Decompression of Chiari malformation with and without duraplasty: morbidity versus recurrence

Clinical article

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Object. The optimal surgical management of Chiari malformation (CM) is evolving. Evidence continues to accrue that supports decompression without duraplasty as an effective treatment to achieve symptomatic relief and anatomical decompression. The risks and benefits of this less invasive operation need to be weighed against decompression with duraplasty.

Methods. The authors performed a retrospective review of all CM decompressions from 2003 to 2007. All operations were performed by a single surgeon at a single institution. Data were analyzed for outcome, postoperative morbidity, and recurrence.

Results. Of 121 unique patients, 56 underwent posterior fossa decompressions without duraplasty (PFD) and 64 patients underwent posterior fossa decompressions with duraplasty (PFDD). Of the 56 PFD patients, 7 (12.5%) needed a subsequent PFDD for symptomatic recurrence. Of the 64 patients who underwent a PFDD, 2 (3.1%) needed a repeated PFDD for symptomatic recurrence. Patients treated with PFDD had an average operative time of 201 minutes in contrast to 127 minutes for those who underwent PFD (p = 0.0001). Patients treated with PFDD had average hospital stays of 4.0 days, whereas that for patients treated with PFD was 2.7 days (p = 0.0001). While in the hospital, patients treated with PFDD used low-grade narcotics, intravenous narcotics, muscle relaxants, and antiemetic medications at statistically significant differing rates.

Conclusions. While PFD was associated with a higher rate of recurrent symptoms requiring repeated decompression, this may be justified by the significantly lower morbidity rate. Clearer delineation of the trade-off between morbidity and recurrence may be used to help patients and their families make decisions regarding care. (DOI: 10.3171/2010.1.PEDS09218)

Key words • pediatric neurosurgery • Chiari malformation Type I • duraplasty • clinical study

The optimal surgical treatment of CM has yet to be delineated. Ever since the landmark 1938 publications of McConnell15 and D’Errico6 describing successful surgical management, there has been open debate on the best operative treatment of this enigmatic disease. One key debate centers on which patients require a duraplasty as part of their operative treatment.3,7,8,12,16 It is increasingly clear that many patients with CM are cured by PFD without duraplasty. However, the neurosurgical community currently lacks the diagnostic ability to determine preoperatively with perfect clarity which patients require a PFDD or simply a PFD. In addition to unclear best treatments, the acuity of disease presentation has decreased. In earlier times patients were often bedridden, unable to ambulate unassisted, and frequently had papilledema.5,13,15 While not bedridden, patients in the 1950s and 1960s were often described as having severe ataxia and being hemi- or quadriplegic with significant sensory deficits.2,10,14 Currently, patients with CM tend to have less advanced neurological deficits and are treated in a nonurgent manner with elective surgeries. Concurrently, the surgical therapies for this disease have come to involve far less morbidity and mortality. D’Errico5 described 4 deaths within 5 weeks of surgery in his series.
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of 8 patients; in his 1965 series Gardner9 reported a morbidity rate of nearly 7% and commented that operations for CM decompressions entail "a definite risk and should be reserved for those patients in whom total disability is threatened by progression of the symptoms." These trends have increased patient expectations for a smooth, nonmorbid, and nonrecurrent treatment of their—or their child's—condition.

Coincident with the rise in patient expectations has been the rise in patient-centered care, with its emphasis on individual patient needs, wants, and preferences.1,4,11,17–19 This trend requires the neurosurgeon to tread gently in the face of variable care—in the face of uncertainty—and to be as well informed as possible about alternatives they may offer their patients. It is not our goal here to determine the superiority of either the PFDD or PFDD. Rather, as the neurosurgical community works to better define best operative care for individual patients, these issues require a clear sense of the choices physicians, patients, and families are making when contemplating a CM decompression. While PFDDs in all symptomatic patients with CM would likely decrease the rate of repeat decompression, what are the costs in terms of morbidity? Conversely, PFDs may make for more comfortable patients, but is it ethical to offer this option if the costs in terms of recurrence are too high? In this paper, we seek to bring greater clarity to the trade-off in morbidity compared with recurrence when contemplating a duraplasty in patients with CM seeking treatment.

Methods

Our hypothesis is that PFD is an effective therapy for many patients with CM and that the slightly higher recurrence rate must be balanced against its lower rate of morbidity. To explore this hypothesis, we performed a retrospective review of patients with CM treated at our institution. All asymptomatic patients underwent serial examinations and radiography. All patients with CM and a syrinx were treated with PFDD. All patients without a syrinx but with symptoms clearly attributable to a radiographically evidenced CM were treated with PFD, unless the family had a strong preference for PFDD or intraoperative observations led the surgeon to believe that a duraplasty was required for adequate decompression. Specifically, the surgeon looked for intradural pulsatility and the reestablishment of a subarachnoid space; if these were not unquestionably present after a full PFD, a PFDD was performed. No patients received, or were candidates for, a ventral decompression, neither pre- nor post-PFDD. In addition, the presence of shunt for hydrocephalus management did not factor into whether a patient underwent duraplasty.

Approval from the University of Louisville Human Subjects Protection Program was obtained. Using the operative database maintained by a single pediatric neurosurgical attending (T.M.M.), we identified all patients with CM operated on since 2000, yielding 121 unique cases. From the hospital and private practice medical records, we collected information on these cases retrospectively. Operating room information was available for 95 patients (cut time and close time); demographic information was available for 121 patients (age, length of stay, sex, weight, and height). From the patient intake form and the patient encounter notes available in the medical records, additional diagnoses, as well as signs and symptoms in 113 patients, were obtained. The number of weight-appropriate doses per day on each of postoperative Days 1, 2, and 3 was collected for the following: nonnarcotic oral pain medications (Tylenol, ibuprofen), low-grade narcotic oral pain medications (Darvocet, Tylenol #3), high-grade narcotic oral pain medications (Lortab, Percocet), intravenous narcotic pain medications (morphine, Nubain, fentanyl), muscle-relaxant medications (baclofen, Valium), and antiemetic medications (Zofran, Phenergan). Information on medicine dosage was available for 96 patients. (In addition to all medications administered on postoperative Day 1 there were those used in both the postanesthesia care unit and the pediatric intensive care unit.)

Categorical data and counts with percentage were analyzed using means and t-tests (or Wilcoxon tests). Descriptive and clinical characteristics were summarized descriptively and tested for differences across surgery types as appropriate. The outcome variables of primary interest were the counts of weight-appropriate doses of 6 classes of medication—nonnarcotics, low- and high-grade and intravenous narcotics, muscle relaxants, antiemetics—given on the first 3 postoperative days. The data represented repeated-measures count data, repeated because measurements were repeated within cases for the 3 postoperative days. The counts of each class of drugs were analyzed via the fitting of a generalized linear mixed model with random intercepts under the Poisson distribution. The generalized linear model was necessary to account for the inherent nonnormality of count data (the Poisson distribution is typically used for count data). The random intercepts were necessary to account for the association among the repeated measurements of the counts on the 3 postoperative days. Each model was fit with terms accounting for the following: surgery type, time, sex, and age. The model fitting surgery type was of primary interest to the investigators; remaining terms were included as control variables, rather than parameters to be tested.

Results

Of 121 unique patients, 58 were male and 63 female. Average age (at first operation) was 11.1 years (range 0.9–50 years), average body mass index was 21.9 (range 6.7–42.5). Fifty-six patients underwent PFD; this involved a wide suboccipital craniectomy, C-1 laminectomy, and careful resection of dural bands without entering the intradural space. Sixty-four patients underwent PFDD; a Y-shaped incision extending caudal past the foramen magnum with a generous pericranial patch, covered with Tisseal (Baxter International). All patients underwent follow-up MR imaging at 6 months.

The presenting signs and symptoms in the PFD and PFDD groups were very similar; only the differences in dizziness, asthma, and visual symptoms reached statistical significance. The presenting signs and symptoms in all patients who underwent a single operation and those who
went on to require reoperation were not statistically different with the exception of nausea and vomiting: patients who would go on to need a second operation were more likely to present initially with nausea and vomiting than those who would not, 55% compared with 18% (p = 0.01). Finally, the signs and symptoms in patients who also had a syrinx are presented; these patients, interestingly, had a lower overall rate of headache-related problems (Fig. 1).

Of the 56 PFD-treated patients, 7 (12.5%) needed a subsequent PFDD for symptomatic recurrence. Of the 64 patients receiving a PFDD, 2 (3.1%) required a repeated PFDD for symptomatic recurrence. One patient who underwent a repeated PFD had undergone a previous operation of unknown detail. Those patients undergoing PFDD were in the operating room longer than those in whom a PFD was performed (201 ± 34 minutes compared with 127 ± 25 minutes, respectively; p = 0.0001). Patients who underwent PFDD also stayed in the hospital significantly longer (4.0 vs 2.7 days, p = 0.0001).

The morbidity was measured by determining complication rates as well as by looking at drug usage while in the hospital. Patients who underwent PFDD used low-grade narcotics, intravenous narcotics, muscle relaxants, and antiemetic medications at statistically significant differing rates. For low-grade narcotics, patients treated with PDF had greater usage on postoperative Days 1 and 2, but less on Day 3 (p = 0.05 for rates of usage and p < 0.0001 for differential rates of change over 3 postoperative days). For intravenous narcotics, patients treated with PFDD used more over all 3 days postoperatively (p = 0.006), and rates of use over 3 days dropped more quickly in the PFD group (p < 0.0001). For muscle relaxants, rates of use between PFDD and PFD groups were similar initially, but dropped off much more quickly in the PFD group (p < 0.0001). Antiemetic medication usage was similar to that of intravenous narcotics: patients treated with PFDD used more over all 3 postoperative days (p = 0.007), and usage rates dropped more quickly in the PFD group (p = 0.04) (Figs. 2 and 3). Two patients (3%) in whom duraplasty was performed developed a pseudomeningocele, and one (1.6%) developed a superficial wound breakdown requiring local wound care only. There were no complications in the PFD-alone group.
undergoing PFDD. Patients in whom PFDD was performed were in the operating room on average 74 minutes longer than those receiving a PFD, a 59% increase. Length of stay was similarly increased, by 1.3 days, a 51% increase over the PFD group. The increased use of low-grade narcotics in patients treated with PFD in the early postoperative phase is best understood in context. The patients treated with PFD had less need for intravenous narcotics but still had postoperative pain to contend with and so used low-grade narcotics; over time their low-grade narcotic use dropped off quickly, and by postoperative Day 3 it was lower than that in patients treated with PFDD who, by inference, were contending with more severe, long-lasting pain. Low-grade narcotic usage in patients treated with PFDD actually increased over the 3 postoperative days as intravenous narcotics were weaned off. Muscle-relaxant usage followed a pattern of use similar to that of low-grade narcotics, with higher initial usage among patients treated with PFD but a more rapid drop off in use in these patients; this is likely due to better initial coverage of pain by intravenous narcotics in the early postoperative phase in the PFD group. Unlike low-grade narcotics, however, PFDD-treated patients’ use of muscle relaxants decreased over 3 days postoperatively; we assume this is because pain lasts longer than muscle spasm in this patient population. Higher use of intravenous narcotics in the PFDD group as well as a faster drop off in usage in the PFD group was also seen and correlates well with inferences about low-grade narcotics and muscle-relaxant usage. Finally, antiemetic usage patterns in these two groups correlates well with what we know about opening the dura of the posterior fossa: these patients feel nauseous and lousy. Accordingly, antiemetic medication usage in patients treated with PFDD was on average about 5-fold that noted in the PFD group over all 3 days postoperatively.

The issue of costs is an unavoidable reality in today’s world. To this end, we sought to clarify some of the financial trade-offs implicit in these data. We obtained cost information on episodes of care beginning on the day of surgery and ending on the day of discharge for all patients in our data set receiving their care after January 1, 2005 (as far back as computerized financial information is available). We used cost data rather than hospital charge data because cost figures are set for any given service and do not vary from patient to patient; hospital charges, on the other hand, vary not only by which services have been delivered but also by which payor is involved. Physician charges for the services were the same no matter which procedure was done (per Current Procedural Terminology Code 63143) and were not included. The average cost per episode of care per patient undergoing a PFD was $14,305, whereas that for patients undergoing a PFDD was $27,210 ($12,904 less). We also answered the following question: at what recurrence rate for PFD patients is the cost equal to conducting PFDDs in our entire population? We found the answer to be a recurrence rate of 44.8% would equalize the costs. The recurrence rates in our series were similar to those reported elsewhere. Unfortunately, we were not able to find any significant preoperative differences in presenting signs or symptoms that might help us to determine ahead of time in which patients there is a higher probability of failing PFD. While patients who would go on to need a second operation were statistically more likely to have nausea/vomiting, this result should be interpreted with caution given the small sample size and the retrospective nature of the data collection. It seems likely that any few signs or symptoms, even if significantly different between groups of patients needing only one operation and those needing a second operation due to recurrence, would be insufficient to preoperatively characterize patients as higher risk for recurrence if they receive a duraplasty. In our series, the presence of any significant syrinx was criteria for an initial duraplasty and thus was not analyzed for prognostic power.

**Discussion**

Our data were entirely consistent with increased health care services delivery intensity for those patients undergoing PFDD. Patients in whom PFDD was performed were in the operating room on average 74 minutes longer than those receiving a PFD, a 59% increase. Length of stay was similarly increased, by 1.3 days, a 51% increase over the PFD group. The increased use of low-grade narcotics in patients treated with PFD in the early postoperative phase is best understood in context. The patients treated with PFD had less need for intravenous narcotics but still had postoperative pain to contend with and so used low-grade narcotics; over time their low-grade narcotic use dropped off quickly, and by postoperative Day 3 it was lower than that in patients treated with PFDD who, by inference, were contending with more severe, long-lasting pain. Low-grade narcotic usage in patients treated with PFDD actually increased over the 3 postoperative days as intravenous narcotics were weaned off. Muscle-relaxant usage followed a pattern of use similar to that of low-grade narcotics, with higher initial usage among patients treated with PFD but a more rapid drop off in use in these patients; this is likely due to better initial coverage of pain by intravenous narcotics in the early postoperative phase in the PFD group. Unlike low-grade narcotics, however, PFDD-treated patients’ use of muscle relaxants decreased over 3 days postoperatively; we assume this is because pain lasts longer than muscle spasm in this patient population. Higher use of intravenous narcotics in the PFDD group as well as a faster drop off in usage in the PFD group was also seen and correlates well with inferences about low-grade narcotics and muscle-relaxant usage. Finally, antiemetic usage patterns in these two groups correlates well with what we know about opening the dura of the posterior fossa: these patients feel nauseous and lousy. Accordingly, antiemetic medication usage in patients treated with PFDD was on average about 5-fold that noted in the PFD group over all 3 days postoperatively.

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**Conclusions**

Currently, the pediatric neurosurgical community lacks perfect clarity on which children are best served by a PFD and which by a PFDD, although clearly for many children the PFD operation is sufficient. The rise in patient-centered care has increased the role of patients and their families in deciding what type of care they receive. We have attempted to more clearly define the trade-offs between the PFD and PFDD operations in children for whom the PFD...
operation is a viable alternative. While the risk of recurrence is slightly higher in patients undergoing a PFD, there are clear benefits to the majority of children for whom the PFD provides definitive therapy. By clarifying these issues, we hope to provide the material needed for better patient understanding and decision making.

**Disclosure**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: IS Mutchnick, RM Janjua, TM Moriarty. Acquisition of data: IS Mutchnick. Analysis and interpretation of data: IS Mutchnick, K Moeller, TM Moriarty. Drafting the article: IS Mutchnick. Critically revising the article: IS Mutchnick. Reviewed final version of the manuscript and approved it for submission: all authors.

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