Original Article
Far Lateral Approach for Foramen Magnum Tumors: Evaluation and Outcome

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ABSTRACT
Background: Foramen magnum lesions represent five percent of spinal neoplasms and one percent of intracranial neoplasms. Clinical presentation is insidious as tumors are slowly growing, the classic foramen magnum syndrome occurs with anteriorly located meningioma, which shows asymmetrical weakness with specific marsh. Foramen magnum meningioma's are classified into intradural, extradural and combined intra & extradural and according to location related to dentate ligament into anterior (midline), anterolateral (anterior to dentate ligament) and posterolateral (posterior to dentate ligament). The most common type is the anterolateral intradural tumors. The far lateral approach is a good valid option for anterior and anterolateral tumors as it allows tumor removal with working angle away from cervicomедullary junction, allows proper proximal control for vertebral artery and proper view of the area anterior to brain stem.

Objective: Evaluation of far lateral approach in foramen magnum tumors.

Patients and Methods: We operated sixteen patients in three years period from January 2012 till February 2015 at Cairo University Hospitals, ten females and six males; age was from 18 to 38 years. All patients were assessed both clinically for neurological deficits and radiologically. Postoperative CT scans and MRI were done postoperatively to ensure tumor removal. Follow up was done at three, twelve and eighteen month’s intervals then yearly. Results: We operated sixteen patients ten females (62.5%) and six males (37.5%), age ranged from 18 to 38 years. Thirteen patients had meningioma’s (81.25%) and three had schwannomas (18.75), four tumors (25%) were anterior midline tumors while the others (75%) were anterolateral. Fourteen cases (87.5%) had total removal of the lesions while the other two (12.5%) were sub totally removed due to adherence to the vertebral artery. Fourteen patients had preoperative weakness (87.5%) which improved postoperatively.

Conclusion: The far lateral approach is a valid and safe approach for anterior and anterolateral foramen magnum lesions with acceptable rate of risk and complications. The working angle is usually satisfactory and could be extended by bony drilling of the posterior third of the occipital condyle for the anterior tumors with satisfactory results.

INTRODUCTION
Foramen magnum region is a bony canal formed anteriorly by the lower third of the clivus, anterior arch of C1 vertebra and odontoid process. Laterally it is bounded by the jugular tubercle, occipital condyle and lateral mass of C1. Posteriorly it is bounded by the squamous occipital bone and posterior arch of Atlas.

It transmits the cervicomедullary junction, cerebellar tonsils, lower cranial nerves, first and second cervical roots, both vertebral arteries, anterior spinal artery and posterior spinal arteries.

Foramen magnum lesions represent five percent of spinal neoplasms and one percent of intracranial neoplasms. The most common neoplasms are meningioma’s representing seventy seven percent of foramen magnum tumors followed by schwannomas and the least are clival chordomas.

Clinical presentation is insidious as tumors are slowly growing with indolent behavior and wide subarachnoid space, the classic foramen magnum syndrome occurs with anteriorly located meningioma, which shows asymmetrical weakness with specific marsh: ipsilateral arm then ipsilateral leg then contralateral leg and at last contralateral arm. Weakness bulbar symptoms and ataxia are all common with variable degrees according to location of the tumor and brain stem compression.

Brunean & George classified foramen magnum meningioma into three types, according to dural, involvement into intradural, extradural and combined intra & extradural. According to location related to dentate ligament into anterior (midline), anterolateral (anterior to dentate ligament) and posterolateral (posterior to dentate ligament). The most common type is the anterolateral intradural tumors.

Approach to those lesions is particularly challenging specially the anterior type. Anterior approaches are particularly difficult including extended endoscopic endonasal approach to the midline skull.
base which represents a breakthrough in anterior minimally invasive approaches moreover dural closure and repair is difficult leading to postoperative CSF leak and infection (contaminated field). Anterior approaches are particularly difficult moreover dural closure and repair is difficult leading to postoperative CSF leak and infection (contaminated field). The far lateral approach is a good valid option for anterior and anterolateral tumors as it allows tumor removal with working angle away from cervicomedullary junction, allows proper proximal control for vertebral artery and proper view of the area anterior to brain stem.

PATIENTS AND METHODS

We operated sixteen patients in three years period from January 2012 through February 2015 at Cairo University Hospitals, ten females and six males; age was from 18 to 38 years. All patients were assessed both clinically for neurological deficits (pyramidal affection, ataxia and cranial nerve palsy) and radiologically by CT scans, MRI and CT angiography for vascular involvement (Fig 1 - Fig 2). The scans give information about location, extensions (rostral and caudal) and nature of the tumor, relation to the cervicomedullary junction, vertebral arteries and bony involvement if any. All patients were operated by far lateral approach with or without condylar drilling. Patients were positioned three quarter prone with the mastoid bone being the highest point using the Mayfield skull fixator. The neck was slightly flexed, vertex angled thirty degrees down and the face rotated slightly ventrally. An inverted hockey stick incision was done starting at the base of mastoid curving medially till the inion then vertically down in the mid line till spine of C3 vertebra. Skin is undermined to expose the fascia to facilitate later closure. Fascia and muscle are elevated with a cuff along superior nuchal line for later closure. Exposure of posterior arch of atlas (C1) till the lateral mass along with spine and lamina of axis (C2) was done. Exposure of suboccipital and perivertebral venous plexuses, vertebral artery and first cervical root was also done. Skeletonisation and mobilization of the vertebral artery was only done if proximal control of the vertebral artery was needed. Removal of the posterior arch was done prior to skeletonisation of the artery. Exposure of the condyle is done afterwards. Bony removal is done till the borders of the sigmoid and transverse sinuses. Ipsilateral side of the foramen magnum was removed and the squamous occipital bone. Dura was opened parallel to sigmoid sinus, ensuing caudally till the caudal extension of the tumor. Dissection and identification of the vertebral arteries and PICA (posterior inferior cerebellar artery) were done along with the bulbar nerves. The tumor was dissected, devascularized, and removed piecemeal. Hemostasis and closure in layers was done. Postoperative CT scans and MRI were done postoperatively to ensure tumor removal (Fig. 3 – Fig. 4). Patients were given perioperative antibiotics and steroids. Clinical assessment for any new deficits or bulbar palsies were checked. Follow up was done at three, twelve and eighteen months intervals and thereafter yearly.

Fig. 1: Sagittal contrast MRI showing foramen magnum meningioma anterior to the cervicomedullary junction.

Fig. 2: Axial MRI showing the same lesion with involvement of the right vertebral artery.

Fig. 3: Follow up MRI of the same patient showing complete removal of the lesion via a far lateral approach.
We operated sixteen patients ten females (62.5%) and six males (37.5%), age ranged from 18 to 38 years. Thirteen patients had meningioma’s (81.25%) and three had schwannomas (18.75), four tumors (25%) were anterior midline tumors while the others (75%) were anterolateral. Fourteen cases (87.5%) had total removal of the lesions while the other two (12.5%) were sub totally removed due to adherence to the vertebral artery. Fourteen patients had preoperative weakness (87.5%) which improved postoperatively. Six patients (37.5%) had preoperative bulbar palsy, four of them improved postoperatively while the other two needed medialization of the vocal cord. We had no approach related complications. We had one case with intraoperative vertebral artery injury during tumor removal, which was controlled by bipolar coagulation with no postoperative squeal. We had no cases of vertebral artery injury, CSF leak or infection.

DISCUSSION

In our study, weakness was the main symptom (87.5%) followed by bulbar palsy (37.5%). Flores et al. stated headache (42.6%) and hemi anesthesia (39.3%) as the most common presenting symptoms, followed by hemiparesis (28.6%), neck pain (21.4%), and gait disturbances (21.4%). Das et al. stated the most common clinical presentation as motor complaints (72.4%). This was in the form of asymmetrical quadriaparesis (62%) or paraparesis (10%). Neck pain with/without suboccipital radiation and sensory symptoms like tingling/numbness (55.2%) were the next most frequent presentations; 31% of the patients presented with sphincteric disturbances. Bydona et al. stated that two (9%) tumors were anterior, seven (32%) were anterolateral and twelve (55%) were lateral.

In our study we operated all patients by the far lateral approach, posterior third of the occipital condyle was removed in two cases only, vertebral artery transposition was not needed but only identification for proximal control, Total removal was done in fourteen cases (87.5%) while the other two (12.5%) were sub totally removed due to their adherence to the vertebral artery. Flores et al. operated all the thirty patients by the far lateral approach. The transcylindar extension was used in 89.3% of the cases; Transposition of the vertebral artery was completed in 10 patients. This technical variant was abandoned afterwards with increased experience with the approach. Gross-total resection was achieved in 85.7% of the patients. On the contrary, Das et al. attempted tumor excision in twenty seven (93.1%) patients and biopsy in two (6.9%) patients. Of the twenty-seven surgical excisions, complete excision was obtained in fifteen (51.7%), whereas, twelve (41.4%) patients underwent subtotal excision. The main approach used was the posterolateral approach (69%) for posterolateral and anterolateral tumors. The far lateral approach was used in six patients (20.7%). Bydona et al. operated using a variety of surgical approaches, the posterior midline approach was used in nine cases (41%) and the far lateral approach in twelve cases (54%). The vertebral arteries were involved in twelve cases (55%) and the basilar artery in one case (5%).

In our study we had no approach related complications whatsoever. We had one case with intraoperative vertebral artery injury during tumor removal, which was controlled by bipolar coagulation with no postoperative squeal. Fourteen patients had...
preoperative weakness (87.5%) improved postoperatively while six patients (37.5%) had preoperative bulbar palsy, four of them improved while the other two needed medialization of the vocal cord. In Flores et al. series of twenty-two patients, the preoperative symptoms improved completely within the initial 8 post-operative weeks. No patients experienced deterioration of neurological function postoperatively. Cerebrospinal fluid leakage occurred in 3 patients and resolved with temporary lumbar CSF drainage. Tracheostomy and gastrostomy tube placement were necessary in two (6.6%) and three patients (10%), respectively. There were no postoperative deaths at last follow-up. While in Bydona et al. series, they had improvement of sensory disturbance, pain and sphincter disturbance after surgery. However, although weakness and gait ataxia generally improved at the last follow-up compared to pre-operative status, there is a noticeable transient worsening of the symptoms immediately after the surgery. In terms of cranial nerve deficits, among the twenty-two patients, four patients improved (18.1%), sixteen remain unchanged (72.7%), and two worsened (9.2%).

**CONCLUSION**

The far lateral approach is a valid and safe approach for anterior and anterolateral foramen magnum lesions with acceptable rate of risk and complications. The working angle is usually satisfactory and could be extended by bony drilling of posterior third of the occipital condyle for the anterior tumors with satisfactory results.

**REFERENCES**