Intrathecal Baclofen Bolus Dosing and Catheter Tip Placement in Pediatric Tone Management

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KEYWORDS

• Pediatric • Cerebral palsy • Intrathecal baclofen • Spasticity • Flex • Bolus • Catheter

KEY POINTS

- High cervical catheter tip placement in intrathecal baclofen (ITB) therapy may be more efficacious.
- Pulsating, bolus, or flex dosing of ITB may be more efficacious than simple continuous infusion.
- There is a large concentration gradient within the cerebral spinal fluid (CSF).
- CSF flow oscillates along a craniocaudal axis and is not a continuous mixing flow as once portrayed.

INTRODUCTION

Nature of the Problem

Intrathecal baclofen (ITB) administered by an implanted pump was approved by the US Food and Drug Administration for the treatment of spasticity of cerebral origin in 1996. Intrathecal baclofen results in fewer systemic side effects than enteral baclofen with higher efficacy. Regarding cerebral palsy, efficacy evidence for managing spasticity was first published in 2000.[1] There has been increasing evidence that ITB is an efficacious treatment for spasticity in children.[2] Most of the studies assessing efficacy are based on a simple continuous infusion of ITB and little is mentioned regarding daily dosing or catheter tip placement.[3,4]

Disclosure: The authors have nothing to disclose.

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Phys Med Rehabil Clin N Am 26 (2015) 89–93

http://dx.doi.org/10.1016/j.pmr.2014.09.011 **pmr.theclinics.com**

1047-9651/15/$ – see front matter

Overall, patient satisfaction with intrathecal baclofen is high.[5] Krach and colleagues[6] showed that intrathecal baclofen therapy does not adversely affect the mortality of patients receiving this therapeutic modality compared with a matched cohort. One retrospective review found that after 1 year of ITB treatment, the mean ITB dose when treating spasticity was approximately 300 μg per day.[7] Despite more than 20 years of clinical use of ITB, there are several unanswered questions, including the ideal catheter tip placement and dosing regimens.

Pulsatile Dosing

Progressive dose increases are thought to be caused by tolerance, defined as requiring a higher dose to achieve the same degree of desired effect. Most practitioners experience this soon after a new ITB pump is implanted. Many patients are well controlled on relatively low doses soon after implantation, but the magnitude of effect quickly dissipates, requiring dose escalation.[8] Pulsatile bolus doses have been proposed as an effective and safe treatment strategy to reverse the need for increasing ITB dosages in patients with the probable tolerance to ITB.[9] There is a paucity of reports regarding ITB dosing regimens as alternative to simple continuous infusion. The published reports have been retrospective case series.[10,11] Interestingly, most clinicians reserve flex or bolus dosing for more severe cases or cases of primarily dystonia that were relatively unresponsive to simple continuous ITB therapy. This supports the notion that pulsatile bolus dosing of ITB may be more efficacious. No studies have compared the efficacy of simple continuous infusion to pulsatile bolus dosing.

Catheter Tip Location

There is one report reviewing the association of catheter tip location and daily dosing. The catheter tip location was variable because no intraoperative imaging was used to determine the catheter tip location. There was a trend for the higher catheter tip placement, resulting in lower daily doses (**Table 1**); however, "linear regression showed that a higher-level intrathecal catheter needs a lower dose, but this was not significant."[12]

Theory Behind Catheter Tip Location and Pulsatile Dosing

We know there is a significant concentration gradient that develops in the cerebral spinal fluid (CSF) for almost all naturally occurring proteins, neurotransmitters, and metabolites.[13,14] The exact mechanism of this is unknown. There is also a concentration gradient for ITB. Bernards[15] demonstrated that the concentration of baclofen is only 0.5% at a distance of 5 cm in comparison with the catheter tip at a steady state with a continuous low dose infusion. This was dramatically increased to almost 50%

Table 1
The number of cases with the intrathecal catheter tips at each level in the spine, along with the mean dose

Level	Number	Mean Dose (μg/d)	SE
Cervical	9	197.8	±78.1
Thoracic	81	266.2	±23.4
Lumbar	15	228.6	±49.5
Sacral	3	466.7	±280.4

Adapted from Sivakumar G, Yap Y, Tsegaye M, et al. Intrathecal baclofen therapy for spasticity of cerebral origin—does the position of the intrathecal catheter matter? Childs Nerv Syst 2010;26(8):1097–102. PMID: 20306056.