies and unavailability of recommended treatment plans[25]. In our study we mostly encountered undifferentiated sinonasal carcinoma. These four patients were in the advanced stages of the disease (T4) and were treated with the combined endoscopic and open approach. Three of these underwent proton therapy and two of them combined it with chemotherapy. One patient refused further oncological therapy. In patients who died, the overall survival spanned 5 to 20 months. Walkman et al. published a cohort of undifferentiated sinonasal carcinomas spanning 15 years. The cohort comprised 27 patients, average age 54.6, and males were predominant (63%). 85% of patients had advanced disease (T4). Surgical therapy was attempted in 23 cases (85%). In the terminal stage of the disease no surgical therapy was indicated. As for the surgical technique, 43% underwent neurosurgical intervention and 57% underwent purely endoscopic intervention. The gross total resection was achieved in 57% of the cases. Combined radio and chemotherapy were applied in 96% of the patients. Two-year survival was reached in 66% of the patients. Five-year survival reached 46% (ref.[25]).

CONCLUSION

Advanced sinonasal tumors are a heterogeneous group of malignant tumors requiring a tailored surgical and oncological approach. A combined endoscopic and transbasal approach presents an advantageous surgical strategy as it allows for greater radicality, reliable skull base reconstruction, and reduces the need for extensive cranial approaches.

Author contributions: LH, VN, MV, DK, JH, CH: performed the surgeries; VN: prepared the manuscript; VN, DP: collected data; DP: performed English correction; LH: revised the manuscript critically; All authors read and approved the final manuscript.
Conflict of interest statement: None declared.

REFERENCES

1. Bracigliano A, Tatangelo F, Perri F, Di Lorenzo G, Tafuto R, Ottaiano A, Clemente O, Barretta ML, Losito NS, Santorsola M, Tafuto S. Malignant Sinonasal Tumors: Update on Histological and Clinical Management. Curr Oncol 2021;28:2420-38.
2. Dutta R, Dubal PM, Svider PF, Liu JK, Baredes S, Eloy JA. Sinonasal malignancies: A population-based analysis of site-specific incidence and survival. Laryngoscope 2015;125:2491-7.
3. Husain Q, Joshi RR, Cracchiolo JR, Roman BR, Ganly I, Tabar V, Cohen MA. Surgical Management Patterns of Sinonasal Malignancy: A Population-Based Study. J Neurol Surg B Skull Base 2019;80:371-9.
4. Turner JH, Reh DD. Incidence and survival in patients with sinonasal cancer: a historical analysis of population-based data. Head Neck 2012;34:877-85.
5. Nicolai P, Battaglia P, Bignami M, Bolzoni Villaret A, Delù G, Khrais T, Lombardi D, Castelnuovo P. Endoscopic surgery for malignant tumors of the sinonasal tract and adjacent skull base: a 10-year experience. Am J Rhinol 2008;22:308-16.
6. Bishop JA. Recently described neoplasms of the sinonasal tract. Semin Diagn Pathol 2016;33:62-70.
7. Van den Oever R. Occupational exposure to dust and sinonasal cancer. An analysis of 386 cases reported to the N.C.C.S.F. Cancer Registry. Acta Otorhinolaryngol Belg 1996;50:19-24.
8. Patel TD, Vazquez A, Dubal PM, Baredes S, Liu JK, Eloy JA. Sinonasal neuroendocrine carcinoma: a population-based analysis of incidence and survival. Int Forum Allergy Rhinol 2015;5:448-53.
9. Thariat J, Moya Plana A, Vérillaud B, Vergez S, Régis-Ferrand F, Digue L, Even C, Costes V, Baujat B, de Gabory L, Baglin AC, Janot F. Diagnostic, pronostic et traitement des carcinomes nasosinusiens (hors mélanomes, sarcomes et lymphomes). Bull Cancer 2020;107:601-11.
10. Parsons JT, Mendenhall WM, Mancuso AA, Cassisi NJ, Million RR. Malignant tumors of the nasal cavity and ethmoid and sphenoid sinuses. Int J Radiat Oncol 1988;14:11-22.

11. Sjöstedt S, Karnov K, Buchwald CV. Diagnostics and treatment of sinonasal cancer. Ugeskr Laeger 2018;180:30259840.
12. Patel SH, Wang Z, Wong WW, Murad MH, Buckey CR, Mohammed K, Alahdab F, Altayar O, Nabhan M, Schild SE, Foote RL. Charged particle therapy versus photon therapy for paranasal sinus and nasal cavity malignant diseases: A systematic review and meta-analysis. Lancet Oncol 2014;15:1027-38.
13. Holliday EB, Frank SJ. Proton Radiation Therapy for Head and Neck Cancer: A Review of the Clinical Experience to Date. Int J Radiat Oncol 2014;89:292-302.
14. Dandy WE. Orbital Tumors. Results Following the Transcranial Operative Attack. New York: Oskar Piest;1941.
15. Unterberger S. Care of frontobasal wounds. Arch Ohren Nasen Kehlkopfheilkd 1958;172:463-84. (in German)
16. Derome PJ. The transbasal approach to tumors invading the base of the skull. In: Schmidek HH, Sweet WH. eds. Grune & Stratton;1982:357-79.
17. Kawakami K, Yamanouchi Y, Kawamura Y, Matsumura H. Operative approach to the frontal skull base: extensive transbasal approach. Neurosurgery 1991;28:720-4.
18. Sekhar LN, Nanda A, Sen CN, Snyderman CN, Janecka IP. The extended frontal approach to tumors of the anterior, middle, and posterior skull base. J Neurosurg 1992;76:198-206.
19. Terasaka S, Day JD, Fukushima T. Extended transbasal approach: anatomy, technique, and indications. Skull Base Surg 1999;9:177-84.
20. Feiz-Erfan Ii, Spetzler RF, Horn EM, Porter RW, Beals SP, Lettieri SC, Joganic EF, Demonte F. Proposed classification for the transbasal approach and its modifications. Skull Base 2008;18:29-47.
21. Gabriel PJ, Kohli G, Hsueh WD, Eloy JA, Liu JK. Efficacy of simultaneous pericranial and nasoseptal "double flap" reconstruction of anterior skull base defects after combined transbasal and endoscopic endonasal approaches. Acta Neurochir 2020;162:641-7.
22. Morioka M, Hamada J, Yano S, Kai Y, Ogata N, Yumoto E, Ushio Y, Kuratsu J. Frontal skull base surgery combined with endonasal endoscopic sinus surgery. Surg Neurol 2005;64:44-9.
23. Chen AM, Daly ME, El-Sayed I, Garcia J, Lee NY, Bucci MK, Kaplan MJ. Patterns of failure after combined-modality approaches incorporating radiotherapy for sinonasal undifferentiated carcinoma of the head and neck. Int J Radiat Oncol Biol Phys 2008;70:338-43.
24. Gamez ME, Lal D, Halyard MY, Wong WW, Vargas C, Ma D, Ko SJ, Foote RL, Patel SH. Outcomes and patterns of failure for sinonasal undifferentiated carcinoma (SNUC): the Mayo Clinic experience. Head Neck 2017;39:1819-24.
25. Workman AD, Brody RM, Kuan EC, Baranov E, Brooks SG, Alonso-Basanta M, M, Newman JG, Rassekh CH, Chalian AA, Chiu AG, Weinstein GS, Feldman MD, Adappa ND, O'Malley BW Jr, Palmer JN. Sinonasal Undifferentiated Carcinoma: A 15-Year Single Institution Experience. J Neurol Surg B Skull Base 2019;80:88-95.