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Clinical Study

Successful resection of anterior and anterolateral lesions at the craniovertebral junction using a simple posterolateral approach

Varun R. Kshettry [a,b], Silky Chotai [a], Jack Hou [a], Tariq Lamki [a], Mario Ammirati [a,*]

[a] Dardinger Microneurosurgical Skull Base Laboratory, Department of Neurological Surgery, Ohio State University Medical Center, N1025 Doan Hall, 410 W. 10th Street, Columbus, OH 43210, USA
[b] Department of Neurological Surgery, Cleveland Clinic, Cleveland, OH, USA

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ABSTRACT

Tumors at the craniovertebral junction (CVJ) often present a challenge due to proximity to vital neurovascular structures. In the last few decades, many authors have proposed complex surgical approaches to access pathologies located anterior or anterolateral to the CVJ with the hopes of reducing morbidity. We propose that the simple posterolateral approach in a semi-sitting position can be used to resect most anterior and anterolateral CVJ tumors safely and effectively. We retrospectively reviewed the clinical series of 10 patients treated by the senior author using the posterolateral suboccipital approach to treat anterior or anterolateral CVJ pathologies. We describe our surgical techniques, outcomes, and present illustrative patients. Gross total resection was achieved in eight patients (80%). Good functional outcome (Glasgow Outcome Scale 4–5) was obtained in all patients. Preoperative symptoms and deficits were improved (78%) or stable (22%) in all patients. There was one (10%) surgical complication that was cerebrospinal fluid leak requiring reoperation. There was no permanent morbidity or mortality in this series. There were two (20%) medical complications including deep vein thrombosis and pulmonary embolus. There were three (30%) transient neurologic complications, dysphagia in two and dysarthria in one, all of which resolved completely in early follow-up. The majority of anterior or anterolateral CVJ lesions can be successfully removed using the simple posterolateral approach.

1. Introduction

Tumors anterior or anterolateral to the brainstem and spinal cord at the craniovertebral junction (CVJ) present a particular challenge to the neurosurgeon. These lesions historically have been more difficult to access given the close proximity to critical neurovascular structures and the brainstem. Earlier attempts at resection of these lesions resulted in considerable morbidity and mortality [1–3]. Since then, multiple neurosurgeons have developed surgical approaches to access and treat these lesions more safely.

Given the vast number of reports in the literature, there is some confusion in the terminology of approaches. These approaches may be divided into anterior, posterior, and lateral approaches. Within the anterior category, there are transoral and transnasal approaches. These approaches have been used for anteriorly based CVJ lesions [4–9]. The transoral approach to anterior CVJ tumors has not gained popularity due to multiple limitations: craniocervical instability and need for fusion, increased risk of meningitis and cerebrospinal fluid (CSF) leak, visualization of tumor–brainstem interface late in dissection, and poor lateral access [5,6,10,11]. Transnasal approaches have gained popularity in the last decade, but are still limited by concerns for increased CSF leak and the steep learning curve associated with endoscopic resection and dural reconstruction [8,12].

Within the posterior approach category are the midline posterior suboccipital approach, the posterolateral approach and the far lateral transcondylar approach. The midline posterior suboccipital approach was the first posterior approach attempted for anterior and anterolateral CVJ tumors [1–3,13–15]. This approach places the head neutrally in the prone or sitting position and involves removal of posterior midline suboccipital bone only. Initial attempts using this approach led to high morbidity and mortality due to the need for brainstem retraction [1,3,13].

The posterolateral approach has been referred to as the lateral suboccipital approach, the "basic" far lateral, and the retrocondylar far lateral approach [11,16–23]. This approach is usually performed in lateral decubitus, park bench, or sitting position. The essence of the approach involves removal of suboccipital bone and C1 lamina from midline laterally until the occipital condyle and exposed vertebral artery, respectively [16,19,24]. The goal of the approach is to move the angle of dissection to be more lateral than the midline approach.

* Corresponding author. Tel.: +1 614 293 1970.
E-mail address: Mario.Ammirati@osumc.edu (M. Ammirati).

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In 1978, Seeger first described the removal of occipital condyle and jugular tubercle to obtain a more lateral angle of attack for anterior CVJ lesions [25]. This technique evolved into what most refer to as the far lateral approach. Rhoton, however, uses the terms "basic" far lateral, which does not involve condylar drilling, and far lateral transcondylar approach [24]. Rhoton also classified several extensions of this far lateral transcondylar approach. The supracondylar transtubercular extension involved drilling out the jugular tubercle to gain more cranial access along the clivus and vertebral artery. The paracondylar extension involved removing the jugular process lateral to the condyle to gain access to the jugular foramen. Finally, in the atlanto-occipital transarticular extension, some of the superior articulating facet of C1 was removed to extend ventral access caudally. These approaches have been adopted by many authors [26–31].

The lateral category of approaches includes the extreme lateral and anterolateral approach. The extreme lateral approach was first described in 1990 by Sen and Sehkar, with multiple subsequent published modifications [32–35]. One key difference between the aforementioned far lateral and the extreme lateral approach is that the latter requires unroofing the vertebral artery from the C1 transverse foramen and medial transposition to allow dural opening and working angle anterior the vertebral artery. The anterolateral approach was described by George et al. This approach is similar to the extreme far lateral, but is done in the supine position with contralateral head rotation to allow an approach anterior to the sternocleidomastoid muscle [36–40].

Despite the plethora of publications in the last two decades, there is still little consensus or evidence on what the optimal approach is to address anterior and anterolateral lesions at the CVJ. While it makes intuitive sense that a more lateral trajectory to these lesions would move the brainstem out of the surgical trajectory, the more lateral approaches each carry their own additional risks. The authors believe that the majority of these lesions do not necessitate extensive lateral skull base approaches. The purpose of this study was to review our clinical outcomes using a simple posterolateral approach to address anterior and anterolateral CVJ lesions.

2. Methods

2.1. Patient selection and data collection

Between January 2006 and November 2012, a total of 10 patients with anterior or anterolateral CVJ tumors underwent surgical resection by the senior author (M.A.). The medical records, neuroimaging and operative details for these patients were retrospectively reviewed.

Preoperative characteristics including age, sex, symptoms, neurological deficits, and prior treatment at the time of presentation were collected. Preoperative MRI was reviewed for lesion location, size, relation to vertebral artery and brainstem T2-signal change indicating pial invasion. In-patient and follow-up clinic charts were reviewed for postoperative outcome including any neurological, medical and surgical complications. The Glasgow Outcome Scale (GOS) was used to evaluate the postoperative functional status of the patients. Institutional Review Board approval was obtained for this study.

2.2. Surgical management

Patients were placed under general anesthesia in a semi-sitting position according to a previously reported protocol [41]. Patients received intraoperative dexamethasone, which was usually continued postoperatively and tapered according to individual situation. Sequential compression devices were placed at the start of surgery and continued postoperatively when in bed. Neither preoperative embolization nor balloon test occlusion were required in any patient. Stereotactic navigation was used in all patients and we achieved very good navigational accuracy utilizing a mask registration system [42]. After application the head holder is flipped superiorly to allow unimpeded navigation registration with the mask.

A midline or paramedian incision was used depending on the bulkiness of the neck. In both cases, the upper level of the incision was in line with the inion and the inferior end terminated in the upper cervical spine. Paraspinal musculature was dissected off the bone in subperiosteal fashion and the exposure was maintained using hooks. The vertebral artery was identified in the C1 sulcal groove, but not transposed. A lateral suboccipital craniotomy was performed up to the occipital condyle and a C1 hemilaminectomy was performed up to the lateral mass in all patients. Occasionally, in tumors with significant caudal extension, a C2 hemilaminectomy was also performed. No condyle was resected in any patient. When craniectomy was performed, closure was supplemented with porex-titanium mesh cranioplasty. A curvilinear dural flap was made medial to the vertebral artery dural entrance and carried superiorly toward the sigmoid sinus. This flap was retracted laterally. CSF was drained from the lateral cerebellar medullary cistern and cisterna magna for brain relaxation and the dentate ligament was cut. Standard microsurgical instruments and techniques were used. An ultrasonic aspirator was used for intratumoral decompression in select tumors. In certain patients, an endoscope-assisted technique was used for better visualization,

Table 1
Preoperative characteristics of patients with tumors at the craniovertebral junction

Patient	Age	Sex	Preoperative symptoms	Preoperative deficit	Prior surgery or radiation
1	75	M	HA, neck pain, mild dysphagia, BUE paresthesias and mild weakness, gait imbalance	Ataxic gait	No
2	65	F	HA, numbness and mild weakness left hand and foot	4/5 left arm, trapezius/SCM, loss of gag reflex, ataxic gait, hyperreflexia	No
3	54	F	Dysphagia, reduced right hearing, gait imbalance	Right tongue deviation, ataxic gait	No
4	33	M	Nausea, dizziness, reduced right hearing	None	No
5	59	F	Asymptomatic	None	No
6	52	F	HA, dysphagia, paresthesias BLE, gait imbalance	None	No
7	45	M	Neck pain, diplopia	Right 6th nerve palsy	No
8	97	F	Moderate quadriparesis, severe gait imbalance	3/5 weakness throughout severe gait ataxia, hyperreflexia	No
9	59	F	HA, neck pain, numbness and weakness bilateral hands, gait imbalance	Right UE 4-/5, right LE 3/5, left LE 4-/5, hyperreflexia, gait ataxia	No
10	59	M	Mild gait imbalance	Ataxic gait	No

B = bilateral, F = female, HA = headache, LE = lower extremity, M = male, SCM = sternocleidomastoid muscle, UE = upper extremity.