POSTOPERATIVE PAIN MANAGEMENT

David J. Caldarella, DPM

Faith Scholnick, DO

Effective pain control is essential for optimal care of the surgical patient. Despite advances in the understanding of the pathophysiology of pain, pharmacology of analgesics, and the development of newer techniques for pain management, many patients unnecessarily suffer from pain following surgery.

Aspects of pain management to be discussed include: analgesics most commonly utilized in podiatric surgery; recent advances in patient controlled anesthesia; and newer medications which are now available for administration to the surgical patient.

NARCOTICS

The word "narcotic" was derived from the Greek word for stupor, *narcos*. At one time, this term was applied to any drug that induced sleep, however, it historically refers to morphine-like analgesics. Today this term is no longer useful in a pharmacological context. Narcotic analgesics are classified as agonists, mixed agonists-antagonists, or partial agonists by their activity at opioid receptors. Five major categories of opioid receptors are known: mu (M) kappa (K) sigma (Σ) delta (Δ) and epsilon (E) . The currently available narcotic analgesics can be defined by their activity at three specific receptor sites: mu, kappa and sigma.

The mu receptors mediate morphine-like supra-spinal analgesia, euphoria, miosis, and respiratory depression. The kappa receptors mediate pentazocine-like spinal analgesia, sedation miosis, and respiratory depression. The sigma receptors, which are probably not true opiate receptors, propagate neuro-behavioral effects such as dysphoria, psychomimetic effects (i.e., hallucination), and respiratory and vasomotor stimulation.

Morphine-like narcotic agonists act at the mu and kappa receptors, and possibly at the delta receptor as well. Narcotic agonists include naturally occurring opium alkaloids (morphine and codeine), semisynthetic analogs (hydromorphone, oxymorphone and oxycodone), and synthetic compounds (meperidine, levorphanol and methadone).

Mixed agonist-antagonist drugs (nalbuphine and pentazocine) have agonist activity at some receptors and antagonist activity at others. Also included in this group are the partial agonists (butorphanol and buprenorphine).

Opioid antagonists, such as naloxone hydrochloride (Narcan), act at the mu receptor to inhibit pharmacological activity of the agonist, and may precipitate withdrawal in dependent patients. Agents in this class prevent or reverse the effects of the opioids, including respiratory depression, sedation, hypotension, as well as pain relief.

Narcotic analgesics as a group possess a variety of secondary pharmacological effects on many organ systems, including:

CNS: Euphoria, drowsiness, apathy, mental confusion. Nausea and vomiting are caused by direct stimulation of the emetic chemoreceptors located in the medulla.

Respiratory: Due to reduced sensitivity of the respiratory center to carbon dioxide, depressant effects first diminish tidal volume, then respiratory rate.

Cardiovascular: Peripheral vasodilation, reduced peripheral resistance, and inhibition of baroreceptors. Orthostatic hypotension and fainting may occur.

Gastrointestinal: Inhibition of peristalsis, which may induce constipation and spasm of the Sphincter of Oddi.

Genito-urinary: Urinary retention may occur with increased bladder sphincter tone.

Narcotic analgesics may be delivered by various means to the surgical patient. In general, intravenous (IV) administration is the most reliable and rapid route. Intramuscular (IM) or subcutaneous (SQ) use may delay absorption and peak effect, especially with impaired tissue perfusion. The oral (PO) route of administration is the most variable in terms of pharmacokinetics, however this is the route preferred by most patients. Many agents undergo a significant first pass effect, and all are metabolized by the liver and excreted primarily in the urine.

NARCOTIC AGONIST ANALGESICS

Morphine Sulfate

Morphine sulfate is the principal opium alkaloid, and is indicated for relief of moderate to severe acute and chronic pain. It is also indicated preoperatively to sedate and allay apprehension, facilitate induction of anesthesia, and reduce anesthetic dosage. Morphine sulfate is not as potent orally as parenterally, due to the effects of first pass metabolism. Oral administration is 1/3 to 1/6 as effective as an equal dosage given parenterally. Recommended dosages are as follows:

Oral: 10 - 30 mg every 4 hours. Controlled release tablets are available, and dosed 30 mg every 8 - 12 hours. The tablets should not be chewed or crushed.

S.Q./IM: 10 mg (4 - 15 mg) / 70 kg adult every 4 hours.

Hydromorphone HCL (Dilaudid)

Hydromorphone is a morphine derivative with eight times the potency of morphine, however it has a shorter duration of action. In general, this agent is more potent than Demerol and is often substituted for other less effective narcotic agents. Administration and dosage is as follows:

Oral: 2 - 4 mg every 4 to 6 hours.

S.Q./IM: 1 to 2 mg every 4 to 6 hours as needed. For severe pain, administer 3 to 4 mg every 4 to 6 hours as needed. Dilaudid may be given by slow IV injection over 2-5 minutes.

Meperidine HCL (Demerol)

Meperidine HCL is a narcotic analgesic with multiple actions which are qualitatively similar to those of morphine. It possesses approximately 1/10 the potency of morphine. Demerol may produce less intense smooth muscle spasm, less constipation, and less depression of the cough reflex than equianalgesic doses of morphine. While SC administration is suitable for occasional use, IM administration is preferred for repeated doses. Demerol is less effective when given orally. The recommended dosing is as follows:

Oral: 50 - 200 mg every 3 - 4 hours.

S.Q./IM: 50 - 150 mg every 3 - 4 hours.

Meperidine, when used to support anesthesia and provide sedation in the reduction of dislocations and fractures, or for the debridement of painful wounds, should be administered by slow IV injection, in doses diluted to 10 mg/ml. Individual titration is recommended, and supportive measures should be readily available.

Codeine

Codeine is a narcotic analgesic and anti-tussive that pharmacologically resembles morphine, but has a milder action. It is widely used as an antitussive due to the low incidence of adverse reactions at the usual dose. It is primarily indicated for the relief of mild to moderate pain, as outlined below:

Adults: 15 - 60 mg every 4 to 6 hours, PO SC, IM or IV. Dosing is recommended to not exceed 120 mg in 24 hours.

Propoxyphene (Darvon)

Darvon is a centrally acting narcotic analgesic which is structurally related to methadone. It is 1/2 to 2/3 as potent as codeine, and is no more and possibly less effective than 30 to 60 mg of codeine or 600 mg of aspirin. It is indicated for the relief of mild to moderate pain, however significant risks have been demonstrated with the concurrent use of this drug and alcohol. Overdosage, alone or in combination with alcohol, has lead to many deaths. The recommended oral dosing is as follows: 65 mg every 4 hours as needed, not to exceed 390 mg per day.

Propoxyphene Napsylate (Darvocet N)

Darvocet N is Darvon in combination with an additional 350 mg of acetaminophen. The usual dose is 100 mg every 4 hours as needed, not to exceed 600 mg per day.

OPIOID AGONIST ANTAGONIST ANALGESICS

Narcotic agonist-antagonist analgesics compete with other substances at the mu receptor. These receptors mediate morphine-like supraspinal analgesia, euphoria, and respiratory and physical depression. Two types of narcotic agonist-antagonists are: (1) Drugs which are antagonists at the mu receptor, and agonists at the other receptors (pentazocine) and (2) Partial agonists (buprenorphine) which have limited agonist activity at the mu receptor. The narcotic agonist-antagonist analgesics are potent agents with a lower abuse potential than pure narcotic agonists.

Pentazocine (Talwin)

Talwin has been shown to produce many side effects, specifically hallucination, as well as other untoward occurrences. It also maintains a high abuse potential and is highly desired as a street drug. This agent is no longer a viable analgesic for pain management.

Butorphanol (Stadol)

This agent is a potent analgesic with both narcotic agonist and antagonist activity. The analgesic potency of butorphanol appears to be 5 times that of morphine. The antagonist activity is 1/40 that of naloxone. The pharmacokinetics of Stadol include a very rapid onset of approximately 10 minutes following IM administration, with peak action at 30 - 40 minutes. It has a half-life of 2.5 hours. Dosing is as follows:

IM: 2 mg every 3 to 4 hours as needed. Dosage range is 1 to 4 mg every 3 to 4 hours. It is recommended to not exceed single doses of greater than 4 mg.

Nalbuphine (Nubain)

This agonist-antagonist medication has actions similar to the phenanthrene derivatives, oxymorphone and naloxone. Nubain's analgesic potency is essentially equivalent to that of morphine. Nubain does not significantly increase pulmonary artery pressure, systemic vascular resistance, or cardiac work, as do most other agonist-antagonists. Administration dosing is as follows:

Adults: The usual dose is 10 mg/70kg adult given SC, IM or IV every 3 to 6 hours.

NSAIDS

While a discussion of non-steroidal anti-inflammatory medications (NSAIDs) is beyond the scope of this text, much success in the management of postoperative pain is enhanced by the selective use of a NSAID preparation in conjunction with narcotic analgesics.

One particular NSAID, Ketorolac Tromethamine (Toradol), has been utilized with great success at the author's institution. It was the first parenteral NSAID to become available in the United States. Other parenteral NSAIDs are available in other countries, but low potency, poor aqueous solubility, and substantial tissue irritation, have limited their usefulness. Like other NSAIDs, Toradol possesses anti-inflammatory, antipyretic, and analgesic activity, and is relatively more effective as an analgesic than as an anti-inflammatory agent. In standard tests in mice, where the relative potency of aspirin was assigned a value 1, the relative potency of ketorolac was 350. Relative values for other NSAIDs include for phenylbutazone (0.8), naproxen (7.0), and indomethacin (60.0). Two single dose, double blind, six hour trials in patients with moderate to severe postoperative pain found 30 mg of IM ketorolac superior to 6 mg of morphine, and at least comparable to 12 mg of morphine. The onset of analgesia with ketorolac was comparable to that of morphine, but the peak effect occurred later (about two hours after injection), and the duration of action was longer, (five to six hours).

The recommended initial dosage of ketorolac for the short term management of pain is a 30 or 60 mg intramuscular loading dose, followed every six hours with 15 or 30 mg as needed to control pain. The maximum recommended total daily dosage is 150 mg in the first 24 hours following surgery, and 120 mg/day in divided doses thereafter. Toradol, used in conjunction with narcotic analgesics (Demerol I.M.), provides excellent management of postoperative pain in the initial 72 hours following surgery. In many instances, the patient's need for the narcotic analgesics is markedly reduced, as Toradol alone has often

times been the sole "pain medication" administered in the hospital following surgery.

The adverse effects of Toradol (I.M.) have been similar to those reported with the short term use of oral NSAIDs. In comparative trials, Toradol caused fewer adverse effects, and was discontinued less often, than either morphine or meperidine. The most common adverse effects of ketorolac, although rare, are drowsiness, dyspepsia, and nausea.

Toradol appears to be as effective as morphine or meperidine for short term relief of moderate to severe postoperative pain, without the potential disadvantages of the opioid analgesics. Since this drug is relatively new, updated information should be reviewed.

An oral form of Toradol has also been introduced. The recommended dosage is 10 mg every 4 - 6 hours as needed for pain. The author's experience with Toradol in the hospital setting has been primarily as an IM injection.

PATIENT CONTROLLED ANALGESIA (PCA)

A major addition to the arena of postoperative pain management has been the introduction of infusion pumps, or "PCA" devices. This modality was designed to safely and effectively deliver analgesics through an intravenous route. Patient controlled analgesia entails the self administration of small doses of narcotics by the patient when experiencing pain. This approach is based on the premise that a negative feedback mechanism for pain exists. When pain is reduced, there will be no further demand of analgesics until the pain returns. PCA devices permit the patient to titrate narcotic analgesics for the maintenance of analgesia, regardless of changes in pharmacodynamics, or varying degrees of postoperative pain.

The mechanics of the PCA system are simple and consist of a microprocessor-controlled infusion pump, which is triggered by the patient pressing a button. When requested, a preset amount of medication is delivered into the patient's intravenous line. The pump prevents administration of the next bolus of medication until a specific period of time (lock-out interval) has elapsed. Hence, patients titrate the narcotic to their own needs within an established and safe guideline. A variety of dosage schedules and devices are available for this purpose in most hospital settings.

An understanding of PCA technology and utilization requires a knowledge of certain "jargon" specific to this device. The following terms are commonly used when referring to PCA devices:

Dose (Increment) - The amount of medication, expressed in milligrams, micrograms, or milliliters, infused into the intravenous line when the patient activates the control button.

Bolus (Loading Dose) - The amount of medication administered as either a loading dose or as an additional dose to supplement PCA therapy.

Basal Rate (Continuous Infusion) - The amount of medication per hour infused continuously by the PCA unit.

Limit (1 hr/4 hr) - The maximum amount of medication that the patient can receive during a 1 hr/4 hr period. This includes the total amount of medication infused- PCA dose and basal dose combined.

Delay Time (Lockout) - The time interval during which the patient cannot initiate another dose.

Many narcotic analgesics have been successfully utilized with the PCA delivery system. The "ideal" narcotic for use in a PCA unit would be highly efficacious, possess a rapid onset of action, have intermediate duration, and no adverse reactions or associated potential for abuse. While no single drug is established to date as ideal, morphine and meperidine are the most commonly utilized. In the majority of hospital settings in this country, PCA prescriptions are ordered through the Anesthesia or Pain Service.

PCA Morphine

The guidelines for the safe and effective use of morphine and meperidine for PCA pain management are listed in Table 1.

Table 1

PCA MORPHINE RECOMMENDATIONS

Morphine, 1 mg/ml or 5 mg/ml

	Adult	Child
PCA Dose	0.5 - 2.5 mg	0.5 - 2.0 mg
Delay	6 - 12 minutes	8 - 15 minutes
Basal	0 - 2 mg/hr	0 - 1 mg/hr
4 hr limit	Up to 35 mg	10 - 30 mg
Bolus	1 - 4 mg	0.5 - 3 mg

For healthy adults (50 - 70 kg) 1.0 - 1.5 mg can be given every 6 minutes; or up to 2.0 mg every 10-12 minutes. With larger doses, an increase of side effects occur, primarily nausea and vomiting.

For elderly patients, 0.1 mg/kg/hr divided equally every 6 minutes, is usually adequate. Opioid clearance is reduced with advancing age, and an increase in the clinical effect is seen.

For children, morphine is the drug of choice with this modality. The recommended dose is 0.05 - 0.1 mg/kg/hr. The total dose is usually 0.1 - 0.2 mg/kg/hr. This is then divided into thirds, with two-thirds as a continuous infusion, and the remaining one-third divided into equal doses.

PCA Meperidine (Demerol)

In a healthy adult, 10 - 15 mg is administered every 6 minutes, or 20 mg every 10 - 12 minutes may be utilized. (Table 2) Meperidine has a lower incidence of nausea and vomiting, pruritis, and sedation, than morphine. This agent is less effective than morphine for periosteal pain, and is often successfully combined with Toradol for potentiation of the narcotic analgesic.

Table 2

PCA MEPERIDINE (Demerol) RECOMMENDATIONS

Meperidine, 10 mg/ml (1/10 as potent as morphine)

	Adult	Child
PCA dose	5 - 20 mg	5 - 20 mg
Delay	6 - 12 minutes	8 - 15 minutes
Basal	5 - 20 mg/hr	0 - 10 mg/hr
4 hr limit	Up to 300 mg	100 - 200 mg
Bolus	10 - 25 mg	5 - 15 mg

Meperidine should be avoided in patients who have a history of seizure activity. Demerol's active metabolite, normeperidine, lowers the seizure threshold and can precipitate an episode.

Patient controlled analgesia (PCA) has been proven to provide efficient and safe postoperative pain management. This system is designed to accommodate a wide range of variables encountered when managing pain in the surgical patient. If PCA is to be utilized successfully, nurses and physicians alike must be educated to its use.

SUMMARY

Postoperative management of pain in the surgical patient is as much an art as a scientific method. Attention to the many variations in individual needs and psychological profile is extremely important and often overlooked. Postoperative pain management should begin preoperatively by conveying information to the patient and their family regarding the expected postoperative course. Local anesthesia is also extremely important in the degree of postoperative pain experienced. An efficiently delivered local nerve block will greatly reduce the amount of narcotic analgesics needed in the immediate postoperative period.

Many types of analgesics are available, in varying routes of administration, to provide relief from surgical pain. A comprehensive understanding of the medications and modalities presented will aid in providing the optimal relief of pain for the surgical patient.

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