Adding Expansile Duraplasty to Posterior Fossa Decompression May Restore Cervical Range of Motion in Grade 3 Chiari Malformation Type 1 Patients

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■ BACKGROUND: **Few studies have assessed the effect of Chiari malformation type 1 (CM-1) surgical decompression on cervical lordosis and range of motion (ROM). We aimed to assess the effect of expansile duraplasty on postoperative cervical mobility and spinal stability.**

■ MATERIALS AND METHODS: **This was a single-center retrospective review of prospectively collected data. Patients were included if they underwent surgical treatment for symptomatic CM-1 between the years 1999 and 2009. Cervical ROM and lordosis were assessed before and after surgery in all patients. Collected data also included clinical improvement, as well as surgical complications after the procedure. Patients were divided into 2 groups. The first group underwent a posterior fossa bony decompression alone, while the second group additionally received an expansile duraplasty. Patients were further subdivided into 3 subgroups on the basis of the severity of tonsillar herniation.**

■ RESULTS: **A total of 76 patients fit our selection criteria. Fifty-five patients belonged to the duraplasty group. Twenty-one patients underwent bony decompression alone. The 2 groups were statistically demographically and clinically similar. There was no difference in clinical outcome or in ROM and cervical lordosis between the groups except for patients with severe tonsillar herniation (CM-I grade 3). These patients had a statistically significant improvement in their postoperative cervical motility without compromising their spinal stability.**

■ CONCLUSION: **Adding an expansile duraplasty to craniovertebral decompression in CM-1 patients with severe tonsillar herniation may restore cervical ROM while preserving stability and alignment. This may relieve postoperative pain and improve clinical prognosis.**

BACKGROUND

The treatment of Chiari malformation type 1 (CM-1) disease has been the subject of much controversy during the past 50 years.[1-7] While some criteria are generally agreed upon as strong indications for a surgical intervention, such as the presence of a syrinx, or worsening neurologic deficits, most symptoms of the disease are still subject to debate as they frequently involve pain.[6] The optimal choice of the surgical intervention itself is even more controversial, as it can range from craniovertebral decompression (CVD) alone to posterior fossa decompression with patch duraplasty and cerebellar tonsillar resection.[8-11] To add to the complexity of this disease, CM-1 could potentially restrict cervical range of motion (ROM) and experts have questioned if and how surgery with CVD could affect cervical ROM, as well as cervical spine alignment and lordosis.[6,7,12]

Few studies have assessed the effect of CM-1 surgery on cervical ROM and lordosis, with most showing preservation of both preoperative ROM and alignment after decompression.[6,7] However, the severity of tonsillar herniation in some cases and the fact that the dura is often found to be restrictive intraoperatively question the impact of expansile duraplasty on cervical and occipitocervical mechanics, especially as they often relate to postoperative pain. We aimed to study the effects of CM-1 decompression with or

Key words
- Cervical lordosis
- Cervical range of motion
- Chiari type 1 malformation
- Expansile duraplasty
- Surgical outcome

Abbreviations and Acronyms
CM-1: Chiari malformation type 1
CVD: Craniovertebral decompression
JOA: Japanese Orthopedic Association
MRI: Magnetic resonance imaging
ROM: Range of motion

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without duraplasty on cervical ROM and cervical lordosis, stratified over different grades of tonsillar herniation.

MATERIAL AND METHODS

This study was a retrospective review of prospectively collected cases of CM-1 patients who underwent surgical treatment between 1999 and 2009 at a single institution. Ethical review board approval was obtained at our institution for the de-identified retrospective collection of patient data. All patients were adults older than 18 years of age. CM-1 was diagnosed using magnetic resonance imaging (MRI) in all cases. CM-1 grading was defined on the basis of previously validated methods in the literature.[5,6,13,14] Briefly, in grade 1 the tonsils descended 5 mm below the level of the foramen magnum but did not reach the arch of C1. Grade 2 was defined by the tonsils reaching the arch of C1, and grade 3 by a descent under the arch (Figure 1).

Cases with assimilated vertebrae and laminar hypoplasia were excluded. Patients were divided in a CVD-only group and a CVD with duraplasty group. Selection of the surgical treatment was at the discretion of the treating physician. Each group was further subdivided according to the preoperative CM-1 grade into the 3 subgroups described earlier.

Surgical indications included severe symptoms such as pressure and Valsalva-type headaches, drop attacks, cranial or peripheral nerve dysfunction, and dysphagia. The presence of a syrinx was also an indication for surgery when coupled with signs of neurologic compromise or uncontrollable headaches. CVD was always done with an attempt to preserve the rectus capitis posterior major, semispinalis, and inferior oblique muscles at their insertion on the C2 arch. A C1 laminectomy was performed in most cases. When duraplasty was deemed necessary, we used a dural Y incision with various grafting material at the discretion of the operator, which included cadaveric dura, bovine pericardium, fascia lata, or autologous pericranium.

Cervical ROM and lordosis measurements were obtained for all patients on preoperative and 12-month follow-up imaging. Measurements were made using a computer drafting software (Autocad 2008, Autodesk, Inc., Mill Valley, California, USA). They were done using hyperflexion and hyperextension cervical plain films according to the method previously validated by Ranawat et al.[7] and Ono et al.[6,15,16] Briefly, the angle between the occiput and C1 was measured at the intersection between a line drawn at the base of the skull and a line connecting the centers of the anterior and posterior C1 arches. The angle at C1–C2 was measured at the intersection between the C1 line and a line drawn parallel to the inferior end plate of the C2 vertebral body. The angle at Oc–C2 was measured at the intersection between the line drawn on the base of the skull and a line drawn parallel to the inferior end plate of the C2 vertebral body. Because a laminectomy was performed at C1, and therefore the line could not be measured at C1, only the angle at Oc–C2 was measured after surgery. The angle at C2–3 or below was measured using a line drawn parallel to the inferior end plate of each vertebral body. The lordosis angle at C2–7 was measured at the intersection between the C2 and C7 lines as described earlier on a lateral x-ray view of the cervical spine in neutral position (Figure 2). An example of these measurements is illustrated in Figure 2.

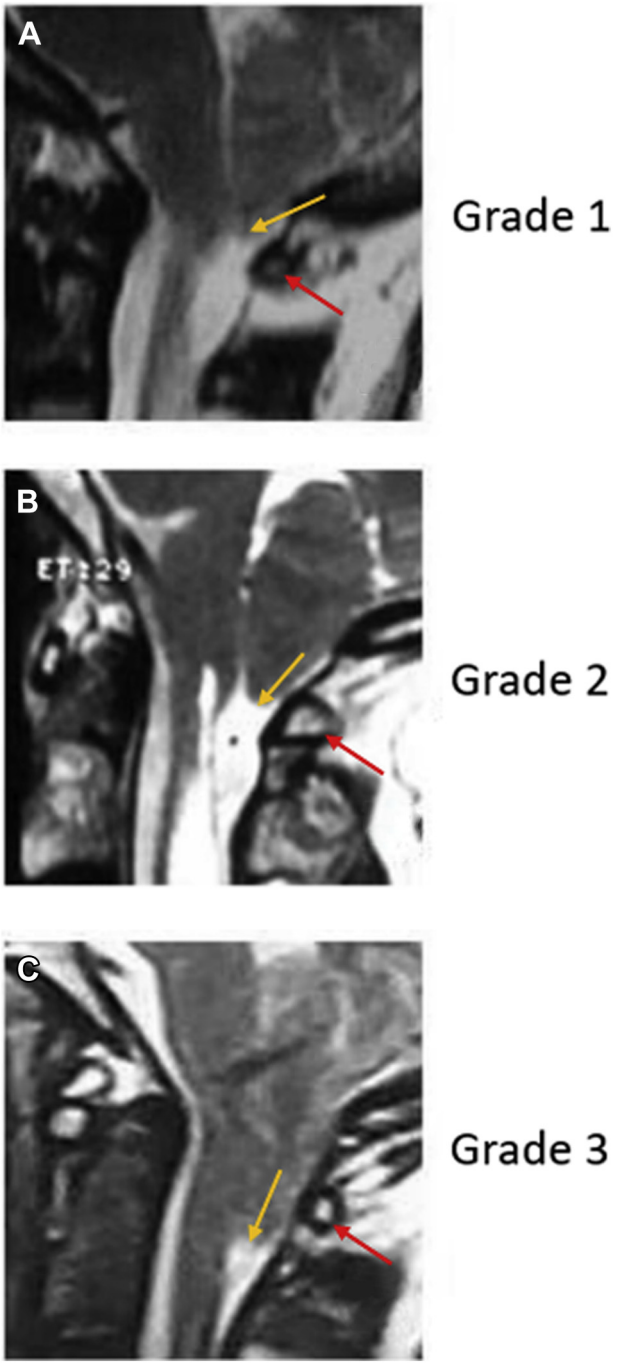

Figure 1. Sagittal magnetic resonance images of the craniocervical junction showing the differences among grade I, II, and III Chiari type 1 malformations. *Yellow arrows* designate the cerebellar tonsils, and *red arrows* designate the arch of C1.

An MRI was obtained in all cases within 3–5 days after surgery and at least 1 more time during a follow-up consultation, which was usually 3–6 months later, to evaluate the decompression, tonsillar herniation, and evolution of any existing