Transoral Decompression and Anterior Stabilization of Atlantoaxial Joint in Patients with Basilar Impression and Chiari Malformation Type I: A Technical Report of 2 Clinical Cases

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■ OBJECTIVE: **Presentation of clinical cases involving successful anterior stabilization of the C1-C2 segment in patients with invaginated C2 odontoid process and Chiari malformation type I.**

■ METHODS: **Clinical case description.**

■ RESULTS: **Two patients with C2 odontoid processes invagination and Chiari malformation type I were surgically treated using the transoral approach. In both cases, anterior decompression of the upper cervical region was performed, followed by anterior stabilization of the C1-C2 segment. In 1 of the cases, this procedure was performed after posterior decompression, which led to transient regression of neurologic symptoms. In both cases, custom-made cervical plates were used for anterior stabilization of the C1-C2 segment. During the follow-up period of more than 2 years, a persistent regression of both the neurologic symptoms and Chiari malformation was observed.**

■ CONCLUSIONS: **Anterior decompression followed by anterior stabilization of the C1-C2 segment is a novel and promising approach to treating Chiari malformation type I in association with C2 odontoid process invagination.**

INTRODUCTION

Chiari malformation type I is defined as a downward displacement of the cerebellar tonsils of >5 mm below the Chamberlain line (the line between the hard palate and the posterior edge of the foramen magnum). In cases with brainstem compression symptoms, the standard surgical treatment approach is suboccipital decompression.[1-3]

Chiari malformation type I is often accompanied by congenital developmental anomalies such as platybasia, C2 odontoid process invagination, and odontoid process retroflexion, which can lead to anterior compression of the brainstem[4] (**Figure 1**). Generally, C2 odontoid process invagination is described as the prominence of the odontoid process of >5 mm above the Chamberlain line.[5,6] Over the last few years, clinical interest in anterior decompression of the brainstem structures followed by posterior stabilization has increased.[7] Transoral resection of the odontoid process with posterior decompression and stabilization has become the standard method of treatment for this condition. A variation of this method includes the same steps in reverse order: posterior decompression and stabilization, followed by transoral decompression.[8-11]

Historically, the approaches to surgical treatment of patients with Chiari malformation type I accompanied by C2 odontoid process invagination went through several stages of development.[7] Initially, staged surgical intervention was the method of choice, with up to a week between stages (anterior decompression followed by posterior decompression and stabilization a week later). However, currently, both stages are performed under 1 stage of anesthesia using 2 different approaches.[12,13]

In this article, we describe a novel method of surgical treatment of the condition through a single transoral approach, used for both the decompression procedure and anterior stabilization of the C1-C2 segment. In both cases, a custom-made cervical plate is used for anterior stabilization.

ANTERIOR STABILIZATION TECHNIQUE

Under general anesthesia, a tracheostomy is carried out and a mouth opener applied. A linear midline incision of the soft palate

Key words
- Anterior stabilization
- Basilar impression
- Chiari malformation type I
- Transoral decompression

Abbreviations and Acronyms
3D: Three-dimensional
CT: Computed tomography
MRI: Magnetic resonance imaging

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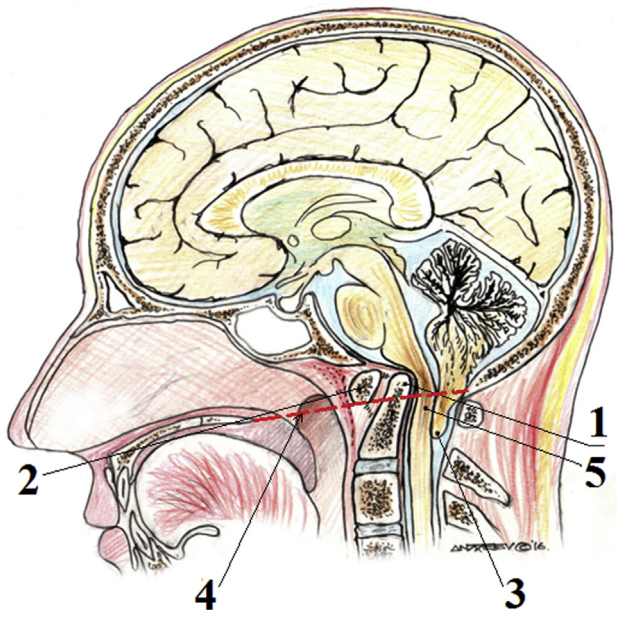

Figure 1. Representation of Chiari malformation type I with basilar impression. Before surgery. 1, C2 odontoid process; 2, C1 anterior arch; 3, displaced cerebellar tonsils; 4, Chamberlain line; 5, upper cervical spinal cord region.

and the posterior pharyngeal wall is made. The anterior arch of C1, bottom portion of the odontoid process, and body of C2 are exposed. The anterior arch of C1 and the deformed odontoid process are carefully resected. At this stage, it is essential to make sure the dura mater is intact at the point of odontoid process impression, because it is likely to be severely thinned and duraplasty is difficult to perform in such a narrow space. Cerebrospinal fluid leakage can increase the risk of inflammatory complications in the postoperative period. During preoperative planning, anterior stabilization of the atlantoaxial joint with a custom-made plate is modeled and rehearsed in each individual case (Figure 2). The anterior elements of the C1-C2 segment are stabilized with a plate custom made in accordance with a stereolithographic model of the craniocervical region of the patient's spine. The concave surface of the plate is fully congruent with the anterior surface of the C1-C2 segment, which ensures optimal surface contact of the plate with the bony structures.

The process of individual metallic plate manufacturing requires three-dimensional (3D) computed tomography (CT) to be performed in a strictly horizontal position. CT data are processed using computer software to produce a digital model of the plate, which is then correlated with the digital model of an individual's cervical vertebrae. Digital modeling of the screw insertion trajectory and screw dimensions as well as the dimensions of the plate itself are also possible. As a result, a perfectly congruent individual metallic plate is manufactured using additive technology and mechanical cutting techniques. The plate manufacturing process takes all the anatomic details of the anterior elements of the C1-C2 vertebrae and their mechanical interaction into account and replicates the anterior surface of the individual C1-C2 segments for each patient, which increases the metal-to-bone contact area and the reliability of fixation. The next stage involves manufacturing a full-scale 3D model of the craniovertebral segment from polymethylmethacrylate using a stereolithographic technique, producing an exact copy of the individual bone structures of each patient. To determine the level of surface congruency between the plate and the vertebrae, the plate is fitted to the stereolithographic model. If needed, additional mechanical adaptation of the plate surface is performed. The metallic plate is fixed using 2 screws inserted into the lateral

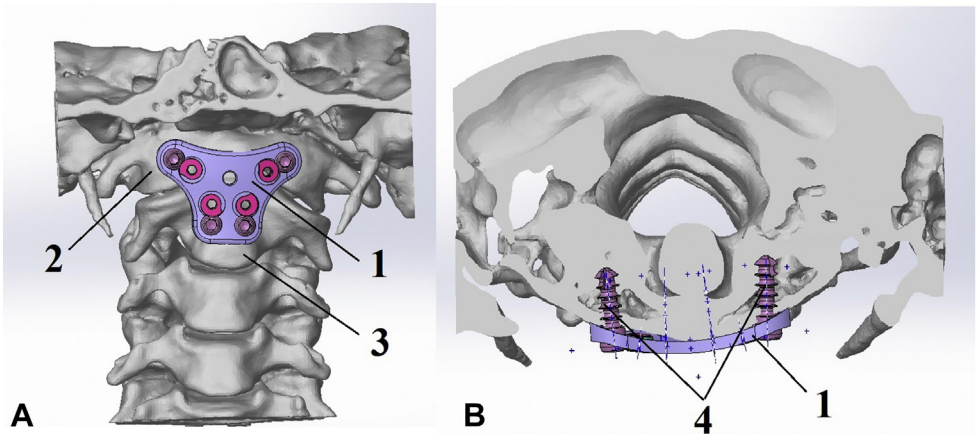

Figure 2. Modeling of the custom-made plate for anterior stabilization of the atlantoaxial joint. (**A**) Frontal view; (**B**) axial view. 1, atlantoaxial joint stabilized with the metallic plate; 2, C1 vertebra; 3, C2 vertebra; 4, screws placed through the C1 lateral masses.