Volumetric Growth of Cervical Schwannoma as a Predictor of Surgical Intervention

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Abstract

BACKGROUND: Cervical schwannomas are benign nerve sheath tumors that commonly present as an asymptomatic mass. Patients may be observed with serial imaging or with surgical excision when the mass is rapidly growing, cranial neuropathies develop, or malignancy is suspected. To our knowledge, the rate of volumetric change seen on serial imaging is not currently defined in the medical literature for determining surgical candidacy.

OBJECTIVES: Assess average growth rates and whether growth rate of cervical schwannoma is a predictor of having undergone surgical management.

METHODS: A 20-year retrospective chart review was performed to identify patients with at least 2 CT or MRI and pathologic or imaging characteristics of cervical scwhannoma. The volume was calculated using 4/3πxyz, with x, y, and z representing dimensions in the axial and coronal planes. The volume and rate of volume change and presence of symptoms were compared between observed, surgical, and gamma knife groups.

RESULTS: A total of 13 patients with a diagnosis of cervical schwannoma and at least 2 serial scans were identified. The patients were divided into surgical (n=5), observation (n=6) and gamma knife (n=2) sub-groups. Mean follow up time for all patients was 21 months (range: 1-80), and not significantly different among sub-groups. The average change in volume was found to be 3.61 cm^3/mo for the entire group, -2.75 cm^3/mo (observation), 11.97 cm^3/mo (surgery) and 1.78 cm^3/mo (gamma knife). Average initial volume for the entire group was 124.4cm3 (range 5-608cm3) and average volume at follow up was 142cm3 (range 5-613). The surgical resection group had a statistically significant change in volume (p=0.03)), whereas no significant growth difference was seen in tumors managed non-operatively. A statistically significant difference was seen between rate of growth of the surgical and observation groups (p=0.016) and between surgical patients and those managed with either observation or gamma knife (p=0.011).

CONCLUSIONS: Rate of tumor growth can be used when evaluating patients presenting with cervical schwannoma and may predict eventual surgical intervention.

Introduction

Schwannomas are benign nerve sheath tumors derived from Schwann cells that arise from peripheral, autonomic or cranial nerves. It is estimated that 25-45% of all extracranial schwannomas occur in the head and neck (Colreavy, 2000) and they are often classified according to their nerve of origin and symptomatology can be quite variable.

Surgical excision is the definitive treatment for head and neck schwannomas. However, the benign, slow growing nature of the tumor combined with the potential for post-operative cranial neuropathy following resection often render the decision to proceed to surgery a challenging one. Management is not clearly delineated, with some advocating immediate resection prior to development of symptoms from tumor compression, and others taking a more conservative approach making use of serial imaging and patient symptomatology to guide timing on intervention. The use of tumor volume and volumetric change as criteria for surgery has not been previously described.

Methods

20-year retrospective chart review was performed to identify 68 patients with pathologic or imaging characteristics of cervical schwannoma.

Inclusion Criteria:
- Patients who had at least two imaging studies
- Radiology consistent with cervical schwannoma
- Histological diagnosis from biopsy

Exclusion Criteria:
- Fewer than two imaging studies, or films were unavailable for our review (n=43)
- The radiographic diagnosis was either unclear or not consistent with schwannoma (n=9)
- Family history of neurofibromatosis was present (n=3)

Tumor volume was calculated using 4/3πxyz, with x, y, and z representing dimensions in the axial and coronal planes as described previously (Schwalje, 2015). The total volume, rate of volume change, and presence of symptoms were compared between observed, surgical, and gamma knife groups. Statistical analysis was completed with SAS version 9.4 (SAS Institute, Cary, NC).

Discussion

- Given the risk for post-operative cranial neuropathy, serial imaging is an acceptable management strategy.
- 2 of the 5 patients managed with surgery developed post-operative cranial neuropathy, one requiring a medialization procedure for UVFP.
- There is a statistically significant increase in tumor volume in patients who ultimately underwent surgical treatment in our series.
- At the very least, growth rate appears to be as good a predictor of surgical outcome as volume.

Results

ID	Age	Sex	Tumor	Vol T0 (cm^3)	Time between scan (mo)	Vol T1 (cm^3)	Growth rate (cm^3/mo)	Mgmt	Pre-op symptoms	Pre-op CN function	Post-op CN function
1	50	F	VS	94.1	8	79.4	-1.8	Obs	Dysphagia	WNL	n/a
2	78	F	VS	35.8	13	35.8	0.0	Obs	None	WNL	n/a
3	41	F	VS	6.5	18	14.1	0.4	Obs	None	WNL	n/a
4	53	M	VS	79.2	2	68.6	-5.3	Obs	None	WNL	n/a
5	63	M	VS	159.2	10	50.8	-10.8	Obs	None	WNL	n/a
6	48	F	ACC S	75.4	64	141	1.0	Obs	None	WNL	n/a
7	63	F	VS	153.1	19	220.5	3.5	GK	None	Dysphagia, XII weak	dysphagia
8	65	F	HS	5.0	22	5.43	0.0	GK	Weak tongue	XII weak	XII weak
9	44	F	VS	90.6	1	123.5	32.9	Surgery	Pulsatile mass	WNL	WNL
10	63	F	SCS	122.1	2	158.9	18.4	Surgery	Mass sensation	WNL	WNL
11	68	F	VS	87.1	80	119.4	0.4	Surgery	Dyspnea	WNL	Dysphagia
12	54	M	PS	607.7	1	612.7	5.0	Surgery	None	WNL	WNL
13	60	M	VS	101.8	37	217	3.1	Surgery	None	WNL	Dysphagia, UVFP

Table 1. Patient characteristics
VS: vagal schwannoma, Acc S: accessory schwannoma, HS: hypoglossal schwannoma**,** SCS: sympathetic chain schwannoma, PS: phrenic schwannoma
Obs: observation, GK: gamma knife, CN: cranial nerve, WNL: within normal limits, UVFP: unilateral vocal fold paralysis

Group	N	Mean Volume T0 (cm^3)	Mean Volume T1 (cm^3)	p-value	Growth Rate (cm^3/mo)
Observed	6	75	65	0.34	-2.75
GK	2	79	113	0.25	1.78
Surgery	5	202	246	**0.03**	12
Observed + GK	8	76	77	0.48	-1.62

Table 2. Difference in mean volumes between subgroups of patients treated for cervical schwannoma

	Odds Ratio	Logistic Regression		Empirical Standard Errors	
		95% CI	P-value	95% CI	P-value
Volume	1.011	[0.985-1.038]	0.3959	[0.996-1.027]	0.1552
Growth Rate	1.285	[0.712-2.319]	0.406	[1.100-1.500]	**0.0015**

Table 3. Logistic regression modeling of volume and growth rate as predictors of surgical outcome

Conclusion

- Rate of volume change is easily calculated from imaging using the 4/3πxyz formula
- Rate of volume change (i.e. tumor growth over time) can be used when evaluating patients presenting with cervical schwannoma and may predict eventual surgical intervention.

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