

Postero-lateral Approach to the Cranio-vertebral Junction: How, When and Why?

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Abstract

To date the postero-lateral approach represents the best strategy for the surgery of the intradural ventro-lateral lesions of the cranio-vertebral junction (CVJ). Over the years, several authors have proposed different variations of this technique, but the principle on which all are based is the ability to access to the ventral region of the brainstem and high cervical cord with minimum retraction and maximum control of the neuro-vascular structures. However, comorbidity related to the surgical procedure is still very high. Posterolateral approach is actually considered the best technique to approach the intradural ventrolateral lesions located at the CVJ. Because the peculiarity of the CVJ, surgeons must know very well the anatomy of this region. Due to the high comorbidity of this approach a very precise surgical planning based on the characteristics of the lesion is required to correctly treat this particular anatomical region to manage correctly the pathology and to prevent any complications.

Keywords: Postero-lateral approach; Cranio-vertebral junction; Surgery; Intradural cranio-vertebral junction lesions; Neurosurgery; Surgical approaches

Introduction

To date the postero-lateral approach represents the best strategy for the surgery of the intradural ventro-lateral lesions of the cranio-vertebral junction (CVJ). Over the years, several authors have proposed different variations of this technique, but the principle on which all are based is the ability to access to the ventral region of the brainstem and high cervical cord with minimum retraction and maximum control of the neuro-vascular structures. However, comorbidity related to the surgical procedure is still very high [1-3]. For this reason, it appears essential to adapt the surgical approach case by case, avoiding unnecessary risks for the patient and, often, the best strategy can be represented by the subtotal removal, even in case of benign lesions of the CVJ.

History

Postero-lateral approach to CVJ finds its origins in the approaches described by Seeger in 1978 [4] and by Heros in 1986 [5]. Seeger, for the first time in 1978, described the dorsolateral approach to CVJ using the term “transcondylar” [4]. The Heros technique consists in a modification of the lateral suboccipital approach with a “extreme-lateral” extension of the bone opening through the condylar fossa and with the removal of the posterior arc of the atlas, in order to expose the vertebral artery [5]. Almost simultaneously, George describes the lateral extension of the conventional suboccipital approach to improve the control of the vertebral artery and the sigmoid sinus [6]. In the nineties several variants of this approach have been proposed. In 1990/91 Sen and Sekhar, to increase the angle of surgical exposure, introduce the partial drilling of the occipital condyle, defining their surgical exposure as extreme-lateral [7]. In the same period, Bertalanffy and Seeger [8], Menezes [9] and Spetzler and Grahm [10]

describe similar surgical technique characterized by the drilling of the occipital condyle for the removal of the ventro-lateral lesions of the CVJ. After the description and dissemination of these techniques, many works have been published that discuss the need, the actual indications and possible complications of this surgical approach.

Surgical Approach

Patient positioning can be very different but the most common are: ¾ prone, lateral park-bench and sitting position. Each of these positions allows focusing the surgical exposure on the occipital condyle and vertebral artery region. In general, an excessive flexion of the head should be avoided in order to prevent a reduction of anterior perimedullary space and the subsequent onset or worsening of neurological symptoms. The skin incision should be performed keeping in mind some anatomical landmark such as: the course of the transverse and sigmoid sinus, the inferior nuchal line and the mastoid tip. The incision can be hockey stick with the straight arm on the midline and the curved arm extended, on the side of lesion, until the mastoid tip, or curvilinear between the mastoid and the midline, in the retro-auricular region. Muscle dissection proceeds from the superficial layer, consisting of the sternocleidomastoid and trapezius, to the middle layer where there are semispinalis and splenius capitis. To dissect these muscles must be disconnected to the superior nuchal line and, the sternocleidomastoid and the splenius capitis should be retracted laterally and the trapezius and the semispinalis medially. The last muscle layer is the deep layer where we find the so-called suboccipital triangle delimited by the muscle rectus capitis posterior maior, and the superior and inferior oblique capitis muscles (Figure 1). It is possible, during the muscular dissection, to meet the mastoid emissary vein which discharge in the sigmoid sinus. In the clinical practice the muscles of the suboccipital triangle are not always easily identifiable but in any cases, they can be sectioned to increase the exposure of the underlying structures. The vertebral artery is at the center of the suboccipital triangle.

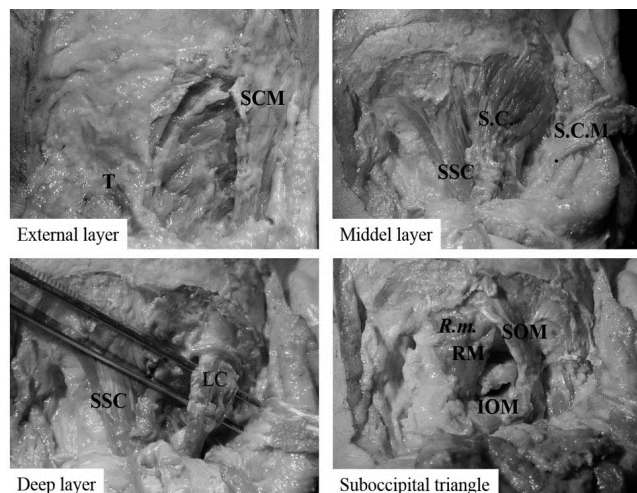


Figure 1: Muscle dissection (T= Trapezius; SCM=Sternocleidomastoid; SSC=Semispinalis Capitis; SC=Splenius Capitis; RM=Rectus Maior; IOM= Inferior Oblique; SOM=Superior Oblique).

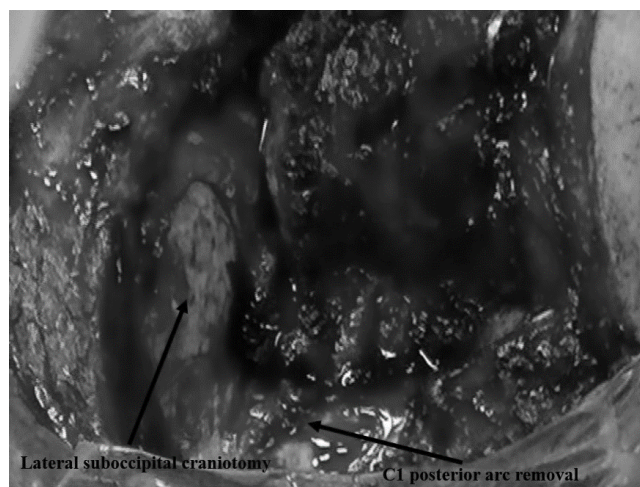


Figure 2: Bone opening (lateral suboccipital craniotomy and C1 posterior arc removal).

The surgeon can locate and identify the artery in the early stage of the procedure palpating the upper edge of the posterior arc of C1. This maneuver is fundamental and allows getting an immediate control of the artery that can be dissected from the groove where she runs at the level of the lateral and superior part of the posterior arc of the atlas. At this time the arc of C1 can be removed safely. The vertebral artery is surrounded by a venous plexus. Coagulate the plexus with bipolar or hemostatic is very important to keep the surgical field clean and not lose the vision. From lateral to medial, the artery turns around the occipital condyle, contracting relationships with the articular capsule of the C0-C1 joint, through the atlanto-occipital membrane and enters the dura mater. The bone opening consists in the removal of posterior part of the C1 arc associated to a lateral suboccipital craniotomy

(Figure 2). Lateral extension of the bone opening must be tailored to each case. In general, it is advisable to extent the removal of the C1 arc until the foramen transversarium and the craniotomy until the course of the sigmoid sinus. Even more tailored must be the drilling of the occipital condyle and the lateral mass of the atlas. The key points are partial resection of the occipital condyle, the medial part of the C1 lateral mass and the drilling of the jugular tubercle (Figures 3-5).



Figure 3: Partial occipital condylectomy.



Figure 4: Jugular tuberclectomy.

The stability of the CVJ is never compromised if the drilling of the occipital condyle does not exceed an upper portion to 50%. During this phase it is possible to identify the condylar emissary vein which is coagulated carefully without using hemostatic material that could dislocate within the jugular gulf, where discharge the vein. The bony canal of the emissary vein may be drilled and represents an important anatomic landmark for the lateral extension of condylectomy. The dura opening can be performed through a curvilinear incision starting from superolateral angle of the bone opening or through a Y shaped incision. Once the dura open is very important to identify immediately the vertebral artery, the spinal accessory nerve and the dentate ligament. The region exposed is the latero-ventral surface of the

brainstem and upper cervical cord, comprising the lower cranial nerves, the first cervical roots, and the vertebral artery up to the junction with the PICA (Figure 6).



Figure 5: Postero-lateral approach, surgical exposure after partial condilectomy and jugular tuberclectomy.

Discussion

The postero-lateral approach is an effective technique for the removal of the ventro-lateral expansive lesions of the CVJ. In the surgery of this kind of tumor the first very important step is a correct surgical exposure [11]. Based on the experience of numerous authors who have described this technique, what today appears crucial is the knowledge of the characteristics of the lesion to be removed that determine the need or not to perform some steps of the postero-lateral approach. The presence of very important neurovascular structures at the level of the CVJ, requires, when not needed, to avoid “excesses” in the execution of the approach [12]. One of the key points of discussion regarding the lateral extension of the approach is the drilling of the occipital condyle. The literature demonstrates that there is no problem of stability of the CVJ when drilling doesn't exceed the 50% of the occipital condyle surface [13]. The hypoglossal canal represents an important anatomical limit during the condyle removal but this structure may have several different positions and orientations [14,15]. Within this range, the drilling of the occipital condyle must be tailored according to some characteristics of the lesion to be removed. A vertebral artery encasement, for example, requires an extent removal of the medial part of the condyle, in order to expose the dural entry point of the artery, to mobilize the vessel and to dissect it from the tumor with maximum control and security [3,11,12,16]. In case of a meningioma with a large anterior dural attachment, a wide surgical exposure is fundamental. The tangent vision to the tumor base implantation may require not only the drilling of the medial part of the occipital condyle but also the jugular tubercle for the tumors with craniospinal extension and the lateral mass of the atlas for spinocranial tumors. Depending upon the extent of the tumor into the cervical canal, partial or total C2 hemylaminectomy could also be required. The wide exposure of the dural attachment allows an early devascularization of the tumor, which should be followed during the debulking and the removal of the lesion, in order to work as much as possible in a bloodless surgical field [12]. Failure to hemostasis and the

consequent reduction of the vision, greatly increase the risk of damage of important neurovascular structures. In the case of extra-dural extension of the tumor, the lateral extension of the approach can reach the jugular foramen, the petrous bone with the exposure of the intrapetrous carotid artery and the fallopian canal [17]. In these cases, it is always essential to perform the transposition of the vertebral artery in order to mobilize the vessel without damaging it [14] (Figure 7). However, for the removal of extradural tumors, different authors recommend an anterolateral approach to the CVJ [18].

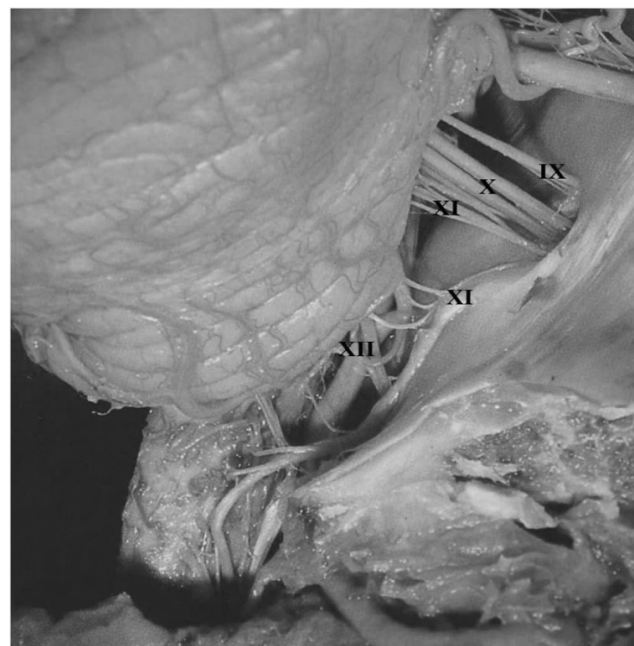


Figure 6: Intradural anatomy of the CVJ exposed by postero-lateral approach.



Figure 7: Vertebral artery transposition.

Conclusion

Postero-lateral approach is the best technique to approach the intradural ventro-lateral lesions located at the level of the CVJ. Because the peculiarity of the CVJ, surgeons must know very well the anatomy of this region. Surgical comorbidity is high and, for this reason, a very precise surgical planning based on the characteristics of the lesion is fundamental.

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