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Case Report

Posterior Fossa Decompression By Biportal Endoscopy In a Patient With Chiari Malformation, Case Report and Description of the Surgical Technique

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Abstract

The advent of endoscopy in medicine has allowed us to visualize and magnify anatomical structures in real time, allowing for safer and less invasive surgical procedures. We describe the biportal endoscopy surgical technique for posterior fossa decompression, craniocervical junction and resection of the posterior C1 arch, as a viable option within the minimally invasive techniques in the treatment of Chiari malformation.

Keywords: Posterior fossa; Decompression; Biportal endoscopy; Chiari malformation

Abbreviations

UBE: Unilateral Endoscopic Biportal; MRI: Magnetic Resonance Imaging; AP Anteroposterior; CCOS The Chicago Chiari Outcome Scale; S.C. WFSE Scientific Committee World Federation Spine Endoscopy.

Introduction

Background

The Chiari malformation was first described in 1891 by Hans Chiari when he published his series of autopsies describing the elongation of the cerebellar tonsils which could be accompanied by the lower part of the stem protruding through the foramen magnum [1-4].

Chiari malformation is estimated to have an overall incidence of 1% [5]. Several classifications have been described depending on the morphological and imaging characteristics [6-10].

- **Chiari 0:** Syringomyelia without tonsillar descent.
- **Chiari 0.5:** Ventrolateral tonsillar herniation with medullary compression.
- **Chiari 1:** Descent of cerebellar tonsils >5mm.
- **Chiari 1.5:** Chiari 1 with medullary kinking and descent of the obex.
- **Chiari 2;** Descent of vermis and brainstem, Myelomeningocele, hydrocephalus.
- **Chiari 3-3.5:** Cervical-cerebellar hydroencephalocele.
- **Chiari 4:** Cerebellar hypoplasia or aplasia.
- **Chiari 5:** Herniation of the occipital lobe through the foramen magnum.

Several studies analyze the multidimensional morphometric and volumetric characteristics within the posterior cranial fossa and their correlation with tonsillar herniation and syringomyelia formation in an effort to understand the pathophysiology of Chiari malformation. However, it is not yet fully understood [11,12].

It is important to notice that the clinical manifestations are diverse and vary with the age [13,14]. This may include headache, motor weakness, altered sensitivity and instability of gait and it can be change according to the structure compromised [15-18] as shown in figure 1.

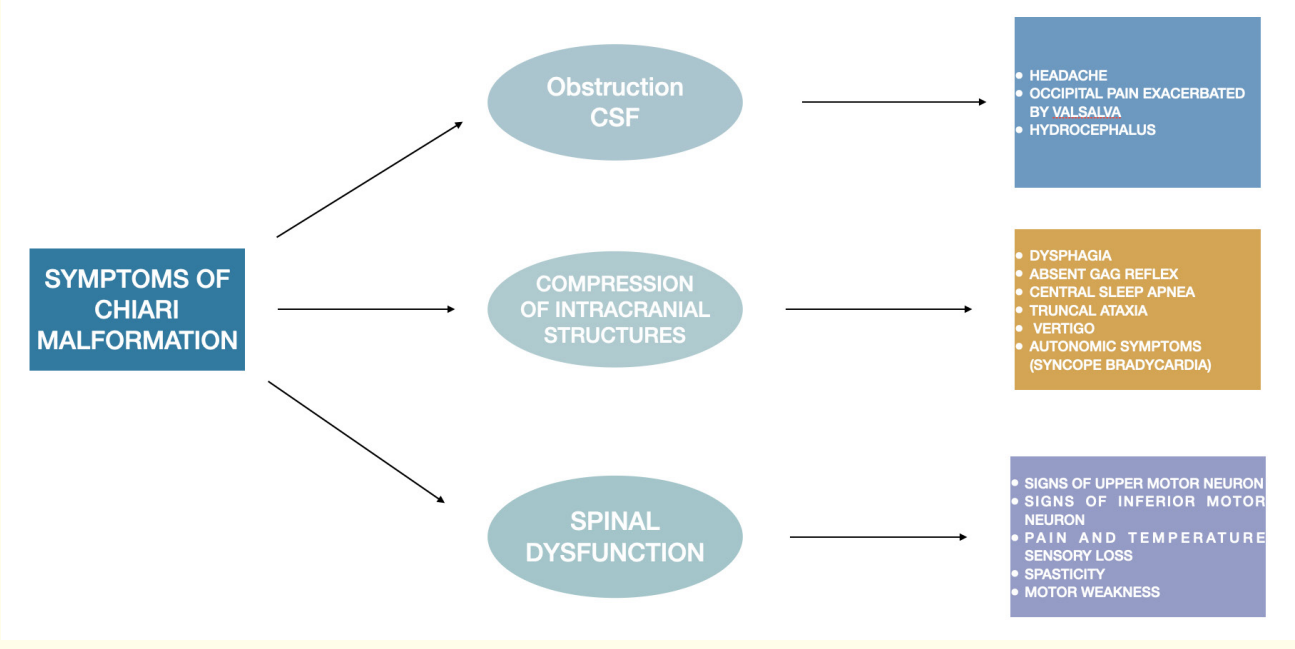

Figure 1: Main symptoms of the Chiari malformation according to the affected structure.

The surgical treatment in Chiari malformation is indicated in symptomatic patients with tonsillar herniation > 5mm through the foramen magnum, syringomyelia or intracranial hypertension of the posterior fossa despite not having tonsillar herniation [19-22].

This consists in a suboccipital craniectomy plus resection of the posterior arch of C1 with or without duroplasty [23,24]. It is estimated that the suboccipital craniectomy should be 22-25mm wide and 20-25mm high [25]. To provide an improvement in symptomatology ranging from 50% to 75% in adults and up to 94% in pediatric patients [26,27].

The first report of posterior fossa decompression by uniportal endoscopic route was made by Ilyas Dolas ed al, first describing the technique in cadaveric specimens and later with a series of cases of patients with Arnold Chiari. This technique is performed under fluoroscopy-assisted planning and intraoperative neuronavigation [28,29].

Before this, minimally invasive surgery for the management of Chiari malformation was open assisted by endoscopy [30-32].

The biportal endoscopy appeared in 1996 when De Antoni et al, published the first surgical technique in which the endoscope and the working instrument were inserted independently through two portals, in 1998 the use of arthroscopy to magnify was described illuminate and irrigate the surgical bed, in 2016 in Korea was publish the unilateral endoscopic biportal technique [33,34] and since then UBE has proven to be effective and safe to solve several spinal pathologies.

Rationale

The open approach for the performance of suboccipital craniectomy involves the disinsertion of both the superficial and deep muscles of the suboccipital region, which conditions muscle atrophy and intense pain in the surgical region, and although the uniportal endoscopy technique for this procedure has already been described, the technique described is performed assisted with neuronavigation, knowing the scope of biportal endoscopy, and since this minimally invasive technique is easily reproducible in both public and private medicine and can be performed with equipment and instruments available In both institutions, it has the characteristic that is made by generating an aquatic space that allows us to visualize in detail the surgical area, this will allow us to perform the suboccipital cranioectomy under direct vision, preserving intact the two muscle layers of the craniocervical region preserving the function of these and avoiding the atrophy of them.

Objective

Describe the surgical technique of suboccipital craniectomy with posterior arch resection of C1 using biportal endoscopy for the treatment of Chiari malformation.

This manuscript is written following SUPER checklist [35].

Materials and Methods

Preoperative, preparations and requirements

Below we will describe the surgical technique biportal endoscopy for decompression of the posterior fossa by suboccipital craniectomy with resection of the posterior arch of C1, in a patient with Chiari malformation.

Woman, 57 years old, who goes to the emergency department for syncope, has a history of chronic occipital headache that increased in intensity with the maneuvers of valsalva, vertigo and dizziness of difficult control, the right side of the dominant gait after many years of evolution and without control of it despite several treatments. A study protocol is performed by brain MRI, after physical examination and history, she was diagnosed with Chiari type 1 malformation, according to imaging studies. Figure 2.

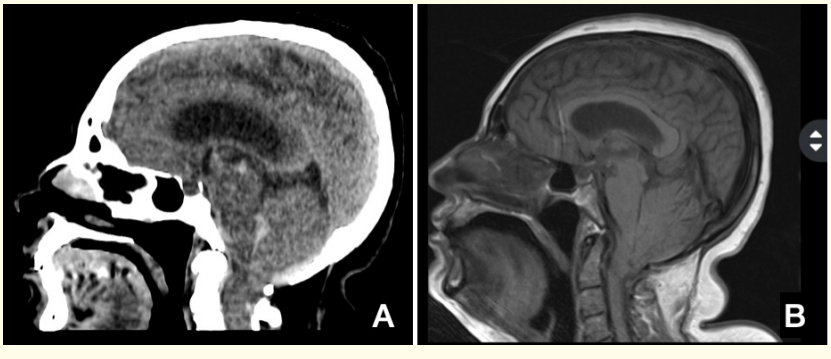

Figure 2: A.-Sagittal section tomography shows descent of the cerebellar tonsils >5mm. With absence of the cisterns of the base and occlusion of the fourth ventricle B: T1-weighted magnetic resonance imaging, sagittal section corroborates descent of the cerebellar tonsils and obliteration of the fourth ventricle.

Surgical technique

Surgical equipment

To carry out this surgical technique it is necessary to have a neurosurgeon, anesthesiologist, instrumentalist, circulating nurse, radiologist technician inside an operating room in a hospital unit.

Patient positioning

Under general anesthesia, the patient should be in a prone decubitus position with a neutral cephalic position, slight cranial occipital flexion and retraction of both shoulders.

Radiological planning

Once the patient is positioned, the inion is located, drawing a straight line on it in a caudal direction towards the foramen magnum that will demarcate the midline Line A, two parallel lines are marked 1cm on each side of the line A which will be called the condylar line, the inion is identified again and a line perpendicular to line A is drawn at 2 cm towards the flow of the inion that crosses both condylar lines, the insertion of these lines will be the entry point on which the incisions will be made.

The planting is confirmed by true AP and lateral X-ray of the craniocervical junction. Figure 3.

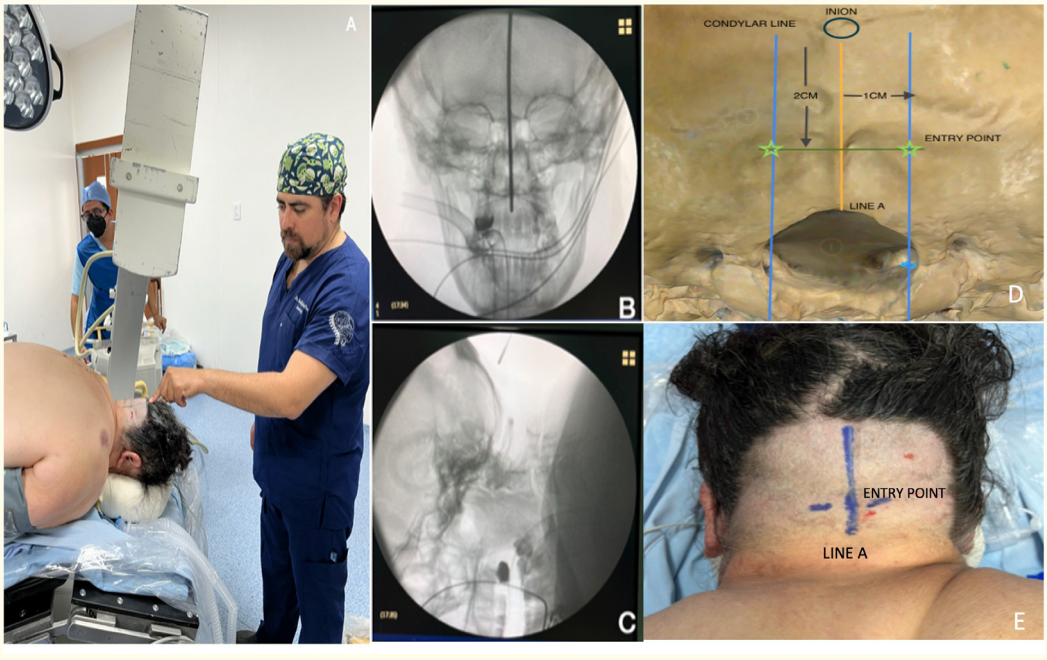

Figure 3: Shows the position of the patient and the fluoroscope-assisted planning, A: marking and position of the patient, B the stylet indicates the midline in a true AP projection, C: the entry point is identified at 2cm of the Inion on the paracondylar line, D: shows the input incisions, E; outlines the lines that are drawn during the planting to locate the point where the incisions of the approach will be made.

Equipment and instruments

Arthroscope, 30-degree endoscope lens, light source, endoscopic camera, monitor, plasma radiofrequency, high-speed drill, 3mm spherical cutting cutter, 1mm and 3mm kerrison rongeurs angled upwards 45 degrees, 3mm and 1mm straight disc clamp, Roton directors, needle holder. 10 blade scalpel, monoportal endoscopy scissors.

Step-by-step description

Suboccipital craniectomy and posterior C1 arch resection. step by step

The surgical field is cleaned and prepared with antiseptic solution, the 2 transverse incisions of 5mm are made at the planned points to carry out the approach with a scalpel sheet 10, muscle

dilation is performed with rant movements until it touches the occipital squama with Penfield 1 dissector, the endoscope with 30° lens is introduced into the desired port and a 3mm headed radiofrequency probe is introduced through the contralateral port to perform the triangulation. During the surgical procedure, a water pressure of 15-20mmhg must be maintained whit an active pressure control pump [36].

Dissection with radiofrequency in intensity 4 of the deep muscular plane, to perform the disinsertion of the suboccipital muscles, until the occipital squama is cleaned identifying the inion and the crest of the occipital, the posterior edge of the foramen magnum is located, the posterior arch of C1 is located, the posterior tubercle of C1 is identified, performing lateral dissection on each side of the posterior tubercle of C, the posterior arch of C1 is removed with the help of 1 and 3 mm Kerrison rongeurs.

The drilling system is introduced starting the craniectomy in the lower nuchal line towards the rear edge of the foramen magnum, drilling carefully until you have a very thin layer of bone that is removed with a kerrison rongeurs, it continues drilling until a craniectomy of approximately 1.5 cm on each side of the midline, the posterior atlantooccipital membrane is identified with the help of Roton›s dissector, which is cut with monoportal endoscopy scissors, to guarantee the craniocervical junction is released, intraoperatively, it is possible to evaluate adequate decompression subjectively by observing if there is pulsation of the tonsils or if it improves the blood flow of the spinal cord at the craniocervical junction evidencing that craniectomy is sufficient. the surgical bed is navigated to ensure that the craniectomy is sufficient, hemostasis is verified, if necessary durotomy can be performed with scalpel and microscissors, in case of performance, the corresponding duroplasty will be performed with duramadre substitute and fibrin glue.

Closing of approach

Hemostasis is verified, in case of finding any bleeding, radiofrequency can be applied directly or indirectly, hemostasis material such as hemostasis sponge and derivatives of regenerated oxidized cellulose can be placed or indirect compression can be generated by directing the irrigation towards the bleeding vessel. Wound is faced in a single plane with Sarnoff point with prolene 3/00, finishing the procedure. Figure 4. Video 1. The surgical time was 45 min, with a bleeding of 30cc.

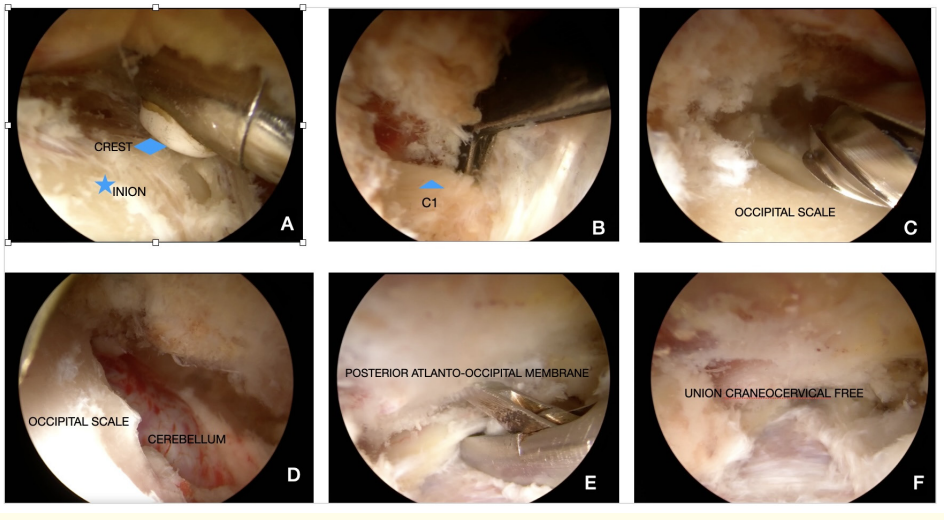

Figure 4: A: Shows the radio frequency dissection of the inion and the occipital crest. B: Shows the resection of the arch of C1 starting from its inner edge. C: Drilled occipital scale with high-speed drill. D: Decompression of the cerebellar region. E: Cut of the posterior atlanto-occipital membrane. F: Decompression of the craniocervical union, occipital craniectomy and posterior arch resection of C.

Video 1 Posterior fossa decompression by biportal endoscopy in a patient with Chiari malformation...

Video 1: After planning the incisions as described in the technique, the instruments are triangulated until they are visualized in the occipital scale, the disinsertion and lifting of the muscle flap begins, maintaining the water pressure at 20 mmhg, it is dissected until it touches and discovers the posterior edge of the foramen magnum, the posterior tubercle of C1 is located and discovered, 1cm is dissected laterally on each side of it and the posterior arch of C1 is removed, to reveal the posterior part of the cervical medulla, taking as a reference the width of the cervical medulla, the drilling of the occipital scale begins with high speed drilling, the bone slabs are removed with Kerrison forceps, a craniectomy is performed between 2.5 – 4 cm of the occipital scale, the posterior atlanto-occipital membrane is identified and cut, hemostasis is verified and the procedure is completed, facing the skin with prolene 3/00.

Postoperative Considerations.

The patient was discharged 24 hours after the surgical procedure. Simple control cranial tomography was performed to assess the diameter of the craniectomy and rule out complications in the immediate postoperative period, such as hematoma in the surgical bed. The tomography showed adequate decompression without postoperative complications, as shown in figure 5.

The points were withdrawn at 2 weeks, where the patient was clinically revalued according to the CCOS[37] reaching 15 points. Surveillance by external consultation will continue every 3 months from the withdrawal and points until the completion of one year.

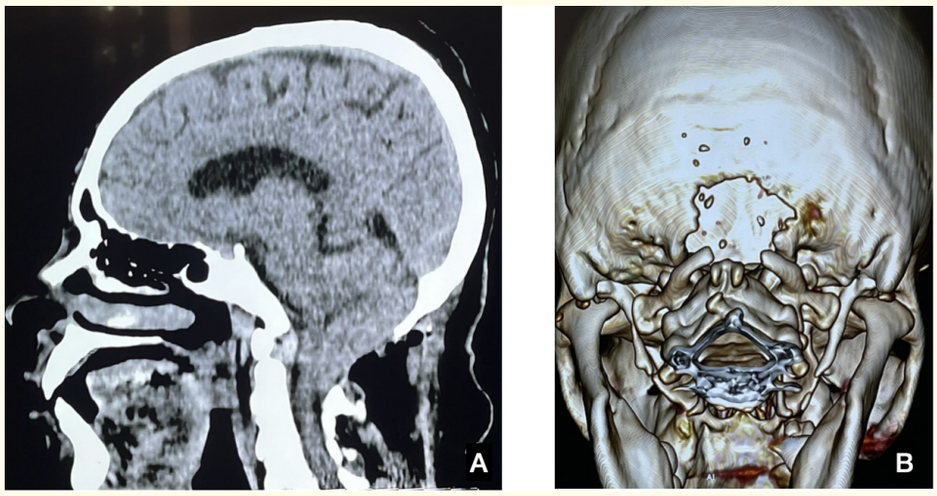

Figure 5: A: Shows sagittal section of cranial tomography in which suboccipital craniectomy and resection of the posterior arch of C1 is observed, as well as opening of the cisterns of the base and fourth ventricle B: Shows 3D reconstruction image in which observes suboccipital craniectomy with resection of the posterior arch of C1.

Tips and pearls

- **Key point 1:** Experience in the biportal endoscopy is necessary before doing this technique.
- **Key point 2:** During surgical planning, it is essential to take a true cranial Rx AP, in the operating room, to perform proper triangulation and perform surgery safely.
- **Key point 3:** It is necessary to first identify the posterior arch of C1 and make the resection of it since this space will be the reference of the midline and the craniocervical union to maintain the location and determine the extension of the craniectomy to the right and left.
- **Key point 4:** The biportal endoscopy technique for suboccipital craniectomy in the treatment of Arnold Chiari is another technique that we can use to treat it.
- **Key point 5:** In case of hemorrhage that does not lead to irrigation, and becomes massive or that loses its anatomical references that prevents it from continuing with the endoscopic procedure, the surgery will have to become an open procedure to continue the craniectomy decompression through suboccipital approach by midline.

Results and Discussion

Minimally invasive surgery has proven effective; however it requires a learning curve and during this process complications can increase [38,39].

The minimally invasive techniques for the treatment of Chiari malformation currently reported are the mini open technique, [40] the endoscopy-assisted open technique, [30,41] the endoscopic technique assisted with tubular retractor [32,39,42] and the complete endoscopic technique [29].

There are few studies that compare endoscopic surgery and traditional open surgery in the treatment of Chiari malformation, these report that both groups presented clinical improvement, however the endoscopic technique group showed less tissue trauma evaluated by determinations of serum creatinine kinase levels, less hospital stay, less amount of bleeding, Shorter surgical time compared to the open technique group [39,42].

Our biportal endoscopic technique was designed and executed by the corresponding author who is a neurosurgeon, international faculty and S.C. WFSE, it was performed without complications and showed a short surgical time, with little bleeding, the patient treated with this technique showed clinical improvement, however comparative prospective studies are required to provide an objective measure of the benefits of biportal endoscopy in the treatment of Chiari malformation and demonstrate its safety and efficacy.

Surgical highlights

Biportal endoscopy is a minimally invasive technique that maximizes surgical scope while preserving anatomy and reducing surgical risks by allowing us to work under direct vision in real time, allowing maximization of vision, better illumination in deep regions, improving the results of surgery. This technique, by combining endoscopic technology with basic surgical instruments, is reproducible both in the private environment and in public health institutions.

Strengths and limitations

Our technique reported a surgical time of 45 minutes and a hospital discharge 24 hours after surgery, which when compared to the only report of Dolas [29] full endoscopic, which reports a minimum surgical time of 175 minutes and a hospital stay of 3 days, gives us the guideline to propose biportal endoscopy as a viable technique in the management of Chiari malformation; The biportal endoscopy technique requires prior training and we suggest seeking the accompaniment of an expert in the realization of your first cases.

Comparison with other surgical techniques and researches

There are still no comparative studies of the biportal endoscopic technique with other techniques, however, although there are few reports of comparative studies of endoscopic techniques whit open surgery; [39,42] this reports that favor endoscopic surgery in the treatment of Chiari malformation by reducing surgical times, days of hospital stay and better preservation of tissues compared to open surgery.

Implications and actions recommended

Previous training in biportal endoscopy is required, before performing the surgical technique, it is suggested to seek the accompaniment of an expert in their first cases.

Conclusion

The biportal endoscopic technique is a viable option within the minimally invasive techniques in the treatment of Chiari malformation. Comparative studies with control groups are required to evaluate its efficacy and safety.

Conflict of Interest

The authors have no conflict of interest to declare. This work did not require any type of financing.

The patient gave her written consent and authorized the performance of the surgery fully understanding the risks linked to the surgical procedure and allowed the use of her information, studies and images for the realization of this publication.

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