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An Overview of Vagal Paraganglioma Surgery: Evaluation of Operative Morbidities and Quality of Life After Surgery

ABSTRACT

Objective: To analyze postoperative morbidity and quality of life of surgically treated patients for vagal paraganglioma.

Methods: Preoperative symptoms and findings, presence of cranial nerve paralysis, radiological findings, surgical techniques, perioperative, and postoperative complications were analyzed retrospectively. Washington University Quality of Life Questionnaire (UW-QOL) was used to evaluate the quality of life of the patients.

Results: Of the 11 patients, 8 were women and 3 were men with an age distribution of 22-70 (mean age, 49.9 years). Two patients had vocal cord paralysis and 1 patient had hypoglossal nerve paresis preoperatively. In 5 patients, the vagus nerve was partially resected; vocal cord movements recovered within 6 months in 2 out of 5 (40%). The continuity of the nerve could not be preserved in the remaining 6 patients, Ishiki type 1 medialization thyroplasty was performed in 4 (44.4%). In 3 patients, the hypoglossal nerve was invaded by the tumor and was sacrificed. Temporary facial paresis occurred in 3 patients who were operated on with transcervical-transparotid approach. Complete recovery was achieved in all within 3 months. In a patient with an extensively large tumor, carotid bypass surgery was performed with the saphenous vein. Except for one patient, the mean scores of all patients were above 90 with UW-QOL.

Conclusion: Surgery, which is the only curative treatment method, may not cause a significant change in the postoperative quality of life in well-selected cases. Trying to protect the vagus nerve by dissecting it as much as possible and rehabilitation with Isshiki type 1 thyroplasty in case of aspiration are key points.

Keywords: Vagal paraganglioma, thyroplasty type 1, vagus nerve

INTRODUCTION

Vagal paragangliomas (VP) are hypervascular tumors originating from the paraganglionic tissue in the vagus perineurium. Considering the general distribution of all paragangliomas according to their localization, only 3% of them have head and neck origin.[1] Paragangliomas can arise basically from 2 different points along the vagus nerve (CN X). Paragangliomas originating from the superior vagal ganglia are called jugular foramen paragangliomas (glomus jugulare), while paragangliomas originating from the inferior vagal ganglia are called VP. VP are very rare tumors and they constitute less than 5% of all head and neck paragangliomas.[2] They are usually located within the first 2 cm of the CN X after it emerges from the skull base, and they frequently originate from the ganglion nodosum. They may rarely be located more rostrally or caudally. Determining the treatment approach for VP is more difficult than it is for carotid body paragangliomas. Besides their superior localization in the parapharyngeal space, which makes surgical access difficult, surgical treatment is very likely to result in paralysis of the vocal cord and the pharyngeal plexus secondary to CN X nerve damage.

In this article, preoperative presentation, surgical approaches, postoperative morbidities, and their effects on the quality of life of 11 surgically treated patients for VP will be discussed.

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METHODS

In this study, the medical records of patients who were operated for VP between 2011 and 2020 were retrospectively analyzed. Preoperative symptoms and findings, presence of cranial nerve paralysis, radiological findings, surgical techniques, and perioperative and postoperative complications were screened from the medical records of the patients. The patients were invited to the clinic for a control examination and re-evaluated in terms of the current status of the cranial nerves, dysphagia, and quality of life. The Turkish validation of the Washington University Quality of Life Questionnaire (UW-QOL), which was created for patients treated for head and neck cancers, was used to evaluate the quality of life.[3,4] The aim and objectives of the study were explained to the patients, informed consent forms were taken, and the patients filled out the UW-QOL with the physician (supplementary document). Twelve questions in the questionnaire were scored between 0 and 100. Health and general quality of life were evaluated with 3 additional general questions. The numerical average of the answers given to the questionnaire questions was accepted as the "compact quality of life score." This study was approved by the Istanbul University Istanbul Faculty of Medicine Clinical Research Ethics Committee (April 1, 2021/158489).

RESULTS

Of the 11 patients included in the study, 8 were women and 3 were men; the youngest patient who was operated on was 22 years old and the oldest patient was 70 years old. The mean age was 49.9 years (SD±14.33). Five of the tumors were on the right side and 6 of them were on the left. Clinical presentations, tumor findings, surgical information, and postoperative complications of the patients are given in Table 1. The most common complaints were the feeling of a mass in the neck and/or throat (n = 6, 54.5%), hoarseness (n = 2), shortness of breath (n = 1), the difficulty of swallowing (n = 1), weakness of tongue movement (n = 1), and pain (n = 1). In 3 (27.3%) patients, the mass was detected incidentally during head and neck imaging performed for different reasons (Figure 1).

The diagnosis was made with clinical and radiological findings in all of the patients. Contrast-enhanced magnetic resonance imaging (MRI) was the preferred imaging modality in all patients.

MAIN POINTS

- Vagal paragangliomas are very rare tumors.
- Their surgery is much more complicated than carotid body tumors. Besides their superior localization which makes surgical access difficult, surgical treatment is very likely to result in multiple cranial nerve paralysis.
- Dissection of the tumor from the nerve fibers may be possible, especially in small-sized tumors. The recovery of nerve functions is 40% in the study.
- Surgery is the only curative treatment method in vagal paragangliomas and it may not cause a significant change in the postoperative quality of life in well-selected cases.

All of the tumors were located in the poststyloid region of the parapharyngeal space. Computed tomography angiography was used in the presence of suspicion of carotid artery invasion and/or skull base invasion. Fine needle aspiration biopsy (FNAB) was not used in the preoperative evaluation. None of the patients underwent preoperative angiography embolization. In 2 patients who were thought to have an invasion of the internal carotid artery, a preoperative balloon occlusion test was performed to test whether cerebral perfusion from the contralateral internal carotid artery could be achieved, and both patients passed the test.

Tumor sizes of all subjects were measured in T1 contrast-enhanced MRI sections; the largest tumor had a maximum diameter of 58 mm and the smallest tumor 21 mm (mean 38.3 mm, SD±11.52). The largest diameters of the tumors which were detected incidentally were 36 mm, 25 mm, and 21 mm, respectively. The diameter of the mass was at least 29 mm in subjects with neck mass complaints. Synchronous contralateral paraganglioma of the carotid body was detected in 2 patients (Figure 2). In these patients, carotid body paraganglioma was operated on first, and VPs were operated on in the second session. Except for 2 patients who presented with hoarseness in the preoperative period, all the others had normal vocal cord movements preoperatively. The patient who presented with complaints of restriction of tongue movements was found to have hypoglossal nerve (CN XII) paresis. No additional preoperative cranial nerve deficit was detected in the remaining subjects.

As a surgical approach, the transcervical-transparotid combined approach was preferred in 7 patients, and the transcervical approach was sufficient in 4 patients. Selective neck dissection including unilateral levels 2a and 3 was performed in all patients to increase surgical exposure and to investigate lymph node metastasis. Temporary facial paresis occurred in 3 patients who were operated on with the transcervical-transparotid approach. Complete recovery was achieved in all within 3 months. Due to CN XII invasion, the nerve was sacrificed in 3 patients one of whom had already had preoperative paralysis of CN XII. In a patient with an extensively large tumor (58 × 58 × 53), carotid bypass surgery was performed with the saphenous vein by the cardiovascular surgery team since the tumor surrounded the internal carotid artery by 360 degrees; no neurological deficits developed in the postoperative period. In 5 patients, the tumor could be dissected from the vagal trunk, and the nerve was partially resected, however, the continuity of the CN X could not be preserved in the remaining 6 patients (Figure 3A and B). In 2 (40%) of the patients who underwent partial CN X resection, vocal cord movements recovered within 6 months postoperatively.

In 6 patients, oral feeding could be achieved on the postoperative first day despite the presence of CN X paralysis; in others, oral feeding was tolerated on the fourth day at most. The 2 patients who already had preoperative vocal cord paralysis did not have any additional problem due to the resection of the CN X nerve, however, Isshiki type 1 medialization thyroplasty was performed under local anesthesia in 4 (44.4%) of the remaining 9 patients; successful results were obtained in terms of voice quality and prevention of aspiration. No patient developed aspiration pneumonia in the postoperative period. When sympathetic chain damage secondary to VP surgery was questioned,

Table 1. Clinical Presentation, Tumor Size, Operation Information, and Postoperative Complications of the Patients

Patient	Age	Complaint	Size (mm)	Surgery	Cranial Nerve/Vascular Damage PR/PO	Oral Feeding (PO)	Permanent Vagal Damage	Hospitalization (day)	Synchronous PG
1	22	Hoarseness	36x31x30	TP+TS	10 (PR); 10-11-12 (invased) sacrificed	First day	+	3	
2	39	Incidentally	36x27x25	TS	10 (perioperatively dissected)	First day	+	3	
3	70	Hoarseness, neck and throat mass, dyspnea, dysphagia	58x58x53	TP+TS	10 (PR); 12-7 (transient), Horner syndrome, ICA resection (saphenous vein graft)	Third day	+	14	
4	65	Neck and throat mass	50x45x31	TP+TS	10-7 (transient), Horner syndrome	Second day (partial fluid aspiration)	+, PO 11th week ThP	5	
5	51	Restricted tongue movement	45x40x40	TP+TS	12 (PR), 10, Horner syndrome	Fourth day	+, PO 10th week ThP	7	
6	58	Neck mass	35x34x25	TP+TS	10 (perioperatively dissected)	Second day (partial fluid aspiration)	+, PO 5th month ThP	4	
7	38	Neck mass	29x27x20	TS	10 (perioperatively dissected)	First day	+, PO 21st day ThP	5	Contralateral carotid
8	63	Incidentally	21x18x15	TP+TS	10, 7 (transient)	First day	+	4	
9	49	Neck mass, pain	35x30x29	TP+TS	10	First day	+	5	
10	55	Incidentally	25x25x21	TS	10 (perioperatively dissected)	First day	PO 5th month VC movement +	3	
11	39	Neck mass	51x49x35	TS	10 (perioperatively dissected)	Third day	PO 6th month VC movement +	5	Contralateral carotid

TP, transparotid approach; TS, transcervical approach; PR, preoperative; PO, postoperative; ThP, Isshiki type 1 thyroplasty; VC, vocal cord; ICA, internal carotid artery; PG, paraganglioma.

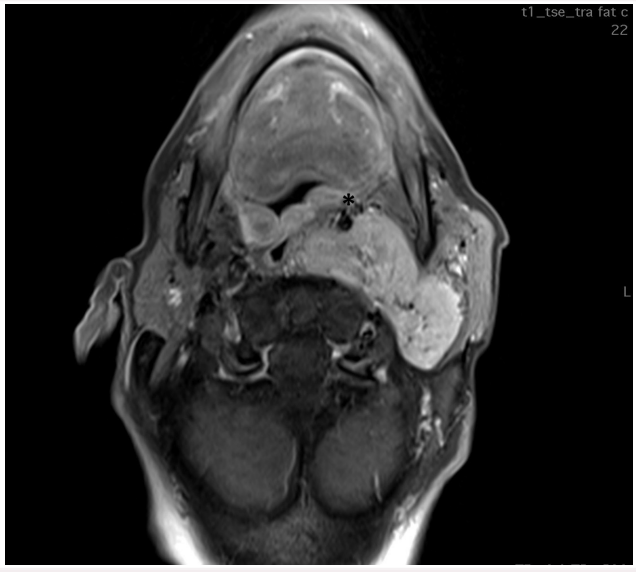


Figure 1. T1 contrasted the MRI axial section of a large VP mimicking a deep lobe parotid tumor (Case 3). The lesion originates from the poststiloid part of the parapharyngeal space, note the anterior displacement of the internal carotid artery (asterix). The patient presented with dyspnea and swallowing difficulties due to the oropharyngeal mass effect of the tumor.

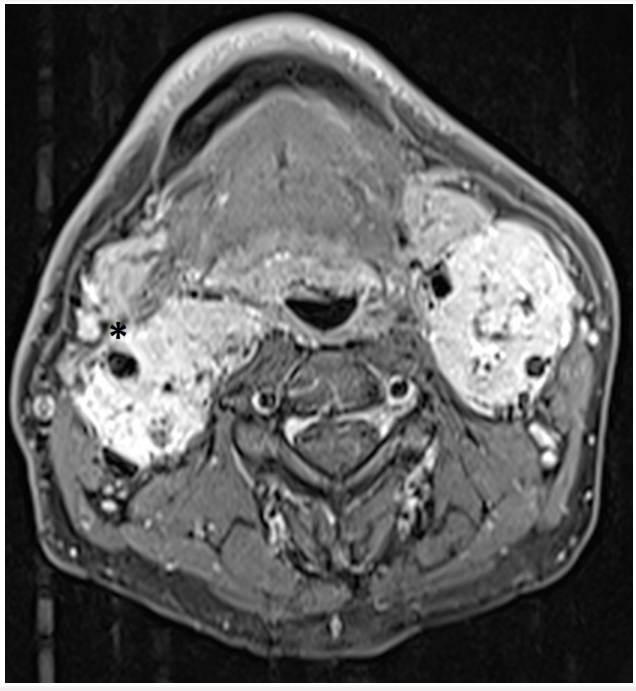


Figure 2. T1 contrasted the axial section of a case of bilateral paraganglioma (Case 11). A carotid body tumor on the left side (asterix), which was operated first, and a VP on the right side. Vagal paragangliomas pushed the common carotid artery anteriorly due to its poststiloid origin, is located more posteriorly in the neck, had a small amount of oropharyngeal expansion, and did not separate internal and external carotid arteries, which distinguishes VP radiologically from carotid body tumors.

3 patients were found to have Horner syndrome in the postoperative period. None of the patients had complaints consistent with first bite syndrome in the long-term follow-up. The results of the UW-QOL questionnaire, which was conducted to inquire about the quality of life, are given in Table 2.

Local control was achieved in all patients, and regional or systemic metastases was not observed in any patient during the follow-up period.

DISCUSSION

VP usually develops in middle-aged adults (mean age: 41-47 years) and there is female gender predominance.[5] The multicentric tumor can be found in 17-37% of all cases and up to 80% in familial types.[5] Familial cases are generally associated with mutations in the succinate dehydrogenase genes.[6] The age of the patients in this study was compatible with the literature, and female patients constituted 72.7% of all patients. There was no family history, but 2 subjects had contralateral carotid body paraganglioma, consistent with multicentric tumors.

Because of their superior localization, VPs are noticed in a relatively later period by the patients. In addition to the complaint of a mass in the neck, which is the most common presenting symptom, they may cause breathing or swallowing difficulties when they cause cranial nerve paralysis or reach large sizes. On the other hand, they can be detected incidentally in some patients. Cranial nerve deficit was seen in 27.3% of the subjects at the time of presentation. In the literature, this rate is around 25-30%, and the nerve that is most frequently affected is the CN X nerve.[7] Multiple cranial nerve paralysis at the time of diagnosis was not detected in any of the patients in the study group, so this may not be expected unless it causes compression at the level of the jugular foramen.

Radiological examinations are the key to the diagnosis of patients with suspected parapharyngeal tumors. To better investigate the soft tissue detail, it is recommended to prefer contrast-enhanced MRI in the first line.[8] In MRI, the tumor appears to be iso- or hypointense compared to muscle tissue in both T1 and T2 examination and demonstrates intense gadolinium contrast enhancement in T1 examination; the salt and pepper appearance consisting of punctual hemorrhagic foci (salt) and signal voids (pepper) due to low flow velocity in T1 and T2 examinations may be seen.[9] They were differentiated from the carotid body paraganglioma based on the findings that they were located superior to the carotid bifurcation, pushed the bifurcation anteriorly and medially, and did not expand the bifurcation.[10] FNAB is not recommended in a tumor that is considered to be paraganglioma at the preliminary diagnosis due to its hypervascular nature. The only method that is important to indicate as an additional examination is a preoperative angiography and balloon occlusion test in large tumors in case of a close relationship with the internal carotid artery. If surgery is planned for such cases, it should be strictly planned in cooperation with the cardiovascular surgery team. Preoperative embolization in paragangliomas is controversial; the aim is to reduce perioperative bleeding.[11] The embolization process itself is a risky procedure; there might be anastomoses between the internal and external carotid systems, or the embolization agent might reflux from the external carotid artery into the internal carotid artery

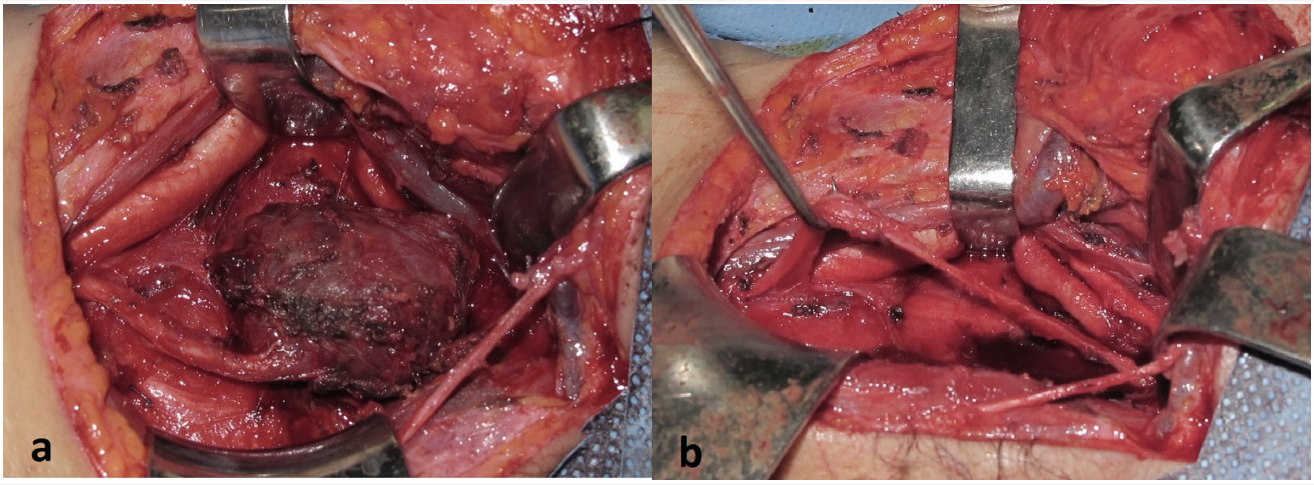


Figure 3. a,b. A left-sided VP (A); in this case, the tumor was dissected from the vagus nerve (B) and a great amount of CN X was protected, but the nerve functions did not recover (Case 2).

and may disrupt the cerebral perfusion.[12] Most of the head and neck paragangliomas are multicompartmental lesions, so they may have multiple feeding arteries, and they must be entirely embolized for adequate devascularization of the tumor, which may be difficult especially in big tumors.[1] The authors did not use preoperative embolization in any of the patients in the series because of the reasons mentioned above.

In VP, tumor invasion of surrounding tissues such as the skull base or carotid artery is not a malignancy criterion. According to the World Health Organization 2017 classification, the only malignancy criterion is the presence of metastases in the extra-paraganglionic tissue.[13] Levels 2-3 selective neck dissection should be performed in every VP surgery to investigate the presence of metastases and to perform correct staging, even if no clinical and radiological metastases are observed in the neck. An advantage of neck dissection is that major vascular structures can be identified in the neck, which provides better surgical exposure. Extra-paraganglionic metastasis was not detected in any patient in the study group.

There are different techniques such as transcervical approach, transcervical-transparotid approach, and transcervical-transmandibular (mandibular splitting) approach for surgical access to the parapharyngeal region.[14] However, if parapharyngeal region surgery is not performed due to malignant histology or recurrent disease, mandibulotomy should be avoided due to unfavorable functional and aesthetic results.[15] The reason for using the transcervical-transparotid approach in the majority of patients (63.6%) in this series is the large volume of the majority of tumors in the study group. The addition of transparotid dissection enables the parotid tail to be elevated and the stylomandibular ligament to be resected; both of these maneuvers will further increase the exposure of the parapharyngeal area.

Postoperative cranial nerve paralysis should be discussed with all patients before surgery. The condition that creates the greatest morbidity after VP surgery is damage to the CN X. Since the tumor originates in the parapharyngeal region, nerve damage will not result in only vocal cord paralysis as in recurrent nerve damage, but also sensory branches of the CN X to the pharynx, soft palate motor innervation, and superior laryngeal nerve will also be affected. In patients with preoperative CN X paralysis, due to the development of paralysis in a long time, physiological adaptation is observed. In such patients, morbidity due to resection of the CN X during the operation was not observed in the study group. It should not be forgotten that VPs are not originating primarily from the nerve, but are tumors invading the nerve through close relationships. Dissection of the tumor from the nerve fibers may be possible, especially in small-sized tumors. The recovery of nerve functions in 40% of the patients in the study group in whom the tumor could be dissected from the nerve supports that the nerve should not be resected at the beginning of the operation, if possible, and every effort should be made to preserve the nerve. The low percentage of permanent severe swallowing dysfunction in our series can be attributed to this approach. In the postoperative period, rehabilitation of other cranial nerve injuries is not necessary, except for vocal cord paralysis. If aspiration secondary to CN X paralysis is evident and the nerve is sacrificed during the operation, medialization of the paralytic vocal cord should be performed as soon as possible for postoperative swallowing rehabilitation. Isshiki type 1 thyroplasty is the preferred modality by the authors, and silicone was used as a medialization agent in all of the patients. As the paralysis of the superior laryngeal nerve accompanies the recurrent laryngeal nerve paralysis in these patients, the vocal cord is fixated in a more lateral position. Type 1 thyroplasty provides a better medialization effect and a permanent result compared to the injection laryngoplasty. Additionally, it has the advantage of being performed under local anesthesia, hence the voice quality can be adjusted during the operation.

Since a valid quality of life questionnaire was not found for benign tumors, UW-QOL was used in this study to measure the quality of life of the patients in the postoperative period. Except for one patient, the mean scores of all patients were above 90. This patient was 70 years old, had preoperative CN X paralysis, and additionally, CN XII and sympathetic plexus paralysis occurred postoperatively. Although there was a significant

Table 2. Washington University Quality of Life Questionnaire (UW-QOL) Scores

Patient	Pain	Appearance	Activity	Recreation	Swallowing	Chewing	Speech	Shoulder	Taste	Saliva	Mood	Anxiety	Score	General 1	General 2	General 3
1	75	100	100	100	100	100	100	70	100	100	100	100	95.4	50	60	100
2	100	100	100	100	100	100	100	100	100	100	100	100	100	50	60	100
3	0	100	50	100	30	50	70	100	100	100	50	100	70,8	25	40	40
4	100	100	100	100	100	100	100	100	100	100	100	100	100	50	60	80
5	100	100	100	100	70	100	70	100	100	100	100	100	95	50	60	60
6	100	100	100	100	70	100	70	100	100	100	100	100	95	50	60	60
7	100	100	100	100	100	100	100	100	100	100	100	100	100	50	60	60
8	75	100	100	75	70	100	70	100	100	100	100	100	90.8	50	60	80
9	75	100	100	100	70	100	100	100	100	100	100	100	95.4	50	80	80
10	100	100	100	100	100	100	100	100	100	100	100	100	100	75	100	100
11	100	100	100	100	70	100	100	100	100	100	100	100	97.5	75	80	80
Total	84.1	100	95.5	97.7	80	95.5	89.1	97.3	100	100	95.5	100	94.5	52.3	65.5	76.4

aspiration problem in the postoperative period, the patient did not accept thyroplasty. For these reasons, quality of life scores was calculated very low. On the contrary, patient number 1 tolerated the surgery very well due to her young age, despite the preoperative CN X paralysis and addition of postoperative CN XI and CN XII paralysis. This patient did not even need thyroplasty, and her UW-QOL scores were found to be high. When other patients are evaluated, it can be commented that thyroplasty is successful in preventing aspiration and accordingly in increasing the quality of life. As a conclusion, considering the scores in general, it can be interpreted that surgical treatment did not have a serious negative impact on the quality of life of the patients in the study.

While deciding on surgical treatment in VP, the pros and cons of the treatment modality should be thoroughly weighed. The following factors should be taken into account: the tumor has a difficult-to-reach location; the operation mostly results in CN X paralysis; the other lower cranial nerves may be invaded by the tumor; the tumor has a close relationship with the carotid and jugular vein, and mostly the tumors are histopathologically benign. It may be more appropriate to choose conservative treatment modalities in elderly patients with systemic comorbidities, in patients with insufficient lung capacity to tolerate aspiration, and in cases of bilateral VP.[16] Radiological follow-up may be preferred in elderly patients because of the shorter life expectancy. The determinant here is the size of the tumor and the severity of the symptoms due to the effect of the mass. There were 2 patients over 65 years of age who were operated on in our series, and both were symptomatic, as the lateral pharyngeal wall was extremely pushed medially by the tumor resulting in airway obstruction. Radiotherapy, which may be an alternative treatment method, is not curative in paragangliomas, but only ceases the progression of the tumor size.[17] Radiotherapy was not preferred in these 2 patients, as it was not presumed to provide symptom relief. Radiotherapy was not preferred in younger patients, as it brings the risk of secondary head and neck malignancies and can cause late-term morbidities. On the other hand, it should be noted that radiotherapy for the treatment of paragangliomas is administered at a lower dose (45 Gy) compared to the radiation doses for the treatment of head and neck malignancies, so the post-treatment morbidities are expected to be low.[18] Proton beam radiotherapy is also recently being recommended for the treatment of VPs.[19]

The low number of cases, the retrospective nature of the study, and the fact that UW-QOL could not be performed in the preoperative period are the weaknesses of the study and prevents making further comments.

CONCLUSION

Due to the high risk of morbidity following surgical treatment of VP, radiotherapy and/or radiological follow-up is increasingly coming to the fore in the current literature. However, surgery, which is the only curative treatment method, may not cause a significant change in the postoperative quality of life in well-selected cases. Trying to protect the CN X by dissecting it as much as possible and rehabilitation with Isshiki type 1 thyroplasty in case of vocal cord paralysis are key points.

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Informed Consent: Informed consent was obtained from all participants who participated in this study.

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