Optimal Pain Control in Abdominal Wall Reconstruction

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Summary: Lack of physician familiarity with alternative pain control strategies is a major reason why opioids remain the most commonly used first-line treatment for pain after surgery. This is perhaps most problematic in abdominal wall reconstruction, where opioids may delay ambulation and return of bowel function, while negatively affecting mental status. In this article, we discuss multimodal strategies for optimal pain control in abdominal wall reconstruction. These strategies are straightforward and are proven to improve pain control while minimizing opioid-associated side effects. (*Plast. Reconstr. Surg.* 142: 142S, 2018.)

The topic of optimal postoperative pain control is gaining more popularity in plastic surgery.[1,2] Adequate postoperative pain control is a major determinant of patient satisfaction.[3] In addition, the stress response associated with inadequate postsurgical pain relief is known to lead to immunosuppression,[4,5] and potentially increased rates of wound infection[6] and reoperation.[7] The increasing focus on the importance of pain control has led to the development of comprehensive enhanced recovery protocols in abdominal wall reconstruction (AWR).[8]

One of the major barriers to adequate and safe postoperative pain relief remains poor physician familiarity with the breadth of options available. The vast majority of surgeons still use opioids as first-line analgesics, rather than using them as adjuncts for breakthrough pain.[5] In its 2012 updated report, the American Society of Anesthesiologists Task Force on Acute Pain Management recommended, when appropriate, the use of preincisional epidural analgesia and the administration of 2 or more nonopioid drugs that target different receptors.[9] As a result, opioids can then be reduced to the role of adjuncts rather than first-line.

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In AWR, postsurgical pain may be significant[10] and a preemptive approach to pain control must be employed. In this article, we discuss optimal procedure-specific pain control strategies as they pertain to complex open AWR. We start by discussing patient and surgical factors that may predict higher postoperative pain after AWR. We then discuss options for pain control that are especially relevant to AWR.

PREDISPOSING FACTORS

In our previous study,[11] we found that the 3 major independent factors predisposing patients to higher narcotic requirements were preoperative chronic narcotic usage (odds ratio [OR], 3.88 for higher postoperative narcotic requirement; $P = 0.016$), administration of high doses of narcotics intraoperatively (OR, 2.83; $P = 0.043$), and the use

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of transfascial sutures for mesh fixation (OR, 4.55; $P = 0.014$). Of note, in that study, we defined high postoperative narcotic requirement as 100 mg of daily oral morphine equivalent or greater and high doses of intraoperative narcotics as 75 mg of oral morphine equivalent during the procedure or greater.

The predisposition of patients on chronic narcotics to requiring higher doses of narcotics postoperatively is well known and is a consequence of opioid tolerance.[12] It is a common misconception that tolerance to opioids is a slow process. In fact, it has been shown that opioid tolerance starts to develop within a matter of minutes.[13] It is not surprising, therefore, that patients who received higher doses of narcotics intraoperatively in our study required more narcotics postoperatively. When caring for patients undergoing AWR, anesthesiologists should be attuned to the negative effects of high intraoperative opioid doses and should employ alternative medications when possible.

PAIN CONTROL STRATEGIES

Narcotics

Often used as first-line treatment for postsurgical pain, opioid pain medications suffer from many unwanted side effects, including respiratory depression, nausea, and the rapid development of tolerance.[5,11,14] Opioids rapidly lose their potency as tolerance develops.[10,13] Even the short-term use of opioids can lead to hyperalgesia.[15] Perhaps, the most frustrating property of opioids is that oversedation and respiratory depression may occur at lower doses than necessary to achieve an analgesic effect.[16] These significant disadvantages have spurred calls for a shift away from opioids as first-line pain treatment by the Joint Commission on Accreditation of Healthcare Organizations, American Society of Anesthesiologists, the Surgeon General, and the Centers for Disease Control.[7,17–19] Not only is it important to minimize postoperative narcotics, but, as noted above, even intraoperative narcotics can have a deleterious effect on postoperative pain.

When prescribing opioids, special attention must be paid to patients with obstructive sleep apnea, in whom opioids decrease genioglossus tone, leading to airway obstruction.[20,21] Another high-risk population includes elderly patients, in whom opioids greatly increase the risk of falls,[22] prolonged delirium,[23] and death.[24]

Nonnarcotic Medications

Known as multimodal analgesia, the administration of 2 or more nonnarcotic medications that act on different receptors has been shown to decrease opioid requirements, and postoperative nausea and vomiting.[25] The use of multimodal analgesia is limited, however, by physician unfamiliarity and lack of comfort. Options for multimodal analgesics include acetaminophen, nonsteroidal antiinflammatory drugs (NSAIDs) [including nonspecific NSAIDs and selective cyclooxygenase (COX)-2 inhibitors], gabapentinoids, and several others.[26]

Acetaminophen is a well-known analgesic that is available in oral and parenteral forms. Intravenous acetaminophen is especially valuable in patients undergoing abdominal surgery, in whom it has been shown to decrease opioid requirements, nausea, vomiting, and the time required for return of bowel function.[27] Although acetaminophen has moderate efficacy when used alone, it appears to have a synergistic effect when combined with NSAIDs.[28]

Gabapentin and pregabalin are effective at preventing central sensitization. They also have a synergistic effect with NSAIDs.[29] Even a single preoperative dose of gabapentin has been shown to significantly decrease postoperative opioid requirements.[30,31] Similar results have been obtained with preoperative and postoperative pregabalin.[32]

NSAIDs can play a very powerful role in the armamentarium of the surgeon because they are capable of minimizing peripheral sensitization.[33] Nonselective NSAIDs, such as ibuprofen, have been shown to strongly decrease the need for postoperative narcotics across a broad range of surgical procedures.[34–36] However, because these nonselective NSAIDs inhibit both COX-1 and COX-2, they can have the unwanted side effects of damaging gastric and intestinal lining and inhibiting platelet aggregation.[37] This has led to the emergence of selective COX-2 inhibitors as a powerful opioid-sparing treatment for pain. There is no known link between the postoperative use of selective COX-2 inhibitors and increased bleeding risk.[5,38–40] Celecoxib, a commonly used COX-2 inhibitor, has been found to reduce opioid requirements and to accelerate return to normal function in patients undergoing abdominoplasty.[41]

Various postoperative protocols for the use of multimodal analgesia exist. Warren et al[42] analyzed their protocol for enhanced recovery after surgery, which included postoperative ketamine,

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ketorolac, and acetaminophen, with or without epidural analgesia. The protocol was found to significantly decrease the requirements for patient-controlled narcotic analgesia even when no epidural was used.

Our postoperative oral multimodal analgesia regimen is started as soon as patients are able to tolerate a clear liquid diet. Due to purchasing limitations, our hospital does not allow the use of intravenous acetaminophen. Our regimen consists of scheduled oral acetaminophen 1,000 mg every 6 hours, celecoxib 200 mg every 8 hours, and gabapentin 300 mg every 8 hours. We avoid the use of any other acetaminophen-containing drugs as this regimen reaches the maximum allowable daily dosage of 4 g/d. Contraindications to the use of celecoxib are known or suspected cardiac or renal disease. We adjust the dose of gabapentin in patients with renal impairment based on glomerular filtration rate and do not use it in patients with obstructive sleep apnea on a continuous positive airway pressure device, as it can exacerbate obstructive sleep apnea (Fig. 1).

Epidural Analgesia

The placement of an epidural catheter outside the subarachnoid space allows the continuous delivery of analgesics and anesthetics, providing

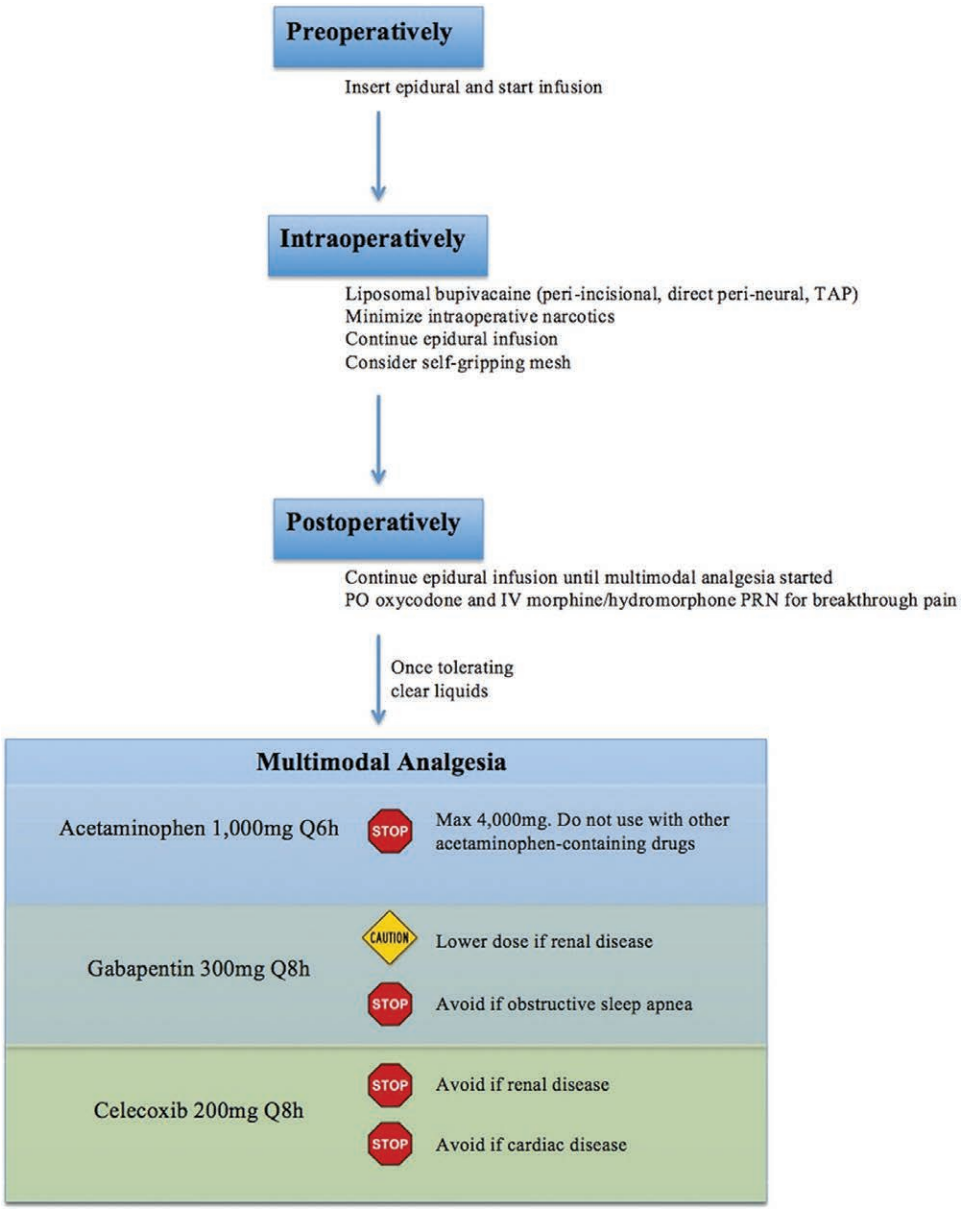

Fig. 1. Overview of our evidence-based pain control strategy.

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potentially full pain blockade below the level of insertion.[1] When placed at the T7 to T9 level, as in AWR cases, epidural analgesia usually does not affect ambulation or bladder function.[1] Epidural analgesia provides superior pain control when compared with intravenous narcotics over a wide range of surgical procedures,[43] and this applies to plastic surgical procedures on the abdominal wall.[44,45] When compared with systemic opioids, epidural analgesia demonstrates decreased postoperative nausea and vomiting,[46] accelerated return of bowel function,[47] improved pulmonary function,[48] and shorter postoperative length of stay.[49] The preoperative placement of an epidural catheter has even been found to significantly decrease costs associated with AWR.[50,51]

One of the goals of adequate pain control in AWR is early ambulation. By controlling pain without oversedation, epidural analgesia likely encourages earlier ambulation, as demonstrated in a study on patients undergoing total joint arthroplasty, in whom epidural analgesia was even found to decrease the incidence of venous thromboembolism.[52]

In our previous study, we found that the use of epidural analgesia was the single most effective strategy to reduce postoperative narcotic requirements (OR 0.28 for higher postoperative narcotic requirement; $P = 0.018$). We usually use a mixture of bupivacaine and fentanyl at a continuous infusion with additional patient-controlled doses. By combining a local anesthetic and an opioid, we are able to achieve a synergistic effect at the spinal level.[53,54] We also start the epidural infusion before the surgical incision is made, to achieve preemptive analgesia.[55]

Local Anesthetics

Local anesthetic injection during AWR can take several forms: injection of the subdermal plane around the incision provides local periincisional analgesia in the form of a field block.[56] In contrast, injection around the individual intercostal nerves as they pierce the posterior rectus sheath provides a broader dermatomal coverage. Even broader is injection into the transversus abdominis plane (TAP). Regional TAP blocks target the intercostal nerves as they travel to the abdominal wall in the layer between the internal oblique and the transversus abdominis muscles. TAP blocks have been shown to decrease pain, shorten length of stay, and decrease narcotic requirements in patients undergoing abdominal plastic surgical procedures, namely abdominal-based free-flap breast reconstruction.[57–59] TAP blocks have also been found to lead to lower parenteral narcotic requirements, and fewer episodes of hypotension, compared with epidural analgesia.[60]

The longest duration of action of free local anesthetics is on the order of 8–12 hours. In contrast, the liposomal formulation of bupivacaine allows slow release of local anesthetic for up to 96 hours.[61,62] Liposomal bupivacaine has been found to decrease pain over several days in abdominoplasty,[63] and several other procedures.[64]

As a follow-up to our previously published study, we analyzed the efficacy of liposomal bupivacaine in AWR. We injected liposomal bupivacaine in 3 different planes: directly around the intercostal nerves after performing retrorectus dissection (**see Video, Supplemental Digital Content 1**, which shows direct infiltration of liposomal bupivacaine around the intercostal nerves as they pierces the posterior rectus sheath, ***http://links.lww.com/PRS/C953***), in the subdermal plane around the incision (**see Video, Supplemental Digital Content 2**, which shows injection of liposomal bupivacaine in the subdermal plane just before skin closure, ***http://links.lww.com/PRS/C954***), and in the TAP. The TAP blocks were performed intraoperatively using surgical landmarks and no ultrasonic imaging. In particular, posterior components separation afforded an opportunity for TAP blocks under direct visualization, as shown in **Video, Supplemental Digital Content 3**, ***http://links.lww.com/PRS/C955***: once the transversus abdominis muscle has been elevated off the transversalis fascia, the plane just superficial to the transversus abdominis muscle can be accessed safely without the risk of injuring the viscera. In our updated case series, 78 patients received liposomal bupivacaine and 94 patients received bupivacaine with epinephrine.

Video 1. Supplemental Digital Content 1 shows the direct infiltration of liposomal bupivacaine around the intercostal nerves as they pierce the posterior rectus sheath, ***http://links.lww.com/PRS/C953***.

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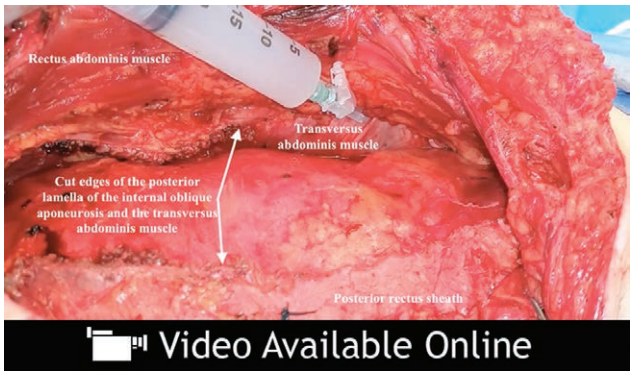
Video 2. Supplemental Digital Content 2 shows the injection of liposomal bupivacaine in the subdermal plane just before skin closure, ***http://links.lww.com/PRS/C954***.



Video 3. Supplemental Digital Content 3 shows transversus abdominis plane (TAP) block using liposomal bupivacaine after posterior components separation, ***http://links.lww.com/PRS/C955***.

With liposomal bupivacaine, the mean daily dose of oral morphine equivalents was 75.2 mg, compared with 134.8 mg with free bupivacaine with epinephrine (P = 0.009) (Ohio State University Institutional Review Board study #2015H0105, unpublished data from ongoing study).

Use of Sutureless Mesh

As demonstrated in our previous study, the use of transfascial suture mesh fixation resulted in increased odds of requiring higher doses of narcotics postoperatively by a factor of 4.55.[9] A novel alternative to transfascial sutures is the use of self-gripping mesh in the retrorectus plane.[65] Using absorbable polylactic acid microgrips, the mesh is able to adhere to the posterior rectus sheath with a force that exceeds that of laparoscopic staples.[66] We have previously shown that the use of this sutureless self-gripping mesh results in lower postoperative pain and narcotic requirement than the use of transfascially sutured mesh.[58]

The use of self-gripping mesh has 2 major requirements: the patient must be a good candidate for the use of permanent synthetic mesh and the posterior rectus sheath must be reapproximated. In patients who underwent AWR with self-gripping mesh, we achieved excellent reconstructive outcomes at a mean follow-up of 612 days, with a 0% rate of hernia recurrence, and an 8.3% rate of surgical-site recurrences, all of which consisted of minor cellulitis resolving with antibiotics.

CONCLUSIONS

Risk factors for greater opioid requirements after AWR include chronic narcotic usage, high intraoperative narcotic usage, and the use of transfascial sutures for mesh fixation. Surgeons performing AWR can improve pain control and decrease opioid-associated side effects in their patients by employing multimodal nonnarcotic analgesics, considering epidural analgesia, using local anesthetics intraoperatively (especially liposomal bupivacaine), and considering self-gripping mesh, when appropriate.

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