Efficacy of Intrathecal Morphine Administration in Pediatric Patients Undergoing Selective Dorsal Rhizotomy
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Background
- Central pain (CP) is a neuromuscular disorder that disrupts normal motor and postural development in children.
- The improper development of or damage to the developing brain impairs the child's abilities to perform specific and effective motor functions.
- The current treatment for CP includes physical therapy and rehabilitation, orthotic devices, and surgery. Selective dorsal rhizotomy (SDR) is a neurosurgical procedure that treats the spasticity associated with CP. SDR involves separating the dorsal and ventral roots, stimulating the dorsal nerve roots, and monitoring the response from target muscles.
- Post-SDR in children have proven that epidural administration of morphine in the post-operative period allows for better pain control as compared to oral pain medications. The more recent use of intrathecal morphine has now allowed for prolonged periods of pain control and less use of narcotics in the immediate post-operative period.

Purpose
The purpose of this study was to evaluate the effectiveness of intrathecal morphine following selective dorsal rhizotomy in pediatric patients previously diagnosed with cerebral palsy.

Methods
- Patient Selection: Patients who underwent multilevel laminectomies for SDR at Akron Children's Hospital, performed by a single surgeon during the study period of June 1, 2015, and June 30, 2019 (N = 20). The control group consisted of patients who did not receive intrathecal morphine.
- Study data: The patients received a dose of morphine intrathecal morphine given by the surgeon at the time of surgery. The data were collected over a four-year period.
- Data Collection: Patients were initially captured by a search from Current Procedural Terminology (CPT) codes for this procedure (63185, 63190, 63929) through EMR from June 1, 2015-July 2019.
- Once patients were identified:
  - Length of stay (LOS), which is expressed by the time on neurosurgery service prior to transition to the inpatient rehabilitation phase.
  - Days on PCA and number of doses administered
  - Doses of oral narcotics administered during the hospital stay.
  - Doses of other narcotics administered in the inpatient rehabilitation
- Study Variables: Demographic variables: age, weight, and gender
  Variables included in the analysis:
  - Time in operating room
  - Extent of surgical exposure (based on level and percentage of roots cut and total amount of narcotic used post-operatively at 96 hours as measured by total dose of hydroxyemorphine administered on PCA)
  - Number of days on PCA
  - Cumulative dose of oral narcotics (morphine equivalent)
  - Number of days on oral narcotics, and number of doses taken.
- Other pain medication including gabapentin, diazepam, and ketorolac that was received within the 96-hour postoperative period was also included in the analysis.

Surgical Technique
- Peacock technique using multi-level laminectomy for bony exposure, typically levels L2-L5. All patients underwent the same technique performed by the same surgeon at a single institution. Laminectomies were performed on L2-L5 using an ultrasonic bone saw. Using an intravenous neuro-monitor and concurrent functional exam, each level from L2 through T1 was looked through systematically. Sensory nerve rootlets were selected and isolated while motor nerves were protected. If there was an abnormal electrical or motor response, the rootlet was cut. Per side, 20-40% of rootlets per level were targeted.
- The control group received intrathecal morphine, while the study group received IV morphine and 5 mg/kg was injected into the subarachnoid space just prior to tying the last dural stitch.
- Patients were weaned to flat for 48 hours, allowing for prone, supine, or lateral positioning. On post-operative day two, patients were allowed to sit up and start to mobilize with the help of physical therapy.

Statistical Analysis
- To identify any statistical difference between the demographics of the two groups, non-parametric descriptive statistics were used in the analysis. Wilcoxon Rank-Sum tests were conducted for age and weight, and Fisher’s exact test was conducted to assess any association with gender.
- For the variable analysis, the Wilcoxon Rank Sum test was used to compare outcomes between the study group and the control group by incorporating the variables identified. A p-value < 0.05 was used to note any significant difference in variables between the groups.

Outcomes
- Ten patients were identified who met the inclusion criteria.
- Seven patients received intrathecal morphine, and eight patients did not receive intrathecal morphine intraoperatively.
- The group demographics between the study group and the control group did not show any statistical significance with regard to gender, age at time of surgery, or weight at time of surgery. Incidentally, 75% of the control group were female as compared to only 29% of the study group (Table 1).

Table 1. Baseline Demographics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Study Group</th>
<th>Control Group</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, %</td>
<td>7/10</td>
<td>9/11</td>
<td>0.251</td>
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</table>

While results did not achieve statistical significance, a trend of less narcotic use in total was noted in the cohort group when compared to the control group.

As an example, the total PCA dose for the study group was 5243 mcg while the total for the control group was 4378 mcg, a 19% difference of 1155 mcg. The same tendency was seen in weight-based dosing as well. 163 mcg/kg in the study group vs. 171 mcg/kg in the control group. Although the mean total number of days on oral narcotics was greater in the study group (38.1) vs. the control group (18.8), the total oral narcotic dose was greater in the control group (17.9 mg) followed by the study group (5.7 mg).

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At our institution, ketorolac is commonly given after 12 hours from surgery, barring any contraindication. The median amount of ketorolac given during the first 96 hours post-operatively was 34 mg in the control group and 14.4 mg in the study group.

Discussion
- Based on the data, it was shown that the use of intrathecal morphine intravenously clinically reduced the opiate need in the first 96 hours post-operatively. Although the data did not show statistical significance amongst the variables selected, there did appear to be a tendency to have less oral narcotic use when intrathecal morphine was given in the operating room.
- Other positive outcomes from this study included less total dose of oral narcotics, less total dose of diapem, and less total dose of ketorolac in the immediate post-operative period.

Limitations
- Small population size.
- The cohort groups were not randomized as the decision to begin using intrathecal morphine on all patients was decided halfway through the study period based on the growing body of literature and success of this procedure.
- Furthermore, differing measures of pain validation could be used in the future to assess postoperative pain status.

Conclusion and Future Opportunities
- Use of intrathecal morphine has shown some benefits in terms of post-operative pain control for patients undergoing multi-level laminectomy for SDR. This confirmed data from prior studies showing that the use of intrathecal morphine lessens the need for post-operative narcotics in the immediate post-operative period (2, 3). Moving forward, a prospective randomized study of SDR patients utilizing the single-level laminectomy technique and pre-operative gabapentin, with the protocolized postoperative pathway may show clinically significant results in the spirit of reducing post-operative narcotic use and enhancing recovery after surgery, the community should consider the utilization of "unconventional" ideas such as long-acting local anesthetic, nerve blocks, or subcutaneous anesthetic medication administration.

References

Another measure that revealed an inverse relationship was the total dose of gabapentin within the first 96 hours post-operatively with 605.5 mg in the control group and 85.4 mg in the study group.