Use of an Orbital Epidural Catheter to Control Pain After Orbital Implant Surgery

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Background: The surgical placement of orbital implants for eviscerations, enucleations, and secondary implantations can cause severe postoperative pain that may not be relieved with high doses of narcotics. We analyzed the effectiveness of a method for postoperative pain control in orbital implant surgery using an orbital epidural pain catheter connected to a patient-controlled analgesia bupivacaine hydrochloride pump.

Methods: One hundred nineteen patients undergoing orbital hydroxyapatite implant surgery received placement of an orbital epidural catheter for the infusion of local anesthetics at the conclusion of their surgery. Patients were asked to gauge their level of comfort into the following 3 categories: total, some, or no pain relief in the first week after surgery. A separate numerical grading scale was used to further quantitate pain. Blood samples were collected in 4 patients to assess the systemic levels of bupivacaine.

Results: Most patients (88.2%) responded with total or some pain relief, with only 11.8% suffering severe pain. The mean numerical pain score was 2.8, within a range of 0 (no pain) to 10 (severe pain). The average plasma bupivacaine level in the 4 patients in whom this was measured was 0.38 µg/mL, which is well below the toxic level of 4.0 µg/mL. Furthermore, there were only 5 minor complications caused by the catheters, ie, 1 retrobulbar hemorrhage and 4 catheters that did not work. No permanent problems arose from any of the complications.

Conclusions: The orbital epidural pain catheter is an effective means to achieve postoperative pain control after orbital implant surgery. The simple technique of insertion and management of the catheters was well tolerated in our patient population.


The surgical placement of orbital implants can be associated with severe postoperative pain in our experience. This is especially true for eviscerations and secondary implantations and, to a lesser extent, enucleations. Traditionally, a single retrobulbar nerve block is administered with local anesthetics to counteract the pain. This direct injection of anesthesia provides rapid and effective pain relief, but the effect is short-lived. Narcotics are often prescribed to address the residual discomfort, but they often cause sedation and sometimes nausea without adequate pain relief.

We herein describe a new method of providing postoperative pain relief after orbital surgery that uses an epidural catheter placed into the orbit for delivery of local anesthetics with a patient-controlled analgesia (PCA) pump. The pump allows for the continuous infusion of local anesthetics in addition to boluses, which is controlled by the patient. The method described is used in anophthalmic orbits, and not in orbits with sighted eyes.

RESULTS

A total of 119 consecutive orbital hydroxyapatite implantations and insertions of orbital epidural catheters was performed. There were 59 females (49.6%) and 60 males (50.4%) ranging in age from 14 to 87 years, with an average age of 43.2 years. The 119 surgical procedures were broken down as follows: secondary implantations constituted 56 (47.0%); eviscerations, 52 (43.7%); and enucleations, 11 (9.2%). The right socket underwent operation in 65 (54.6%) patients; the left, in 54 (45.4%). All implants were hydroxyapatite spheres with sizes ranging from 14 mm in 1 patient, 16 mm in 5 patients, 18 mm in 104 patients, and 20 mm in 9 patients. The catheters were kept in the orbit an average of 3.47 days before being removed.

All 119 patients responded to questions about postoperative pain during the first postoperative week. Sixty-one pa-
PATIENTS AND METHODS

One hundred nineteen patients who underwent orbital hydroxyapatite implant surgery under general anesthesia for primary enucleation, enucleation, or secondary orbital implantation from July 25, 1991, through October 1, 1996, were studied retrospectively. Informed consent was obtained for the orbital surgery and the placement of an orbital epidural pain catheter for postoperative pain control. At the conclusion of surgery, all patients had an 18-gauge intravenous catheter-needle unit (angiocath) placed under the skin and orbicularis muscle, 1 cm from the lateral canthus of the socket undergoing operation. The angiocath was advanced toward the socket under the skin and muscle until reaching the lateral orbital rim and then angled backward toward the orbital apex (Figure 1).

An epidural catheter was premarked at 35 mm and inserted into the angiocath, placing the epidural catheter near the orbital apex. The angiocath was then removed, as was the wire stent inside the catheter, leaving the catheter in place. An intermittent injection cap was then attached to the distal end of the catheter. A 3-mL syringe with bupivacaine hydrochloride (Marcaine) was used to check the placement on the catheter, ensuring there was no return of blood and therefore that it was not intravascular. This precaution was performed to avoid serious systemic toxic effects due to the local anesthetic. The full 3 mL of bupivacaine hydrochloride was then slowly injected into the catheter, confirming the patency of the tubing and delivering anesthetic to the posterior orbit. The catheter was secured to the skin at the lateral canthus with a 3-0 chronic suture and Steri-Strips (3M Health Care, St Paul, Minn). This ensured that 35 mm of the catheter would be maintained in the orbit. A pressure patch was placed on the eye, and the intermittent injection cap was left exposed for easy access to the orbital catheter.

On discharge from the hospital, the patient received preservative-free bupivacaine from a computerized ambulatory drug delivery PCA pump (model 5800R; SIMS Deltec, Inc, St Paul, Minn) (Figure 2). The pump cassette holds 100 mL of bupivacaine, and the priming tube holds 1 mL. The pump delivered a continuous infusion of 0.5% bupivacaine hydrochloride at 1 mL/h, which was coordinated by a home health care agency. This dosage of 1 mL/h was chosen because we were previously accustomed to administering a single 1-mL retrobulbar injection of bupivacaine hydrochloride at the conclusion of orbital implant surgery. A lower dose of bupivacaine for our orbital pain catheter may be effective and safer. The pump also allowed the patient to administer boluses of 1 mL of 0.5% bupivacaine hydrochloride every 3 hours as needed in addition to the continuous infusion of bupivacaine. In this manner, the patient could press the dose button to provide optimal timing of anesthesia. (Initially, the demand bolus doses of 3 mL 0.5% bupivacaine hydrochloride were allowed every 3 hours, but this bolus volume was too substantial, with a few patients complaining of a pressure sensation around the orbit and the nurses reporting a tightness to the orbits.) All patients were also given prescriptions for oral oxycodone hydrochloride or hydrocodone bitartrate for breakthrough pain. The home health care nurse educated the patient as to the use of the orbital catheter and PCA pump. Our study included daily visits by the nurse to check the functioning of the pump and to gauge the patient's pain.

The patients were questioned as to their level of pain, which was categorized into the following 3 groups: no pain, some pain (described as mild to moderate pain), or severe pain. They were also asked to quantitate numerically their pain on a scale of 0 to 10, with 0 indicating no pain and 10, severe pain. Blood samples were collected from 4 patients for measurement of total bupivacaine plasma levels on the first 3 postoperative days and recorded. This was performed to assess systemic penetration of the bupivacaine and to compare these levels with the toxic level. The home health care nurse was instructed to report any bleeding, wet dressings, uncontrollable pain, or neurologic changes.

Beginning postoperative day 2, the catheter was left in place if 3 or more boluses were used. If fewer than 3 boluses were used since the previous day, then oral analgesic was also given prescriptions for oral oxycodone hydrochloride or hydrocodone bitartrate for breakthrough pain. The home health care nurse educated the patient as to the use of the orbital catheter and PCA pump. Our study included daily visits by the nurse to check the functioning of the pump and to gauge the patient's pain.

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Surgery involving orbital implants for evisceration, enucleation, or secondary implantations can be associated with severe pain in the first few postoperative days. In our experience, pain is most severe and frequent in patients undergoing secondary implantations. Most orbital surgery is performed under general anesthesia and supplemented with a retrobulbar injection of 2% lidocaine hydrochloride (Xylocaine), 0.5% bupivacaine hydrochloride (with epinephrine, 1:100 000), and hyaluronidase (Wydase). The retrobulbar block augments hemostasis through the vasoconstrictive effect of epinephrine, and the lidocaine decreases the likelihood of cardiac arrhythmias associated with optic nerve and extraocular muscle manipulation.1,2 Immediate postoperative pain relief is achieved through the single injection of local (regional) anesthetics, such as lidocaine, or the longer-lasting bupivacaine at the conclusion of surgery.

Local anesthetics reversibly interrupt neuronal impulses by interfering with the sodium channels in the nerve’s cell membranes, thus dampening the sensation of pain in a given area of the body.3 The effects of these injections are transient, however, and the patient is left with pain as the block wears off. The anesthetic effect of bupivacaine if given with epinephrine only lasts from 180 to 240 minutes.4 Narcotics taken intravenously, intramuscularly, or, more commonly, orally can produce sedation, a confused mental state, nausea, or respiratory depression without addressing the issue of relieving the pain.3 Ideally, postsurgical analgesia should provide total pain relief without adverse effects.

Epidural pain catheters have been used in other areas of the body to relieve postsurgical pain. An analgesic can be continuously infused into the catheter, which is positioned in the epidural space around nerves that innervate the affected area. Probably the most familiar use of the epidural catheters is for women in labor, who receive epidural blocks into the epidural space at the lumbar level with bupivacaine to numb the perineal area.5-8 Extradural catheters infused with bupivacaine or opioids have also been used in abdominal and thoracic surgery with successful relief from pain.9-15

The first reported use of a retrobulbar catheter for the continuous infusion of local anesthesia was by Scheie16 in 1956. He described a technique for intraocular surgery and enucleations that involved the placement of a fine polyethylene tube into the intraconal space. Although he did not use true continuous anesthesia, the tubing could be accessed for repeated postoperative injections of local anesthesia. He performed this procedure on 125 patients and found it provided excellent postoperative pain relief. Most important, there were no complications, including no cases of apnea or catheter infection. In 1983 Tamai17 and Schepens18 independently described the use of retrobulbar catheters during and immediately after vitreoretinal surgery. Both authors found the method to be safe and effective. More recently, James S. Linder, MD, and Murray D. Christianson, MD, placed orbital catheters in 8 patients following anophthalmic socket surgery and connected the catheters to a continuous infusion of bupivacaine hydrochloride for 24 hours after surgery (unpublished data, presented at the American Society of Ophthalmic Plastic and Reconstructive Surgery Annual Meeting, San Francisco, Calif, October 25, 1997). This method provided

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<th>Patient No.</th>
<th>Level by Postoperative Day, µg/mL</th>
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*Ellipses indicate not applicable.
prompt and effective pain relief without any complications due to toxic effects of bupivacaine. Our experience with orbital catheters in more than 120 patients is similar to those of other reports of providing safe and thorough pain relief.

Another advance in anesthesia has been the use of PCA, which provides a continuous infusion of anesthesia and boluses on demand. A patient can administer medication by pressing a button on an intravenous pump that delivers preset amounts of anesthetics or narcotics.6,19,20 The physician calibrates the PCA machine to deliver a controlled dosage when the button is pressed, and a lockout interval limits the maximum dose a patient can receive.21,22 We developed a new method for the control of postoperative pain for surgery involving orbital implants that uses the concepts of epidural pain catheters and PCA pumps. The orbital epidural catheter and computerized ambulatory drug delivery PCA pump incorporate features of continuous analgesic infusion and PCA.23 An epidural catheter is inserted into the lateral canthal area at the conclusion of orbital surgery and advanced posterior to the implant toward the apex of the orbit. The lateral canthal region was chosen for the catheter placement, because the insertion of the catheter would be less likely to damage orbital structures than through other approaches. This method ensures bupivacaine delivery to the orbital apex and the ability to bathe the retrobulbar pain and sensory ciliary nerve fibers with anesthesia.

Approximately 35 mm of catheter length is inserted through the skin and orbicularis muscle and then along the bony lateral orbital wall, which is approximately 40 mm.24,25 This places the catheter and infusion of local anesthetic around the nerves in the posterior orbit with good clearance of the superior orbital fissure. A syringe is used to draw back on the tubing to ensure there is no return of blood. Once it is determined the catheter is not in the intravascular space, bupivacaine is flushed into the catheter to ensure easy passage of fluid and to confirm the tubing is not blocked or kinked. A bolus of bupivacaine given at the conclusion of surgery bathes the retrobulbar space in anesthesia, providing immediate postoperative relief of pain. This is analogous to placing an epidural catheter in the lumbar region around the exiting spinal nerves for pain control. The catheter is secured to the skin with a suture, and a pressure patch is placed over the eye. The end of the catheter is capped with an intermittent injection cap for future use.

A dosing regimen of continuous bupivacaine infusion coupled with intermittent boluses of bupivacaine hydrochloride every 3 hours provides constant pain relief for the patient that cannot be achieved with the traditional single retrobulbar block. The bolusing regimen is controlled by the patient by encouraging the patient to press a button on the PCA device to deliver a predetermined amount of bupivacaine hydrochloride every 3 hours. Patient-controlled analgesia provides a more precise and optimal delivery system for pain relief. The orbital pain catheter incorporates the concepts of epidural pain relief and PCA. The PCA device also allowed us to stop the continuous infusion and place the pump on demand mode on postoperative day 2. If the patient continued to self-administer medication with bupivacaine bo-

luses because of persistent pain, the continuous infusion was restarted until the patient’s pain was more adequately controlled.

Bupivacaine provides a numbing effect directly to the sensory nerves at the operative site in the orbit, and patients are able to maintain a clear sensorium without the unwanted adverse sedating effects of narcotics. Although lidocaine has fewer toxic effects to the cardiovascular or central nervous system than other amide local anesthetics, bupivacaine is more potent and has a longer duration of action than lidocaine. Bupivacaine is the most commonly used long-acting local anesthetic for epidural anesthesia.26 Doses of bupivacaine that can be delivered safely to the patient are carefully calculated based on average body weight, infusion rates, and bolus doses for 0.5% bupivacaine solution. In this manner, toxic effects of bupivacaine can be avoided. Since the inception of the bupivacaine orbital pain pump in 1991, we assumed that the systemic bupivacaine penetration was negligible. Toxic reactions to bupivacaine usually only occur at total plasma concentrations greater than 4.0 µg/mL.27-29

A single case report from 1984 details the unusual history of one patient who had bupivacaine-induced convulsions at a plasma level of 1.1 µg/mL.30 Wittppen et al31 reported a series in which 9 patients experienced respiratory arrest following retrobulbar anesthesia. The mean plasma bupivacaine level in all patients was 0.55 µg/mL, with a range of 0.2 to 1.1 µg/mL. It was concluded that because all the bupivacaine levels were well below the levels required for central nervous system toxic effects, systemic bupivacaine was not the etiologic factor responsible for the respiratory arrest. The patients in our study had an average bupivacaine plasma level of 0.38 µg/mL, which is well below the toxic range. We could not conclude that this low bupivacaine plasma level ensures safety, but it does demonstrate that the 4 patients in whom we measured plasma levels had minimal systemic bupivacaine penetration.

The toxic effects of bupivacaine include seizures, respiratory depression, arrhythmias, and cardiovascular collapse.27-32-34 There have been numerous articles in the ophthalmic literature to substantiate the serious adverse effects of retrobulbar injection of bupivacaine, including retinal artery or vein obstruction, retrobulbar hemorrhage, brainstem anesthesia, and apnea.35-38 The proposed mechanism of apnea is not completely elucidated, but it is believed that bupivacaine gains access to the respiratory nucleus in the midbrain and blocks the respiratory drive. Several theories have been postulated as to how bupivacaine might enter the area of the brainstem after a retrobulbar injection. These include direct intra-arterial and intravenous injection, but the most likely pathogenesis is by direct injection into the optic nerve sheath.39,40 By injecting the optic nerve sheath, bupivacaine can gain access to the subarachnoid space, travel through the optic canal, and pass down the clivus to the brainstem. Similarly, the placement of orbital catheters after enucleations may allow a greater chance for central nervous system penetration due to the exposed optic nerve sheath.

To avoid disastrous complications with retrobulbar anesthesia and orbital catheters, aspirating the syringe for return of blood is recommended before injection. Pa-
patients receiving retrobulbar injections should also be monitored closely, and equipment for ventilatory support and cardiopulmonary resuscitation with trained personnel should be readily available. In all our patients receiving orbital catheters, aspiration followed by slow injection of bupivacaine was performed under constant monitoring of vital signs. Patients were connected to the PCA bupivacaine pump postoperatively and monitored in the recovery room for 2 hours before discharge. We did not encounter any serious complications in our patients such as apnea, infections, or cardiac abnormalities.

The orbital pain catheter provides an effective way to lessen or abolish postoperative socket pain. Most of the patients in this study (88.2%) seemed to have total or moderate postoperative pain relief. An average postoperative pain score of 2.8 demonstrates the effectiveness of the bupivacaine catheter. The patients who underwent secondary orbital implantations experienced the most severe pain, probably because more extensive socket dissection and extracocular muscle manipulation is required than in eviscerations or enucleations. For this reason, perhaps, those patients undergoing secondary orbital implant surgery are the best candidates for an orbital pain catheter. The regional placement of the pain catheter into the orbit also diminishes adverse systemic effects encountered with other general forms of pain relief, as no patients complained of nausea or sedation. Our purpose was not only to describe a new method of postoperative pain relief, but also to document that it was well tolerated with minimal complications in our patient population. Of the few complications reported, there were no serious or permanent deleterious effects. The 1 retrobulbar hemorrhage created mild proptosis that resolved, but there was obviously no threat to vision as would be the main concern in a sighted eye. The 4 catheters that were not infusing or leaking and had to be repositioned or pulled did not adversely affect that outcome of the orbital surgery.

Before introduction of this method, we encountered numerous patients with severe pain after the placement of orbital implants. Many of these patients had severe discomfort despite high doses of oxycodone and even morphine sulfate (MS Contin) and fentanyl citrate patches. The implementation of an orbital catheter and the PCA bupivacaine pump has made a major clinical difference, leaving most patients essentially pain free, without the undesirable side effects of heavy doses of narcotics. We herein describe a new technique that appears to substantially decrease postoperative pain for orbital implant surgery, while having the added benefit of being safe and easy to use.

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