When Is Duraplasty Required in the Surgical Treatment of Chiari Malformation Type I Based on Tonsillar Descending Grading Scale?

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Key words
- Cerebellar tonsillar descent grading
- Chiari malformation type I
- Posterior fossa decompression duraplasty

Abbreviations and Acronyms
CCJ: Craniocervical junction
CM-I: Chiari malformation type I
CSF: Cerebrospinal fluid
CTD: Cerebellar tonsillar descent
JOA: Japanese Orthopaedic Association
MRI: Magnetic resonance imaging
PFD: Posterior fossa decompression

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OBJECTIVE: **To evaluate the effect of duraplasty based on cerebellar tonsillar descent (CTD) grade in the surgical treatment of Chiari malformation type I (CM-I).**

METHODS: **Medical records and magnetic resonance imaging (MRI) scans of 82 patients with surgical correction of CM-I performed at the authors' clinic from 1998–2009 were reviewed. The preoperative CTD grading scale was obtained. Patients were divided two groups: duraplasty group (group 1) and nonduraplasty group (group 2). The preoperative and postoperative size of the syringomyelia cavity, Japanese Orthopaedic Association (JOA) scores, recovery rate, and postoperative complications were determined.**

RESULTS: **There was 58 patients in group 1, who underwent combined foramen magnum decompression, C1 (and C2 if necessary) laminectomy, and duraplasty; the 24 patients in group 2 underwent posterior fossa decompression (PFD) alone with no dural opening performed. There were no statistically significant differences between preoperative and postoperative size of the syringomyelia cavity and JOA scores of duraplasty (group 1) and nonduraplasty (group 2) groups in CTD grades 1 and 2; in CTD grade 3, the decrease in syrinx cavity and clinical improvement were statistically better in group 1 compared with group 2 ($P < 0.05$). Complications in group 1 were statistically significantly increased compared with group 2 ($P < 0.05$).**

CONCLUSIONS: **This study shows that PFD and duraplasty for the treatment of CTD grade 3 Chiari malformation may lead to a more reliable reduction in the volume of concomitant syringomyelia and JOA scores. In CTD grade 1 and 2 patients, PFD without duraplasty may be performed.**

INTRODUCTION

For surgical treatment of Chiari malformation type I (CM-I), there is no consensus among surgeons about which method is preferred. More recently, many surgeons have advocated posterior fossa decompression (PFD) without duraplasty (7, 21, 30). Other surgeons prefer to perform bone decompression of the posterior fossa and duraplasty (12, 17, 26). PFD with duraplasty is associated with a lower risk of reoperation than PFD without duraplasty but a greater risk for cerebrospinal fluid (CSF)–related complications. We hypothesized that extradural PFD with or without duraplasty may be better tolerated by patients than intradural procedures. Duraplasty itself with PFD surgery may decrease postoperative syrinx size, improve Japanese Orthopaedic Association (JOA) scores (4), and improve recovery rate. To evaluate our hypothesis, we retrospectively studied 82 consecutive patients undergoing PFD with or without duraplasty and compared the outcomes of patients. To our knowledge, there has been no published report on the effect of duraplasty based cerebellar tonsillar descent (CTD) grading in the surgical treatment of CM-I. The main aim of this study was to assess the effectiveness of duraplasty based on CTD grading scale in symptomatic CM-I.

METHODS

Patients

After approval from the our clinic review board, the senior author's (Y.A.) database of all 82 consecutive patients who had CM-I with or without syringomyelia over a 10-year period (1998–2009) was reviewed. All patients were older than 18 years and underwent the PFD procedure at our institution. CM-I cases were diagnosed with the aid of magnetic resonance imaging (MRI). The definition of CM-I in this study was that the cerebellar tonsil descended more than 5 mm below the foramen magnum. The preoperative stage of CTD was determined on MRI based on the following three classifications: grade 1, the tonsil descended more than 5 mm below the foramen magnum but did not reach the C1 arch; grade 2, the tonsil reached the C1 arch; and Grade 3, the tonsil descended over the C1 arch (**Figure 1**). For

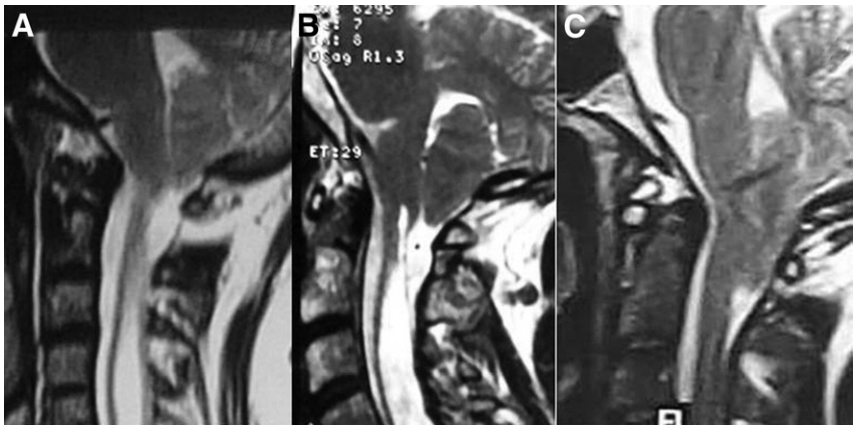

Figure 1. (A) Grade 1 tonsillar descent. Tonsil descended to above C1 arch. **(B)** Grade 2 tonsillar descent. Tonsil descended to C1 arch level. **(C)** Grade 3 tonsillar descent. Tonsil descended below C1 arch.

comparisons among these categories, JOA scores, recovery rate, decrease in syrinx size, complications, and reoperation rate were assessed for each grade (**Table 1**).

Surgical indications were usually headache or tussive headache; drop attacks; neck, arm, or back pain; swallowing difficulties; or upper extremity numbness or tingling. The presence of a syrinx was also an indication for surgery when it occurred in the presence of the aforementioned symptoms.

Surgical Procedure

All patients underwent osseous decompression including PFD and C1 laminectomy and were grouped according to tonsillar descending grading scale. The degree of tonsillar descent was graded in relation to the superior and inferior borders of the C1 lamina. The specific surgical procedure (nonduraplasty or duraplasty) was chosen based on the surgeon's experience and preference. After general anesthesia was administered, all surgeries were performed with the patient in the prone position with rigid head fixation. A midline incision extending from the inion to the upper cervical spine was used to perform a standard subperiosteal dissection of muscle from the occipital and cervical region. Muscle attachments were preserved at the superior nuchal line and usually at the C2 lamina. Osseous decompression was achieved with a high-speed air drill, encompassing the inferior aspect of the occipital bone with modest superior extension (approximately 1.5–2.0 cm) and lateral extension to the lateralmost aspect of the foramen magnum and cervical spinal canal, and C1 laminectomy (and C2 if necessary) was performed. In the duraplasty group, after the dura was opened, dural grafting was performed with cadaveric dura, bovine pericardium, fascia lata, or autologous pericranium. No sealant was used to reinforce the dural suture line, and no forced inspiratory pressure was routinely used to test the integrity of the dural closure. In the nonduraplasty group, only bone removal was performed. Finally, the wound was meticulously closed with interrupted sutures, each layer at a time: muscles, fascia, subcutaneous tissue, and skin.

Follow-up

Postoperative clinical improvement was assessed from clinic notes and generally reflected subjective reports of improvement in symptoms evaluated using the JOA scale and recovery rate. Recovery rate according to the JOA scale (15), which indicates the degree of normalization after surgery, was calculated using the following formula:

$$\text{Recovery rate (\%)} = \frac{\text{Postoperative score} - \text{Preoperative score}}{18 - \text{Preoperative score}} \times 100$$

All patients underwent MRI 3–5 days after surgery and at least one subsequent MRI session at the follow-up consultation, usually 6–12 months later. The presence or absence of syringomyelia and its location and extent in the cervical or the thoracic cord (or both) were assessed preoperatively and at least 6 months postoperatively and as needed thereafter. Syrinx improvement was defined as any demonstrable decrease in maximal syrinx diameter, as seen on MRI at least 6 months postoperatively. In practical terms, syrinxes that were smaller postoperatively showed minimal residual, indistinguishable from mild dilation of the central canal. In patients with postoperative MRI (**Figure 2**), the change in the size of the syrinx cavity was classified as improved (decreased maximal diameter), unchanged, or increased.

Outcome Measures

The long-term (average 9 months postoperatively) surgery-related result was considered excellent if symptoms resolved. The result was considered good if the patient experienced significant improvement but also residual symptoms. A poor result indicated no change in symptoms or deterioration. Specifically noted symptoms were assessed at the time of follow-up examination.

Statistical Evaluation

Statistical analysis was performed with the assistance of computer statistics programs (SPSS 10.0.7; SPSS, Inc., Chicago, Illinois, USA) by one of the authors (Y.T.). Statistical analysis was performed using Student *t* test, analysis of variance test, and univariate and multivariate regression analysis. A probability value < 0.05 was considered statistically significant.

RESULTS

Mean age of patients in each group was similar at the time of surgery (duraplasty group 38.9 years and nonduraplasty group 31 years). There were 58 patients in group 1, who underwent combined PFD, C1 (and C2 if necessary) laminectomy, and duraplasty; the 24 patients in group 2 underwent PFD without duraplasty. There were 36 men and 46 women.

Group 1 (Duraplasty Group)

Of the 58 patients in group 1, 25 (43.1%) were in CTD grade 1, 21 (36.2%) were in CTD grade 2, and 12 (20.7%) were in CTD grade 3. The means of the JOA scores before surgery and at the final follow-up evaluation