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Pain Management in Plastic Surgery

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Abstract

Most patients who undergo cosmetic surgery do not report pain during the immediate postoperative period. However, most patients who underwent liposuction combined with or without other plastic surgical procedure suffer pain after surgery. There are three main techniques in acute pain management postoperatively which are systemic analgesia, regional analgesia, and local/topical analgesia, and these are the extent of trauma during the procedure, surgeon's skill, prior disease, location and type of incision, and psychological and cultural factors. Treatment for each type of plastic surgery and the resulting pain require techniques that can be used as single method or combined with each other to relieve postoperative pain after plastic surgery. Nausea, vomiting, constipation, somnolence, etc., are well-known adverse effects of opioids. Although these effects may seem minor, they can lead to significant complications following some type of plastic surgeries, for example, face-lift hematoma following nausea and vomiting, pulmonary complications from respiratory depression, and even thromboembolic phenomena from bed rest following prolonged opioid use. Multimodal pain management has been documented to increase patient satisfaction and reduce both opioid use and the incidence of PONV. Combination of pain management in plastic surgery included patient-controlled analgesia intravenous (PCA-IV), patient-controlled epidural analgesia (PCEA), patient-controlled regional analgesia (PCRA), field block (TAP block), continuous wound infusion system using pain pump and tumescent analgesia with local anesthetics.

Keywords: postoperative pain, IV-PCA, PCEA, PCRA, field block, TAP block, tumescent analgesia, opioids, NSAIDs

1. Introduction

Plastic surgery has become increasingly done over the last decades. The surgeon and patients become aware of the importance of postoperative pain control. This has occurred in part in an attempt to improve the patient experience and satisfaction. However, pain remains a major patient concern. Most patients who undergo cosmetic surgery do not report pain during the immediate postoperative period. However, most patients who underwent liposuction combined with or without other surgical procedure report pain after surgery. Pain is unpleasant sensory and emotional experience associated with tissue injury [2]. Postoperative pain is mainly derived from acute tissue manipulation during the surgical procedure. In fact, a recent study documented that 30–80% of patients undergoing outpatient surgery encountered moderate-to-severe postoperative pain. The characteristics of pain that should be evaluated are onset, location, irradiation, type of pain, duration, and pain-related behavioral responses [2–4].

Along with this increased awareness of the importance for pain management, a variety of newer analgesics modalities designed to reduce pain have arrived on the scene. In the era of health care reformation, it is important to consider that pain management techniques can contribute to the overall value of care that is delivered to patients.

1.1. Concept of multimodal pain management

Treatment for each type of plastic surgery and resulted pain requires a specific approach and must be individualized to the patient. There are three main techniques for acute postoperative pain management: systemic analgesia, regional analgesia, and local/topical analgesia. Systemic analgesia can be given through intravenous injection, oral or rectal route, intramuscular, and skin patch. Regional analgesia technique can be divided into neuraxial analgesia and peripheral nerve block. Currently, pain management through intravenous injection or continuous neuraxial and peripheral nerve blocks is more controllable and safer since the invention of pain pump, which commonly use the principal of patient-controlled analgesia. Opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), mild analgesics, local anesthetics, etc., are all valuable in the multimodal pain management [4–6].

Nausea, vomiting, constipation, somnolence, etc., are well-known adverse effects of opioids. Although these effects may seem minor to some, they can lead to significant complications following certain types of plastic surgery, for example, face-lift hematoma following nausea and vomiting, pulmonary complications from respiratory depression, and even thromboembolic phenomena from bed rest following prolonged opioid use. In fact, a recent study documented adverse side effects in 17% of patients due to opioids. Most importantly, multimodal pain therapy including pharmaceutical agents mentioned above, long-acting local anesthetic preparations, and pain pumps may in large part replace isolated narcotic treatment of postoperative pain. This approach has been documented to increase patient satisfaction and reduce both opioid use and the incidence of nausea and vomiting in a large variety of nonfacial esthetic procedures. Although this multimodal treatment seems to have significant benefits, postoperative dosing becomes more complex, and adverse drug interactions and drug overdose become more likely [1–10].

There are some combinations that is proven to have a good effect in multimodal analgesia, such as paracetamol and NSAIDs, paracetamol with opioids, nonselective NSAIDs or selective

cyclooxygenase (COX)-2 inhibitors with opioids, and alpha-2-delta modulators (gabapentin and pregabalin) with opioids, N-methyl-D-aspartate (NMDA) antagonists ketamine and magnesium, also alpha-2-agonists clonidine and dexmedetomidine with opioids. Combination of central neuraxial analgesia through epidural with NSAIDs proved favorable by suppressing stress response and suppressing pro-inflammatory factor [4–9].

2. Systemic analgesia

There are several systemic analgesic protocols to relieve postoperative pain in plastic surgery, but the IV administration of opioid and nonopioid analgesics is the most used. In the following paragraphs, each one of these managements is described, being possible for the combination of the different alternatives of analgesia.

2.1. Oral administration

Postoperative pain management for ambulatory patients usually is treated with NSAIDs. This type of analgesics is the most important treatment for nociceptive pain. These kind of patients may also need a short-acting opioids such as hydrocodone, oxycodone, and acetaminophen. In immediate postoperative pain management, we prefer to use short-acting opioids rather than long-acting ones. However, if the patient is already on long-acting opioid before surgery, it is more appropriate to continue the long-acting opioid with combination of short-acting opioid for postoperative pain [3–9].

2.2. Intravenous bolus injection

Intravenous (IV) injection drugs that are commonly used as postoperative pain management are opioids (morphine and oxycodone). They are given based on patient's need, usually for every 2–4 h. This condition can become a burden for both nurse and patient when the ratio between nurse and patient is low. NSAIDs also can be given intravenously for a short period, 1–2 days [5, 7, 9, 11–13].

2.3. Intravenous patient-controlled analgesia (PCA-IV)

Patient-controlled analgesia (PCA) was used since 1971. PCA is one of the pain management techniques using a programmable pump intravenous device. The machine is put at patient's bedside and connected to the IV line than contains a bag of premixed opioid solution. The patient can self-administer analgesic on demand by pressing the button connected to the PCA machine. The demand dose is already determined by the physician. The machine will lock for the amount of time before it can send another demand dose (lockout period), so it can protect the patient from overdosing. PCA device can also release the drug at a low-dose continuous infusion rate [3]. There are several advantages of PCA such as painless route to deliver opioid, give accurate analgesia, help the nursing staff in patient's pain control, and ensure the medication level compared with intermittent bolus injection or continuous IV infusion of opioid. PCA is used when the patient cannot take oral medication either in preoperative or

postoperative time or has nausea that causing the patient unable to take oral medication. PCA often use to control severe pain level such as burn injuries.

Minimal analgesia can be reached with opioid titration until minimum effective analgesia concentration (MEAC) can be reached, which becomes the border between pain and analgesia. Furthermore, the dosage for causing analgesia varied among the patients and can be concluded that variability in opioid's pharmacodynamic causes differences in the dosage. Individual MEAC can be determined by level of opioid endogen in preoperative cerebrospinal fluid. Patient with higher level of opioid endogen in cerebrospinal fluid needs lower MEAC to achieve and maintain the analgesia effect [3, 5, 7, 9, 11–15] (**Figure 1**).

In the figure above, X axis is the opioid plasma concentration and Y axis is the pain intensity from severe pain to no pain. Small circles show correlation between opioid concentration and pain intensity in an interval of increased opioid concentration. At the beginning, progressive increase of opioid concentration does not change pain intensity, but then with a little increase of opioid concentration, it can decrease pain intensity until pain is resolved. Increase of opioid concentration after this point will not give an extra effect.

2.3.1. PCA variable

PCA can be given in many methods, and the following two are the most common methods used in daily practice:

- Demand dose (the dosage has been made by the anesthetist and given by patient to him/herself in a given period of time)
- Continuous infusion/background infusion along with demand dose in accordance with patient's need.

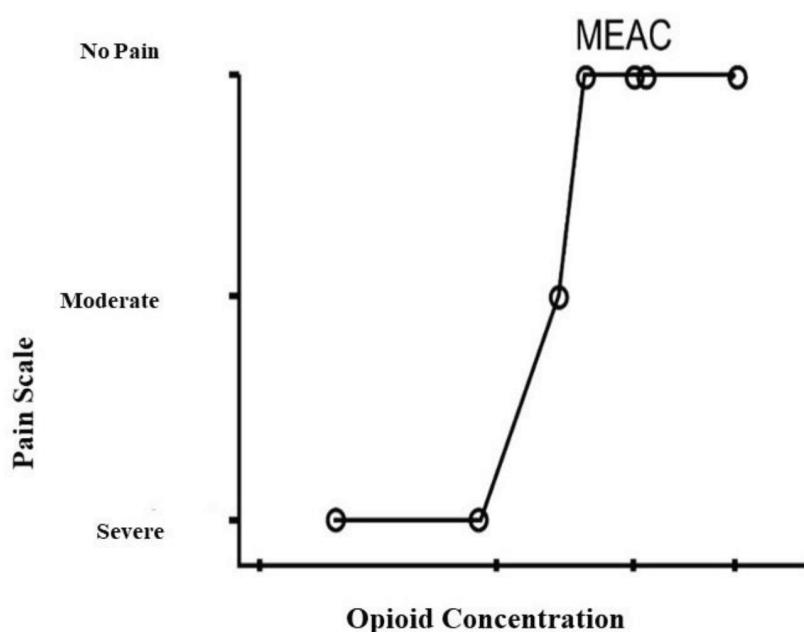


Figure 1. Response to opioid concentration and pain intensity [17].

2.3.1.1. *Programmed intermittent bolus (PIB)*

PIB is a specific dosage of drug that is programmed in PCA to give automatic bolus drug in specific intervals. PIB does not depend on demand dose or continuous infusion. PIB is usually used for epidural analgesia or peripheral nerve block analgesia. Time interval is around 15–60 min, which means every for 15–60 min. PCA machine will automatically give bolus drug in a specific dose. For all PCA method, there are basic variables, such as: (a) initial bolus dose, (b) demand dose, (c) lockout interval, (d) Background infusion, (e) Maximum dose limitation 1 and 4 h [15–19].

2.3.1.2. *Initial bolus dose*

It is possible to give drugs titration when activated by the program (not the patient). Initial bolus dose can be used by the nurse in postanesthesia care unit (PACU) to titrate opioid dose until reach MEAC or by the nurse at ward to administer the extra dose for the breakthrough pain. Initial bolus dose is the key for the success in pain management using PCA. Without it, there is a big possibility that pain may not be resolve adequately and patient can be disappointed using the PCA machine [15–19].

2.3.1.3. *Demand dose*

Demand dose is also known as incremental dose or PCA dose. It is amount of analgesia that is given to the patient when patient press the demand button. PCA dose aims to maintain opioid level in MEAC level. PCA dose is the maintenance dose [15–19].

2.3.1.4. *Lockout interval*

To prevent opioid overdose with continuous demand, all PCA machines use lockout interval. It gives time lapse after administration of demand dose, and the machine will not respond to any demand dose, even though patient press the button, until certain time. This is one of the security systems in the PCA machine [15–19].

2.3.1.5. *Background infusion*

Infusion with constant speed is given without considering the patient's demand. Background infusion is seldom used for patients with acute pain because of risk of overdose. Background infusion is usually administered to the patients who use opioid with large dose previously. Background infusion can be given by electrical PCA machine. Continuous infusion used as adjuvant in administration of bolus dose can increase analgesia effect for the patient, so they can sleep without any disturbance due to pain. Disadvantages from this system are that opioid could still be given without considering the sedation level and can increase the risk of respiratory depression. Routine use of background infusion is not recommended. Background infusion may be useful in patients who are tolerant toward opioid, patients who are common in using opioid and need higher dose, or patients who have sleep disturbance at night due to pain [15–19].

2.3.1.6. Maximum dose limitation

Some machine may have time limit 1 or 4 h. This program limits patient interval either 1 or 4 h to get total cumulative dose. Usage of the interval 1 or 4 h is controversial. Prolimitation said that the limitation could give better security, while the contra side said there is no evidence that shows this limitation could give better security. In the other hand, if patient needs demand dose or PCA dose in large amount until it reaches the limitation for 1 or 4 h, may be they really need that much dose to resolve the pain; thus, it is not necessary to reach that need. The usual maximum dose for morphine is 10 mg in 1 h or 30 mg in 4 h. Keep in mind that PCA is used as maintenance therapies and pain should be under controlled before PCA is started. Disadvantages of this system are that opioid could still be given without considering the sedation level and can increase the risk of respiratory depression [15–19] (**Figure 2**).

2.4. Opioid for IV-PCA

Knowledge about pharmacology is the basic to use PCA effectively. A physician should understand not only indication and contraindication, but also pharmacodynamic and pharmacokinetic of opioid, including absorption, distribution, biotransformation, and elimination from many types of opioid. Besides that, a doctor needs to understand specific physiologic response that can be happened when a drug binds to specific receptor inside or outside the

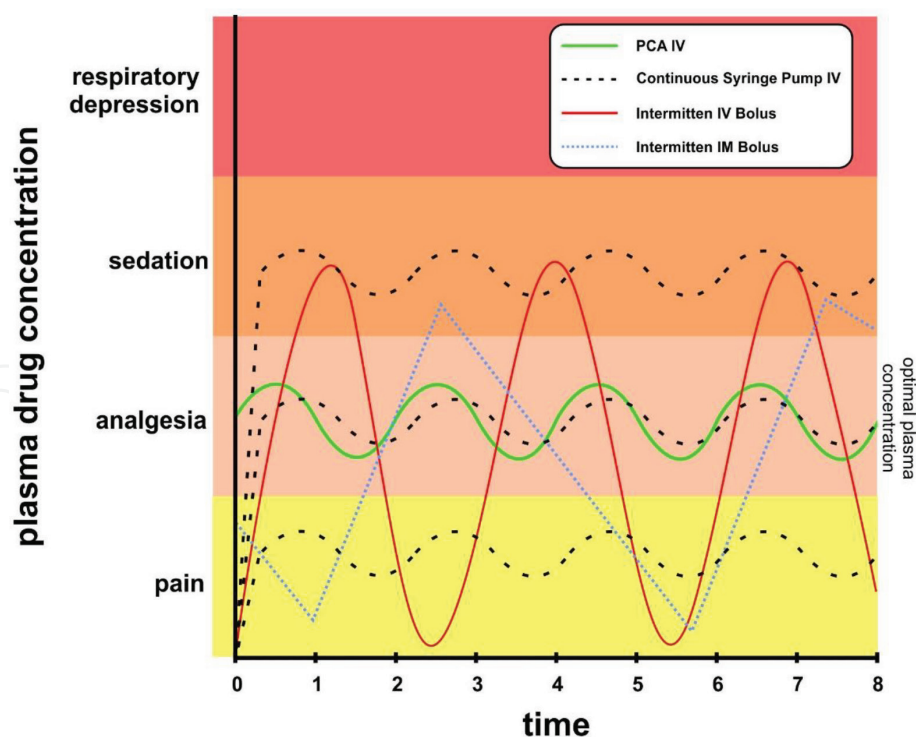


Figure 2. Comparison between plasma drug concentration and their administration. Plasma drug concentration after small frequent dose PCA administration compared with large dose intramuscular or intravenous administration every 2–4 hours and continuous infusion intravenous. Ideally, plasma drug concentration is constant in analgesia range without any surge of plasma drug concentration that lead to over sedation and respiratory depression or low level of drugs that cause inadequate analgesia. Small but frequent dose could be reached by PCA.

brain. Knowledge about all of the above will become essential to choose the right opioid that can be used in the PCA system. Parenteral opioid has three characters when binding with micro-opioid pure agonist, agonist-antagonist, and partial agonist. Character of pure agonist is the mainstay in acute pain management because can give full binding to microreceptor, and there is no maximal limit of analgesia (more opioid titration will give better effect in resolving pain.) However, there is a clinical maximal limitation that can give adverse effects such as sedation, respiratory depression, and often limit extra dose before reaching adequate level of analgesia. microagonist opioids are also effective in equianalgesic dose (i.e., 10 mg morphine = 2 mg hydromorphone = 100 mg meperidine) [15–19].

There are no significant differences in adverse effects due to opioids, even though patient can develop nausea, vomiting, or pruritus with one opioid, but not with other opioid drugs. All μ agonist decrease intestine movement, that contribute in ileus paralytic after surgery [15, 16, 18, 20].

Agonist-antagonist opioids activate κ receptor and antagonist toward microreceptor. Even though they are used with maximal effect limitation toward respiratory depression, it can give a wider safety margin, and this effect can happen with very large dose comparing it with microagonist. The most important thing is that agonist-antagonist has maximal limit of analgesic effect, so this group cannot make better analgesia compared with microagonist. Furthermore, agonist-antagonist drugs will induce acute withdrawal response in patients who receive microagonist opioids before. Due to activation of σ receptor, this group often induces psychotomimetic adverse effects. These type of opioids are uncommon to be used in PCA IV [15, 17, 18].

All opioids have been used successfully for PCA intravenous analgesia, with morphine as the most substance to be studied. Whatever opioid is chosen for intravenous PCA, knowledge about pharmacology is needed to control variable dose in PCA machine. Key component for effective PCA therapy is the right titration to get analgesia. Loading dose of morphine is 2–4 mg (or equianalgesic dose for alternative opioid) given every 5–10 min in postanesthesia care unit (PACU) until pain score ≤ 4 from 10 or if respiratory rate < 12 times per minute, which will give limitation for the next opioid administration. It should become a consideration to use multimodal therapy to achieve optimal analgesia and to decrease the use of opioid and will decrease the possibility of adverse effect and respiratory depression (**Table 1**).

Opioid	Concentration	Demand dose	Lockout (min)	Continuous basal
Morphine	1 mg/ml	1–2 mg	6–10	0–2 mg/h
Fentanyl	10–20 μ g/ml	20–50 μ g	5–10	0–60 μ g/h
Sufentanil	1–4 μ g/ml	4–6 μ g	1–10	0–8 μ g/h
Hydromorphone	0.1–0.2 mg/ml	0.2–0.4	6–10	0–0.4 mg/h
Tramadol	10–20 mg/ml	10–20 mg	6–10	0–20 mg/h
Oxycodone	1–2 mg/ml	1–2 mg	5–10	0–2 mg/h

Continuous infusion is not recommended in early design.

Table 1. Common PCA regimen.

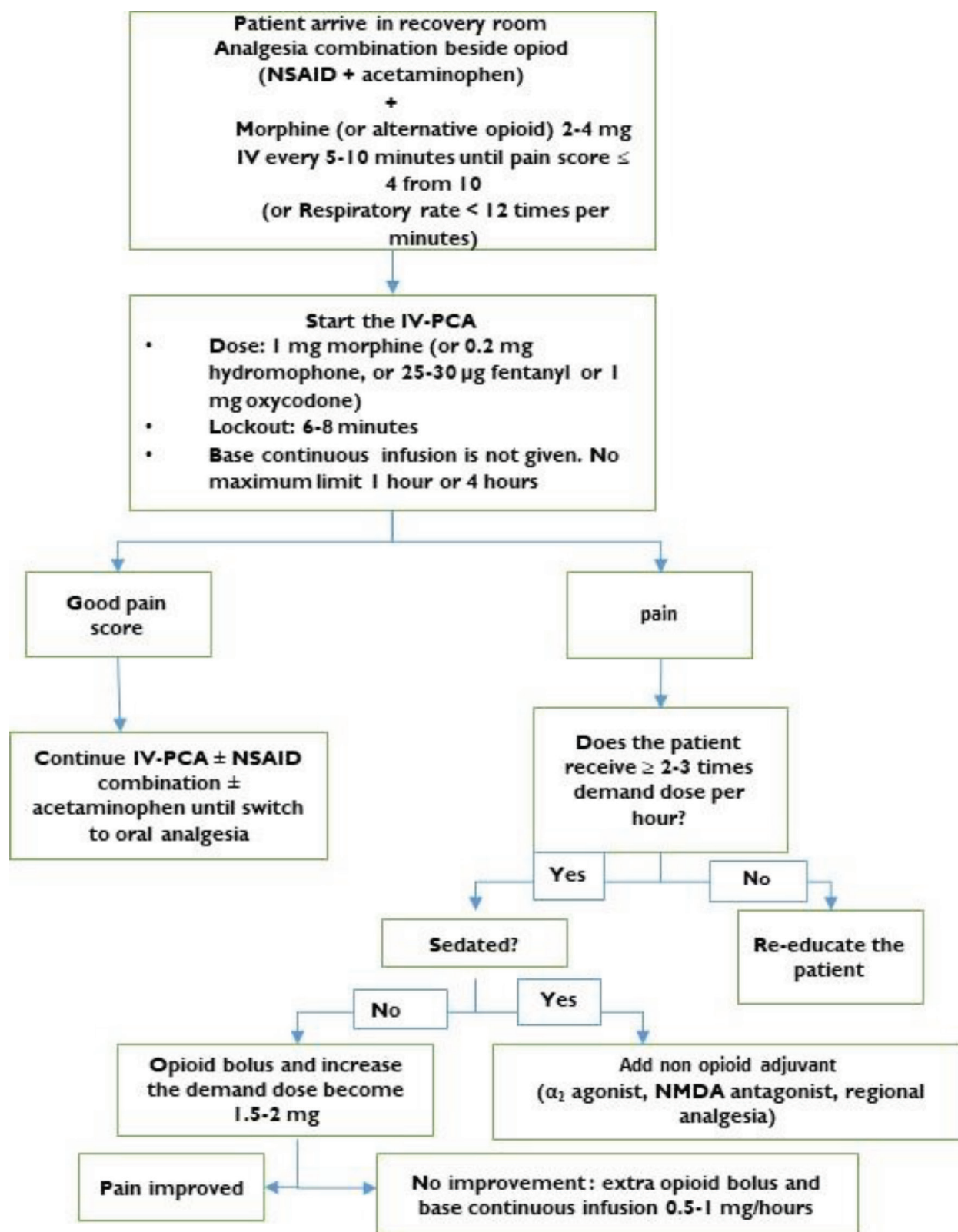


Figure 3. Simplified algorithm of IV-PCA management for basic setting of IV-PCA with morphine.

2.4.1. Initial dose and adjusted dose

There is no ideal dose in IV-PCA. Deciding dose for PCA depends on patient and expected postoperative pain. The key component of effective PCA therapy is initial titration to achieve pain-free condition or minimal pain before starting the IV-PCA program. One consideration is that multimodal therapy approach must start early to optimize the analgesia and decrease the need of opioid, so can decrease the adverse effect and respiratory depression. Pain management with PCA will fail if initial analgesia cannot be achieved. This condition will disappoint the patient who still feels pain even though the machine has been started. Patient will be frustrated and refuse to use PCA. Keep in mind that basic principle of PCA is to maintain the analgesia in optimal range for the patient [15, 17, 18] (**Figure 3**).

3. Regional analgesia

Analgesia with regional techniques has been fashionable due to its advantages: effective, safe, economical, and easy to perform. There are numerous techniques of perioperative analgesic blocks, which have benefited with the advent of ultrasound. The following paragraphs describe some procedures.

3.1. Central neuraxial analgesia

3.1.1. Patient-controlled epidural analgesia (PCEA)

Epidural analgesia is a safe and effective method to handle pain in any patient. It can be used for babies, children, adult, elderly in a short period (hours until days) or long period (weeks until months). Epidural analgesia can give superior regional analgesia compared with conventional systemic route (IV or oral) with minimum systemic side effect (nausea, sedation, or constipation). Drugs in epidural space are distributed through three main routes: (1) diffusion process through dura to cerebrospinal fluid, then to spinal cord or nerve root, (2) through uptake in epidural space blood vessel into systemic circulation, and (3) fat uptake of drug in epidural space where it can enter cerebrospinal fluid or systemic circulation. Epidural analgesia insertion can be combined with PCA machine to reduce pain with patient as the controller, which is known as patient-controlled epidural analgesia (PCEA). PCEA is an effective method to control pain with analgesia and local anesthesia through a catheter inside the epidural space connected with a pain pump that delivers small dose of drugs directly to the epidural space. Unlike systemic administration, drugs that are injected into the epidural space are potent because it is close to the opioid and alpha agonist receptors in dorsal horn. Due to small dose, the side effects are minimum such as nausea, sedation, and respiratory depression. Usage of this method is usually seen in obstetric surgery and postsurgery pain management for lower abdomen, thoracic, and cancer pain or chronic pain management. Currently, there are two main methods in PCEA usage such as demand

dose only (PCEA dose) and continuous infusion with demand dose (PCEA + continuous infusion). Continuous infusion is an administration of drug with constant speed, without any consideration of patient’s need. When the pain increases for some reason, activation of demand dose will cause administration of extra small dose that increases the drug’s volume and the patient will be pain free. Some of PCEA machines make it possible for doctor to set other parameters in administration of drugs that is known as programmed intermittent epidural bolus (PIEB) [21–28] (**Table 2**).

Best pain management using epidural analgesia can be reached with combination of local anesthetic and opioid because they can work synergistic to decrease pain with fewer side effects than with single drug. All drugs and fluid that are injected into the epidural space should be free from preservative to avoid central nervous system toxicity [6].

The American Society of Anesthesiologist (ASA) published a clinical practice guidance to prevent infection from epidural analgesia. They recommend insertion of epidural catheter with aseptic technique, such as washing hand, sterile gloves, sterile gown, mask (used to cover mouth and nose), skin preparation, and sterile drapes around injection site. The tip of the epidural catheter should be placed based on the surgical dermatomes. Catheter should be fixed to minimize possibility of catheter misplace outside from the epidural space, migrate to subarachnoid space, or even migrate to a blood vessel. Dressing is adjusted so it will not cover the insertion. Nosocomial infection should be considered, and the use of prophylactics antibiotics is recommended, especially for patients with risk of infection (i.e., diabetics, patient who received steroid therapy or immunosuppression and patient who are hospitalized more than 48 h with epidural catheter) [29] (**Tables 3 and 4**).

Before PCEA is started, a loading dose should be administered to reach the initial block level using higher concentration of local anesthetic than the concentration in PCEA solution. Continuous rate for adult patients needs adjustment depending on patient’s need. Continuous infusion is usually not used in PCEA [21–27] (**Table 5**).

3.2. Peripheral nerve blocks

Nerve block with local anesthetic in a specific location at or around the main nerve will depolarize the nerve and obtund the pain sensation in that specific area. Advantages of nerve block such as single accurate injection can block larger area of sensation without tissue distortion at the operative site. In the other hand, this method has the disadvantage of the sensation of

Surgery site and injury	Epidural insertion
Thoracic	T4-T8
Upper abdomen	T7-T10
Lower abdomen	T9-L1
Hip and lower extremities	L1-L4

Table 2. Epidural insertion based on surgery site.

Opioid	Concentration	Loading dose*	PCEA dose*	Lockout interval (min)	Continuous rate*	4 h limitation (ml)
Morphine	50 µg/ml	2–4 mg	2–4 ml	10–15	6–12 ml/h	40–70
Hydromorphone	10 µg/ml	500–1500 µg	2–4 ml	6–10	6–12 ml/h	40–70
Fentanyl	2–5 µg/ml	75–100 µg	2–4 ml	6	6–15 ml/h	40–70
Sufentanil	2 µg/ml	0.5 µg/kg	2–4 ml	6	0.1 µg/kg/h	40–70

*Depend on epidural catheter insertion, surgery condition, and patient's physical status.

Table 3. Opioid dose of PCEA guideline.

Incision site	Analgesia solution	Continuous infusion (ml/h)	Demand dose (ml)	Lockout interval (min)	PIEB (ml every)	
					Volume (ml)	Time (min)
Common Regimen	0.05% bupivacaine + 2–5 µg/ml fentanyl	4–10	2–6	10–15	—	—
	0.0625% bupivacaine + 2–5 µg/ml fentanyl	4–10	3–5	10–15	6–10	30–60
	0.1% bupivacaine + 2–5 µg/ml fentanyl	6–8	2–3	10–20	10	60
	0.125% bupivacaine + 0.05–0.1 mg/ml morphine	4–6	5–10	15–20	—	—
	0.0625–0.125% levobupivacaine + sufentanil 0.5 µg/ml	10	5	10–15	10	60
	0.1% levobupivacaine + fentanyl 2 µg/ml	10	5	10–15	5–10	30–60
	0.1–0.2% ropivacaine + 2–5 µg/ml fentanyl	3–5	2–5	10–20	5 2.5	30 15
Thoracic	0.0625–0.125% bupivacaine + 2–5 µg/ml fentanyl	3–4	2–3	10–15	—	—
Abdominal	0.0625% bupivacaine + 2–5 µg/ml fentanyl	4–6	3–4	10–15	—	—
	0.125% bupivacaine + 0.5 µg/ml sufentanil	3–5	2–3	10–15	—	—
	0.1–0.2% ropivacaine + 2–5 µg/ml fentanyl	3–5	2–5	10–15	—	—
	0.125% bupivacaine + 0.05–0.1 mg/ml morphine	4–6	10	15–20	—	—
Lower extremity	0.0625–0.125% bupivacaine + 2–5 µg/ml fentanyl	4	2	10–15	—	—

Table 4. PCEA regimen for acute postsurgery pain.

Type of surgery	Catheter location	Continuous infusion rate (ml/h)
Thoracic	T2-T9	4–10
Upper abdominal	T4-L1	4–10
Lower abdominal	T10-L3	8–18
Lower extremity	T12-L3	8–18

Table 5. Common continuous infusion rates for epidural analgesia.

numbness in areas other than the operative site and unpredictable effect due to individual anatomic variation [6–30].

Regional anesthesia can be given as continuous block and demand dose using patient-controlled regional anesthesia (PCRA). Commonly, PCRA is used in brachial plexus block, sciatic nerve block, and femoral nerve block. PCRA can decrease the consumption of local anesthesia without increasing the pain and high satisfaction level of patient who has undergone total hip or knee arthroplasty compared with continuous infusion. This method should be able to reduce motor block, minimize block of sensory, and better control from breakthrough pain [30–32]. The recommendation for PCRA setting is low basal infusion rate with 4–6 ml/h. for lower extremity and 6–10 ml/h. for upper extremity along with 2–10 ml small bolus doses with 20–60 min lockout interval [5, 31–35].

3.2.1. Drug of choice

All local anesthetics can be used, although the common choice is the short-acting drugs such as lidocaine and prilocaine. Tachyphylaxis has been reported and this condition is associated with occasional cyanosis caused by methemoglobinemia. Perhaps, it is for this reason that the drug is less favored. Bupivacaine, levobupivacaine, and ropivacaine have all been used for continuous peripheral nerve block (CPNB), but in general, there is no enough data available to suggest the best local anesthetic. Some experts suggest that ropivacaine is preferred because it has the capacity to maintain motor function. Casati preferred ropivacaine compared to lidocaine for this reason. However, the evidence for this CPNB difference is limited and varied. For example, 0.2% ropivacaine provides the same pain relief rate when used in interscalene CPNB after shoulder surgery when compared with 0.15% bupivacaine or 0.11% levobupivacaine, but greater motor blockade is obtained. Comparison between bupivacaine and levobupivacaine was not found to be a significant difference. Similar studies doubled the concentration of these drugs (0.25% levobupivacaine compared with 0.25 and 0.4% ropivacaine) showing that analgesia and motor block effects for interscalene catheters were similar at 0.25% levobupivacaine and 0.4% ropivacaine, but better than 0.25% ropivacaine. In a popliteal infusion study, Casati et al. also showed that 0.125% levobupivacaine was roughly equivalent to 0.2% of ropivacaine, either from analgesia or motor block sparing effect [33–39].

The term “analgesic gap” has been used for periods of inadequate analgesia that often occur after the loss of the initial block effect associated with catheter placement, but before subsequent local anesthetic infusions produce full effect. It may be especially difficult to treat if the patient is discharged after an outpatient operation with a catheter and infusion system. Keep in mind

that regular oral analgesia should be started before the block runs out, and additional analgesia is readily available and used as early as the patient begins to feel uncomfortable with the pain.

Despite the recently published preclinical evidence of perineural pregabalin infusions and addition of clonidine, dexamethasone, and buprenorphine in perineural bupivacaine injected in mice, these data are still premature and until now there has been no drug other than local anesthesia approved by the FDA for continuous perineural administration. Randomized controlled clinical trials have failed to show the advantage of adding clonidine or epinephrine to perineural infusions. There are sporadic RCTs that show the benefits of some opioids in perineural infusions, but all these studies lack the active systemic control group that cannot assess the importance of perineural vs. intravenous opioid drug delivery. On the other hand, the addition of opioids often leads to an increased incidence of opioid-related side-effects. Recent data support previous evidence showing that total doses, not concentration/volume, are a major factor affecting clinical effects for continuous infusion of peripheral nerves [33, 35, 38–40].

3.2.2. PCRA brachial plexus

Insertion of brachial plexus catheter is generally divided into four parts: interscalene, supraclavicular, infraclavicular, and axillary. Choosing the right location for the insertion of the catheter in certain surgical procedures is of great importance compared to considering the variety of anesthesia techniques to be used.

3.2.2.1. PCRA axillary nerve block

After elective surgery on the hands, continuous axillary blocks using 0.1 or 0.2% ropivacaine did not have a better effect when compared to a control group using saline, and both groups still need additional analgesia. However, both in the continuous group and the recurrent bolus dose group using the 0.25% bupivacaine regimen gave better results in relieving pain with no difference in the two groups with the different techniques, either on the pain score, motor block degree, or on opioid requirements, although plasma bupivacaine levels were higher in the continuous group. Both 0.125% bupivacaine and 0.125% ropivacaine, given as a 10-ml patient-controlled bolus dosage in outpatients, can relieve pain equally well. In addition to pain relief, continuous axillary block can provide an increased effect of vascular flow in patients after fingers reimplantation surgery [33, 39, 41].

3.2.2.2. PCRA brachial plexus periclavicular (supraclavicular/infraclavicular)

The periclavicular area has the advantage for the placement of a brachial plexus catheter. Unlike the axilla, this area is cleaner and relatively with less movement. With the increasing popularity of the infraclavicular block, various approaches of plexus catheterization are also increasingly used. The infraclavicular catheter has been widely used to relieve postoperative pain in the arms, elbows, and hands, even in patients undergoing outpatient treatment. Ilfeld et al. compared the use of ropivacaine infusions in the infraclavicular brachial plexus compared with normal saline use in patients undergoing postsurgical upper-limb care treatment; patients receiving ropivacaine infusions experienced fewer pain complaints, fewer sleep disturbances, and used less opioids, resulting in fewer opioid side effects, and higher patient satisfaction [31, 33, 39, 42].

3.2.2.3. PCRA interscalene brachialis

Shoulder surgery can be very painful. Early and effective rehabilitation is important in improving postoperative outcomes. Given the substantial restriction of rehabilitation, it may not be surprising that the subject of local anesthetic infusion through the interscalene catheter is a new discussion in the literature on continuous peripheral nerve blocks and their use for pain relief following major surgery on the shoulders that has been widespread. The growing evidence now confirms that, in general, continuous interscalene brachial plexus may provide superior analgesia than intravenous opioids. For example, patient-controlled interscalene analgesia or continuous infusion of interscalene analgesia may ease pain, increase patient satisfaction, reduce opioid side effects compared with analgesia with IV-PCA and oral opioid analgesia. Interscalene analgesia also eases pain better and reduces opioid need after shoulder surgery compared with single injection interscalene block and infusion of local anesthesia into the glenohumeral joint or subacromial bursa, although mild adverse events may increase. For the record, it is worth mentioning that the most popular skin area for catheter access placement to the interscalene brachial plexus is also relatively mobile. For this reason, some anesthesiologists who use this technique will direct the catheter to the skin that is not moving much using tunneling technique [31, 33–35, 37, 39, 43–45].

3.2.2.4. Regimen dose

Some experts have used a number of different infusion strategies, ranging from simple continuous infusion rates, or controlled by patients, intermittent dose of bolus on demand only, to a combination of the two. The optimal local anesthetic regimen for CPNB is a combination of continuous infusion and patient-controlled bolus dosage which is known as patient controlled regional analgesia (PCRA). Grossi and Allegri and several other studies concluded that the best infusion regimen is a combination of continuous basal infusion with minimal rate, along with an intermittent bolus on demand that would otherwise result in a lower total local anesthetic use, than a continuous infusion course at a rate relatively with high infusion with equally effective analgesia results. There is insufficient evidence for optimal infusion rates, bolus doses on demand, or lockout intervals, although continuous infusion rates of 4–10 ml/h, bolus dose on demand 2–5 ml, and 20–60 min lockout interval have been successfully used. However, there will always be variations between patients, and the regimen should be adjusted to give the desired effect [33, 35, 37, 39, 41–46].

Currently, no known maximum safe dose for long-acting local anesthetics is administered continuously or via PCRA. In some studies, involving patients without kidney or liver disease, perineural infusions for 5 days with scheduled times indicate that the concentration of the drug in the blood is at a safe level. Administration of bupivacaine may be considered at a maximum infusion rate of 0.5 mg/kg/h based on predictions from data of patients receiving epidural bupivacaine infusion. Patients undergoing shoulder surgery using an interscalene catheter, supplemental block with large bolus dose (6 ml) can decrease continuous infusion rate from 8 to 4 ml/h and may prolong the duration of the infusion. However, many incidents and increased intensity of breakthrough pain, sleep disorders,

and decreased pain management satisfaction were reported. Therefore, if outpatients do not regain control to obtain additional local anesthesia, practitioners experience a dilemma regarding the use of analgesia selected between strong analgesia for a shorter period of time or weaker analgesia for a longer period of time. For the record, the duration of the infusion may be increased by progressively decreasing the basal infusion rate with a programmable infusion pump, thereby theoretically maximizing postoperative analgesia [33, 35, 37, 39, 41–46].

Different results in doses of drug regimens can be caused by various factors, such as catheter design (no stimulation vs. stimulation), catheter placement (ultrasound vs. stimulation vs. combination) techniques, local anesthetic types (ropivacaine vs. bupivacaine vs. levobupivacaine) and concentration, infusion basal rate, bolus volume, lockout interval, operating procedures, yield evaluation, measurement sensitivity, and many other factors. As a result, there is no evidence-based regimen that is ideal, although researchers have provided clinical recommendations. However, there are some clinical situations where bolus dose administration is theoretically useful such as increasing block strength before wound care or potentially painful physical therapy. An RCT study showed that bolus on demand at PCRA reduced the need for local anesthesia. This provides three possible advantages: (1) theoretically reduces the motor block by decreasing the required basal infusion rate (to date, there is insufficient research), (2) reducing the incidence of numbness in the extremities, and (3) increasing the duration of the infusion/analgesia for outpatients who are dismissed from hospital with predetermined local anesthetic reservoir volume [31, 33, 37, 39, 43, 44, 46].

Some patients, especially the geriatrics, will experience a decrease in postoperative cognitive impairment. Therefore, most practitioners provide education to patients with their family/caregiver. They should be given oral and written instructions, along with contact numbers of health workers who can be contacted. In addition to standard outpatient instructions, the items described include the after effects of anesthesia, instructions on the infusion pump, management of breakthrough pain, care of peripheral nerve catheters, the protection of limbs, and plans for catheter release. In addition, it is necessary to inform the onset of pain in the operative limb after the loss of peripheral nerve block effects, the possibility of fluid leakage at the site of the catheter and its treatment, and possible complications such as nerve injury, local infection, toxicity of local anesthetics, and pulmonary disorders. One variation of the technique that recently attracted attention was the use of mandated/programmed intermittent bolus (PIB) doses, using the theoretical basis that increased local anesthetic volumes administered at one time that could increase perineural spread compared to volume/dose equivalent given as a basal infusion. Continuous adductor channel block requires a higher local basal anesthetic rate than the femoral nerve block. One study showed that although local anesthetic agents were given at relatively high rates (8 ml/h), the spread of local anesthetics remained limited. Subsequent studies involving healthy volunteers showed 0.2% ropivacaine at 8 ml/h as basal dose or intermittent bolus doses hourly gave the same sensory perceptions and quadriceps strength. Similar results are also reported for interscalene, femoral, and popliteal/sciatic catheters. For these reasons, the use of recurrent bolus doses can be reduced, unless recent RCTs may demonstrate the benefit of analgesia after thoracotomy at relatively

Surgery procedure	Anesthesia intraoperative	Postoperative PCRA			
		Medicine	Continuous (ml/h)	Bolus on demand (ml)	Lockout interval (min)
Shoulder surgery	Interscalene catheter: 20–25 ml ropivacaine 0.5% or 15–20 ml bupivacaine 0.5% + epinephrine 1:300,000 or 15–20 ml levobupivacaine 0.5%	Ropivacaine 0.2%	0–5	2–5	15–30
		Bupivacaine 0.1–0.125%	(child: 0.02 ml/kg)	(child: 0.1 ml/kg)	20–60
		Levobupivacaine 0.1–0.2%	0–6	2–5	20–60
			0–6	2–5	
Upper and lower arm surgery	Infraclavicular or supraclavicular catheter: 20–25 ml ropivacaine 0.5% or 15–20 ml bupivacaine 0.5% + epinephrine 1:300,000 or 15–20 ml levobupivacaine 0.5%	Ropivacaine 0.2%	0–5	2–5	15–30
		Bupivacaine 0.1–0.125%	(child: 0.02 ml/kg)	(child: 0.1 ml/kg)	20–60
		Levobupivacaine 0.1–0.2%	0–6	2–5	20–60
			0–6	2–5	
Lower arm and hand surgery	Axillary: 15–20 ml bupivacaine 0.5% or 15–20 ml levobupivacaine 0.5%	Bupivacaine 0.25%	0–10	2–10	30–60
		Levobupivacaine 0.1–0.2%	0–10	2–10	30–60

Table 6. List of surgery, operative anesthesia, and postoperative analgesia.

large levobupivacaine (15 ml) volumes via paravertebral catheters, every 6 h compared with continuous infusions [33, 42, 44, 46] (**Table 6**).

3.2.3. PCRA femoral nerve

The femoral nerve block is particularly indicated for pain control associated with unilateral anterior knee surgery. It is important to remember that the posterior obturator nerve provides an articular branch that supplies the posterior aspect of the knee, and this nerve may contribute to the pain that occurs in the posterior aspect of the knee after knee surgery, even though the femoral nerve block is effective. Therefore, additional sciatic nerve block is required if surgery is performed in the distal or posterior areas of the knee joint (e.g., on anterior or posterior cruciate ligament repair). It is not uncommon to require obturator nerve blocks and/or sciatic nerve separately, in addition to the femoral nerve block after total knee replacement surgery. Often the pain experienced in the posterior knee is short and effectively controlled with a single injection block. Continuous femoral nerve block has been shown to improve postoperative outcomes of total knee arthroplasty, better than single-shot femoral nerve block and continuous epidural [33, 35–39, 46–49].

For early bolus injections, 0.25 ml/kg ropivacaine (0.25–0.5%) or bupivacaine (0.25–0.5%) as bolus injection for intra- and postoperative analgesia should be combined with general anesthesia. If used as a single anesthetic, a dose of 0.5 ml/kg is usually required. With this technique, breakthrough pain is rare, and patients feel comfortable when followed by a continuous dose of 0.1 ml/kg/h in children or 5 ml/h in adults with 0.25% ropivacaine or bupivacaine 0.25%. The use of PCRA can give a better effect. Increased PCRA requirements are often caused by improper catheter placement [33, 37, 38, 47, 48, 50–52] (**Table 7**).

Local anesthesia	PCA setting			PIB	
	Continuous (ml/h)	Bolus (ml)	Lockout (min)	Volume (ml)	Interval (every)
Bupivacaine 0.1–0.25%	0–10 (child: 0.1 ml/kg/h)	5–10	30–60	—	—
Ropivacaine 0.2–0.25%	2–8 (child: 0.1 ml/kg/h)	4–15	30–60	30 5–10	4 h 60–75 min
Levobupivacaine 0.125–0.25%	0–5	5–10	20–30	—	—

Table 7. Setting of PCRA with catheter in femoral nerve.

3.2.4. PCRA sciatic nerve

The sciatica nerve block is particularly indicated for pain management associated with unilateral ankle, and in cases of lower leg operation. It is important to note that the saphenous nerves supply the medial aspect of the lower legs, ankles, and even the soles, which are branches of the femoral nerve. A single injection sciatica nerve block usually lasts relatively long, up to 36 h and continuous nerve blocks may be indicated for special cases. Arthroplasty surgery on the ankle is a good example requiring a sciatica nerve block. If necessary, it can be combined with a saphenous nerve block. For early bolus injections, 0.25 ml/kg of ropivacaine 0.2–0.5% or 0.2–0.5% bupivacaine may be used as bolus injection for intra- and postoperative analgesia if block is combined with general anesthesia. If used as a single anesthetic, a dose of 0.5 ml/kg is usually required. With this technique, breakthrough pain is very rare, and patients feel comfortable when followed by a continuous dose of 0.1 ml/kg/h in children or 5 ml/h in adults with 0.25% ropivacaine or bupivacaine 0.25%. The use of PCRA can give a better effect. High PCRA demands are often caused by improper catheter placement. In continuous popliteal sciatic block, local anesthetic administered as a programmed intermittent bolus (PIB) in conjunction with PCA provided similar pain relief as a continuous infusion technique combined with PCA. However, the new dosing regimen reduced the need for additional PCA and the overall total consumption of local anesthetic [33, 36, 39, 46, 47, 49, 53, 54] (**Table 8**).

The home release of patients with a peripheral nerve catheter can be performed by various techniques such as the patient may be discharged with written instructions, the health worker

Location of sciatic catheter	Local anesthesia	Setting of PCA		
		Continuous (ml/h)	Bolus on demand (ml)	Lockout interval (min)
Subgluteus	Ropivacaine 0.2%	5–10 (child: 0.1 ml/kg/h)	5–10	30–60
Anterior	Ropivacaine 0.2%	5–6	5–10	15–30
Popliteal	Ropivacaine 0.2%	8–12	4–10	30–60
	Levobupivacaine 0.125%	3–10	3–5	15–60

Table 8. PCRA setting with catheter in sciatic nerve (with or without femoral nerve block).

may perform this procedure, or the patient's caregiver (or sometimes the patient himself) can release the catheter with instructions provided by healthcare workers via telephone. Among these techniques, there are no procedures that are superior to others. Based on one of the surveys, 98% of patients feel comfortable removing their own catheters at home by giving instructions via telephone. Only 4% chose to return to health workers to remove catheters, and 43% felt comfortable with written instructions. Nonsterile gloves need to be given to patients if they intend to remove their own catheter at home. However, if the catheter is done by stitching fixation, then it should be removed only by medical personnel [33].

3.3. Field blocks

3.3.1. *Transversus abdominis plane block (TAP block)*

The TAP block is a novel technique for postoperative analgesia especially in the initial postoperative period. TAP block is a technique of locoregional anesthesia that involves the abdominal wall. This block was recently introduced for operations that involve the abdominal wall. The local anesthetic is placed in the plane between transversus abdominis muscle (TAM) and the internal oblique muscle (IOM), where there are sensorial afferent bundles of the nerves T7 to T12 and L1. The local anesthetic injected in the plane blocks the sensory afferents of all these nerves, providing pain relief for the entire anterior abdominal wall. Postoperative pain is an important issue with abdominoplasty and flank liposuction procedures. Bupivacaine hydrochloride (0.5%, 5 mg/ml, total dose, 2 mg/kg), 0.5% lignocaine, 0.375% bupivacaine 20 ml, levobupivacaine to a maximum dose of 1 mg/kg each side, and 0.75% ropivacaine up to 1.5 mg/kg (to a maximum dose of 150 mg) or other local anesthetics are injected bilaterally in the plane between the internal oblique muscles and the transversus abdominis muscles using a blunt needle, with or without USG guidance or injected directly during the surgical procedure. Doses were increased in order to provide prolonged postoperative analgesia. Prolonged analgesic effect can be achieved by continuous blockade using catheter for drug delivery, but it is technically more demanding. For abdominal plastic surgery, TAP block to control postoperative pain administered after the flap resection and prior to the muscles plication. TAP block is used in esthetic abdominoplasty and postbariatric surgery. Compared between these two surgical procedures, TAP block gives better pain control in esthetic abdominoplasty than in postbariatric surgery. The larger amount of tissue resected in bariatric surgery gives greater stimulation of pain fiber. TAP block technique is associated with low postoperative requirements for morphine or other pain medication. It has got potential to substitute the use of intravenous opioid analgesics and hence to avoid its complications. It has been proved to cater significant analgesic effect especially below T10 up to L1 level [55–59].

The TAP block can be done either in preoperative or in postoperative, but because the abdominal wall is intact preoperatively, it is preferred to be done before the surgery. The procedure must be done under extreme aseptic technique due to the risk of peritoneum penetration. The patient is positioned supine in both techniques [60]. There are two common techniques for TAP block [57–61]: (1) The blind TAP: the point of entry for the blind TAP is the lumbar triangle of Petit. The needle is inserted cephalad to the iliac crest and advanced until two distinct “pops” are felt as the needle transverses the external oblique and internal oblique muscles. To make the loss of resistance more appreciable, it is recommended to use a blunt needle.

(2) The ultrasound-guided TAP: the ultrasound probe is placed midway between the costal margin and the iliac crest to image in the transverse plane. The muscle layers are identified on the ultrasound image. The needle is gradually passed through the skin, subcutaneous tissue, EO, and IO, until it lies between the IO and TA—this is where the local anesthetic should be injected (**Figure 4** and **Table 9**).

3.3.2. Continuous wound infusion system

Continuous wound infusion of local anesthetic will block the transmission of nociceptive stimuli from the wound surface, inhibit response of local inflammation to surgical wound, and suppress the spinal cord from systemic absorption of local anesthetics. Currently, this special wound infusion catheter can be inserted intra- and perioperatively into the wound. Liu et al. performed a meta-analysis on the available randomized controlled trials (RCTs). Forty-four prospective randomized trials met the inclusion criteria for analysis. Overall results and

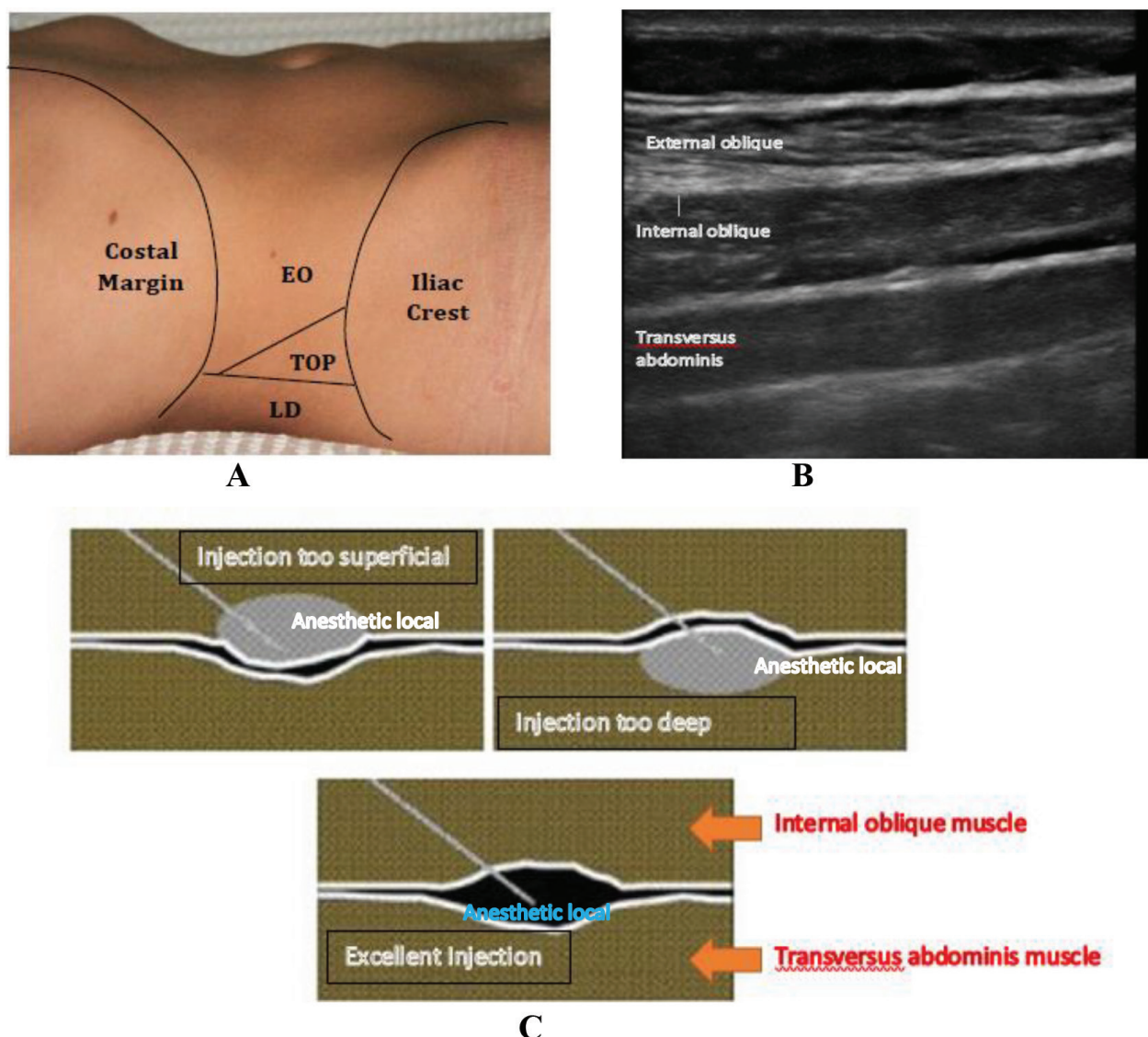


Figure 4. Landmark (a), USG guide (b), and location of TAP injection (c) [60].

Complications	Contraindications	
	Absolute	Relative
Local anesthetic toxicity	Patient refusal	Coagulopathy
Intraperitoneal injection	Allergy to local anesthetic	Surgery at injection site
Bowel injury	Localized infection over injection point	
Hepatic injury		

Table 9. Complication and contraindication of TAP block [60].

all subgroup analysis showed that continuous local anesthetic infusion improved pain scores and decreased the need for supplemental narcotics. These results were statistically significant. Another randomized controlled trials had been done to examine the efficacy of this system in pain management, from the trials when compared with placebo, and this system can reduce the pain score as much as 33%. It is recommended that in the absence of neuraxial blocks or peripheral nerve blocks, wound infiltration should be performed whenever possible [6, 62–65].

To deliver continuous wound infusion, we can use a pain pump that has been studied in various types of surgical procedures. Although pain pumps have been used in many surgical procedures, their use is relatively new in plastic surgery. The catheter is placed in the surgical site and local anesthetics are delivered to the site. Typically, using 0.25% bupivacaine or 0.25–0.5% ropivacaine can be infused continuously, bolused, or delivered via a patient-controlled delivery system. The 0.25% bupivacaine is usually infused at 2 ml/h for 48 h, delivering 120 mg per day. This is well below the recommended maximum dose of 400 mg in 24 h [6, 62, 63, 65, 66]. Baroody et al. [67], in a study of 16 patients with autologous latissimus dorsi breast reconstruction with historical controls, showed that continuous infusion of 0.25% bupivacaine, 2.08 ml/h, decreased pain level and significantly used less opioid in the postoperative period. They also observed that there was a reduction in PONV. Lu and Fine [68] published a study of the use of indwelling catheters for the continuous infiltration of bupivacaine using pain pump in 74 consecutive breast reductions and 74 consecutive tissue expander breast reconstruction patients, and each group was compared with patients receiving conventional analgesia. Pain and average pain score was significantly lower, but do not eliminate pain, in the pain pump group than in the comparison group, as were cumulative amounts of pain medications. There were no statistically significant differences in the number of complications or in the rate of PONV.

One study found that there was a 91–93% overall patient satisfaction with the pain pumps, which was statistically significantly greater than the saline group satisfaction rate. There was significant improvement in patient satisfaction in the bupivacaine group, and their PCA narcotic use was decreased in the first 48 h [62]. Giordano et al. [69] in their study about abdominal donor site analgesia in patients undergoing free lower abdominal flap breast reconstruction comparing pain pump use vs. control found a significantly decreased use of opioids after using pain pump vs. control and a trend toward reduction in the antiemetic medicament use and shorter hospital stay. One thing to be kept in mind is that the surgeon and anesthetist must be aware of the risk of local anesthetic systemic toxicity, although it is very rare. Care must be taken not to exceed the daily maximum dose of local anesthetics,

including the amount infiltrated with surgery as well as the total amount infused via the pain pump [62, 66, 70, 71]. Even though pain pump is popular, the cost-effectiveness of these pain pumps needs further investigation.

3.3.3. *Tumescent analgesia*

Tumescent analgesia (TA) is a part of local anesthesia using a very dilute local anesthetic, which delivered subcutaneously in a large volume of fluid. In plastic surgery, TA can be used alone or with sedation to achieve intraoperative analgesia. It can also be used along with neuraxial analgesia or general anesthesia to get postoperative analgesia and lower intraoperative anesthesia. This technique was used most commonly in liposuction, but can also be used in other plastic surgeries such as subcutaneous mass excisions and scar revisions, excisional body contouring (abdominoplasty, body lifts, arm lifts, and thigh lifts), breast augmentation, reduction, mastopexy, gynecomastia, and capsular contracture revision, mastectomy, burn excision and skin grafting, skin procedures (dermabrasion and laser resurfacing), face and neck lifts, and hair grafting. TA can be used in other procedures to decrease intra- and postoperative pain, allowing less use or elimination of anesthesia and opioids. The addition of diluted epinephrine in TA leads to vasoconstriction that can significantly lower the blood loss, minimizing bruising, and postoperative soreness. The advantages of TA are fewer narcotic use, less sedation, and less general anesthesia needed, faster recovery, and earlier discharge. These advantages could prevent the use of general anesthesia and decrease the possibility of pulmonary thromboembolism [72–76].

TA fluid formula is based on 1000 ml of either 0.9% saline or ringer lactate solution. When the tumescent technique is used with general anesthesia, the concentration of epinephrine is 1:1,000,000. This solution can be added with bupivacaine, lidocaine, hyaluronidase, or triamcinolone 10 mg/L and has also been used to decrease ecchymosis and edema, but there is a little comparative evidence regarding its usefulness. Lidocaine is most commonly used as a local anesthetic in TA. The recommended maximum dose of lidocaine used for TA is different compared to a traditional local infiltration (**Table 10**). Bupivacaine can be used alone or with lidocaine. A patient who received bupivacaine has a shorter hospital stay. If the patient is allergic to lidocaine, prilocaine can be used instead. The recommended dose of prilocaine of 8 mg/kg for small volume liposuction and doses up to 35 mg/kg is safe. Patient should be monitored for 12 h after administration of prilocaine to evaluate if there are methemoglobinemia sign and symptoms such as a headache, dyspnea, lightheadedness, weakness, confusion, delirium, palpitations, chest pain, cyanosis, dysrhythmias, seizures, coma, acidosis, and cardiac or neurologic ischemia and should be precautious in liver patients [72–76].

Tumescent fluid is administered with an 18G long spinal needle for a small procedure or blunt infiltration cannula for the larger procedures. Before TA is given, lidocaine 1% and 1:100,000 epinephrine is injected intradermally to decrease skin bleeding. Plasma peak of lidocaine is seen 10–14 h after its administration, but in the highly vascularized area, the peak of lidocaine reaches in 6 h. Monitoring should be extended in a patient who receives high dose of lidocaine. Lidocaine toxicity is suspected in a patient with restlessness, drowsiness, light-headedness, metallic taste, tinnitus, slurred speech, and numbness in lips and tongue, shivering, muscle twitching, tremors followed by convulsion, central nervous system depression, coma, respiratory depression, and cardiac arrest. If signs of toxicity appear, stop infusion of fluids with

Medication	Concentration (%)	Maximum dose range		
		Without epinephrine (mg/kg) for TA	With epinephrine (mg/kg) for TA	"Traditional local infiltration" dose with and without epinephrine (mg/kg)
Lidocaine	1.0	30–60	90–120	4–7
Bupivacaine	0.25	120–240	180	2.5–3
Ropivacaine	0.2	120–360	120–360	2.7
Mepivacaine	1.0	45–90	120	4–7
Etidocaine	0.5	120–180	180	4–5.5
Epinephrine (1:1000)	1:1000	0.5–2 ml of 1:1000		
Sodium bicarbonate (8.4%)	8.4	10–12.5 ml		

Table 10. Common tumescent analgesia concentration and dose.

local anesthetics, protect airway and oxygenation, call for help, and give benzodiazepines if seizures happened. Manage arrhythmia based on ACLS guidelines but avoid lidocaine, give lipid emulsion therapy if cardiac or neurological event persists [70–73].

Discomfort during injection of lidocaine can be decreased with the addition of sodium bicarbonate. Sodium bicarbonate is contraindicated as addition to bupivacaine because it can precipitate the solution. High volumes of TA infusion have a risk of intravascular fluid overload with cardiac and pulmonary effect. In a patient with cardiac, pulmonary, or renal pathology, the pros and cons of TA must be considered with the limitation of the injected volume. Patient with high-volume TA can have a risk of mild hyponatremia and hypokalemia, lowering body temperature with impaired thermoregulatory system, and acute nerve compression. Administration of TA at 37°C can decrease the risk of hypothermia. In a patient with nerve compression, this condition can be resolved after giving diuretics [72, 73].

4. Conclusion

The patients who undergo plastic surgery procedure can experience various types of pain, including background pain, breakthrough pain, and procedural pain. Treatment for each type of plastic surgery and resulted pain requires a specific approach and must be individualized to the patient. There are three main techniques in acute pain management postoperatively, such as systemic analgesia, regional analgesia, and local/topical analgesia. Currently, pain management through intravenous injection or continuous central neuraxial and peripheral nerve block is more controllable and safer since the invention of pain pump, which commonly use the principal of patient-controlled analgesia. Multimodal treatment seems to have significant benefits, postoperative dosing becomes more complex, and adverse drug interactions and drug overdose become more likely. There is some combination that has demonstrated a good effect in multimodal analgesia. PCA intravenous, patient-controlled epidural analgesia (PCEA) and patient-controlled regional analgesia (PCRA) can be combined with other pain

killers, such as paracetamol, NSAIDs, alpha-2-delta modulators (gabapentin and pregabalin), N-methyl-D-aspartate (NMDA) antagonists (ketamine and magnesium), alpha-2-agonists (clonidine and dexmedetomidine), TAP block, continuous wound infusion system using pain pump, and tumescent analgesia with local anesthetic.

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