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Pain Management in the Emergency Department: a Review Article on Options and Methods

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Abstract

Context: The aim of this review is to recognizing different methods of analgesia for emergency medicine physicians (EMPs) allows them to have various pain relief methods to reduce pain and to be able to use it according to the patient's condition and to improve the quality of their services.

Evidence acquisition: In this review article, the search engines and scientific databases of Google Scholar, Science Direct, PubMed, Medline, Scopus, and Cochrane for emergency pain management methods were reviewed. Among the findings, high quality articles were eventually selected from 2000 to 2018, and after reviewing them, we have conducted a comprehensive comparison of the usual methods of pain control in the emergency department (ED).

Results: For better understanding, the results are reported in to separate subheadings including "Parenteral agents" and "Regional blocks". Non-opioids analgesics such as nonsteroidal anti-inflammatory drugs (NSAIDs) and acetaminophen are commonly used in the treatment of acute pain. However, the relief of acute moderate to severe pain usually requires opioid agents. Considering the side effects of systemic drugs and the restrictions on the use of analgesics, especially opioids, regional blocks of pain as part of a multimodal analgesic strategy can be helpful.

Conclusion: This study was designed to investigate and identify the disadvantages and advantages of using each drug to be able to make the right choices in different clinical situations for patients while paying attention to the limitations of the use of these analgesic drugs.

Key words: Analgesics, Opioid; Anesthesia, Conduction; Emergency Service, Hospital; Pain Management

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CONTEXT

Pain is one of the main complaints of patients referred to the hospital and comprises almost 80% of the causes for referral to the emergency department (ED) (1, 2). Pain management in the emergency department is one of the quality-of-care indicators and can be used as a marker for assessing the care in the ED (3-7). Factors such as race, age, sex, ability to express pain, underlying illness, physician awareness, and fear of complications can prevent proper pain control in patients. Pain control should not be delayed while waiting for test results and paraclinical actions. The primary basis for pain relief is the administration of systemic analgesic agents such as narcotics or nonsteroidal anti-inflammatory drugs (NSAIDs) (8-10). The type of treatment regime should be chosen and administered in a way that, in addition to being able to improve several types of pain in the patient, have few side effects and do not interfere with other drugs (11). Studies have shown that patients whose primary pain is well managed and treated in the ED have a higher overall satisfaction with hospital services (12-14). However, there is an almost universal agreement about the inadequate treatment of pain in the ED (2, 15). As a result, recognizing different methods of analgesia and pain management for emergency medicine physicians (EMPs) allows them to have various pain relief methods to reduce pain and to be able to use it according to the patient's condition and to improve the quality of their services.

EVIDENCE ACQUISITION

In this review article, the search engines and scientific databases of Google Scholar, Science Direct, PubMed, Medline, Scopus, and Cochrane for "emergency pain management methods" were

reviewed. Among the findings, high quality articles were eventually selected from 2000 to 2018, and after performing critical appraisal, we have conducted a comprehensive comparison of the usual methods of pain control in the ED.

RESULTS

For better understanding, the results are reported in to separate subheadings including "Parenteral agents" and "Regional blocks".

Parenteral agents

- **Morphine**

Morphine is one of the main opioid agents due to its easier access in the hospital system in the treatment of patients with extremity trauma and moderate to severe pain (16, 17). The current recommendation for the treatment of acute pain in the ED is the use of the dose of bolus morphine initially, and then gradual titration to the desired analgesia (18, 19). Morphine has undesirable side effects, including sedation, nausea, hypothermia, and respiratory depression (20-31). Perhaps due to these side effects, most EMPs avoid administration of 7 to 10 mg of morphine in the initial bolus dose while two studies have shown that even 0.1 mg/kg of intravenous morphine is inadequate for pain relief (32-34). However, studies have shown that this drug can be used in patients without severe complications at standard doses for a long time (17). Also, for preventing of its abuse, the preparation and administration of this drug in hospitals has been controlled, which can delay its use (20). The study by Elsner et al. showed that although the achievement of favorable analgesia in the administration of subcutaneous morphine can be up to 24 minutes longer than intravenous (IV) use, there is no significant difference in analgesia derived from these two methods (35). However, due to the lack of the need for IV access in subcutaneous administration, this method can be useful in some cases (35).

- **Meperidine (Pethidine)**

Meperidine, like morphine, is one of the major opioids used in analgesia for admitted patients (36, 37); however, specialists suggest the use of morphine over meperidine due to less toxicity and greater efficacy (38-40). Morphine induces less nausea in parenteral use than meperidine (41). Also, several complications for this drug, even in regards to a cumulative dose, have been reported in young patients with normal renal function (40, 42, 43). It was assumed that, in contrast to meperidine, morphine causes more spasticity in the Oddi sphincter, so it is better not to use it in acute pancreatitis (44). Of course, there is no evidence to contraindicate the use of morphine for pancreatitis and gallbladder disease. Even Thompson suggests that morphine may be more beneficial than meperidine due to its prolonged analgesia and lower risk of seizures (45).

- **Fentanyl**

Fentanyl opioids are synthetic fat-soluble drugs that can remain in the body for up to 72 hours, depending on the type of administration (46).

Fentanyl is another opioid used in the ED, with an analgesic effect 100 times higher than morphine. IV fentanyl, compared with IV morphine, has a faster onset effect. However, its half-life is shorter, only around 30–60 minutes; therefore, it requires repeated doses for prolonged pain management (47, 48). The study of Parental et al. showed that IV fentanyl had no significant difference in reducing pain and side effects in comparison with IV morphine (47). Studies have shown that the use of fentanyl-based titration protocols in the ED can improve analgesia without increasing unwanted side effects (49, 50); consequently, it may be a good alternative to IV morphine (47). Studies have also shown that most patients prefer fentanyl to morphine due to fewer digestive tract complications (especially constipation) (46, 51-53).

Theoretically, the administration of IV opioid vs. the intranasal (IN) method due to the mechanism of drug absorption should have an onset of approximately 5 minutes faster. However, the results of some studies have shown that the analgesic effect of IV morphine is not significantly different from IN fentanyl (54). Due to the nature of the bioavailability of IN fentanyl and the absence of its passing through the liver and thus no effect of the first-pass liver metabolism, this drug can reach a therapeutic serum level within 2 minutes (55). In addition, due to the lack of a need for IV access, IN administration of fentanyl can be a better option than IV morphine in some instances (54).

- **Hydromorphone**

This semi-synthetic opioid is analogous to morphine and has a very similar chemical structure (56). In a study by Chang et al., it was found that, unlike morphine, EMPs are more comfortable using hydromorphone to control pain. This is probably due to the higher effectiveness of hydromorphone and therefore it is administered in a lower dose and this causes the physician to think there was a lower amount of prescribed opiate given to the patient (32). A recent Cochrane review also revealed that 32 studies had shown a positive effect of hydromorphone on acute pain relief (57).

- **Ketorolac**

In the United States and Europe, ketorolac injections are widely used as an injectable painkiller. It is commonly used because of the high analgesic power of ketorolac. In the control of acute pain, its analgesic effect is similar to injectable opioids such as morphine and pethidine (58). The absence of respiratory depression, the lack of dependence, and the long-lasting effect of relief are some of the most important advantages of ketorolac compared to injectable opioids. Also, ketorolac and injectable opioids have synergistic effects with each other and can reduce the necessary dose of opioids by simultaneous administration of injected ketorolac and opioids (59-61). Another study showed no significant difference in pain control with morphine or ketorolac. However, the simultaneous use of both reduces the need for rescue therapy. Complications were reduced in the morphine combined with ketorolac group (62). The results of the Victor study showed that pain relief after pethidine or ketorolac was significant, but the time to return to normal work after taking ketorolac was shorter (63).

- **Ibuprofen**

Many physicians believe that among the NSAIDs, ketorolac has more analgesic power than oral ibuprofen (64). However, a review of studies has shown that oral ibuprofen has a similar analgesic effect to parenteral ketorolac (65). On the other hand, studies have shown that ketorolac can cause significant bleeding after some surgical procedures such as post-tonsillectomy (66, 67). However, a Cochrane review showed that NSAIDs are not a significant factor in the incidence of bleeding (68). A study by Moss et al. showed that analgesia induced by injected ibuprofen not only reduced the need for opioid use in the opioid group but also reduced complications such as nausea (67). In contrast to the opiate and paracetamol drugs, ibuprofen has anti-inflammatory properties, which can play an essential role in limiting inflammatory cascades and reducing pain, especially after invasive procedures (67). It is clinically important to use this drug as an analgesic, especially in children, where the use of opiates can have more risks and complications (69).

- **Paracetamol**

Paracetamol is another medication that can be used in the ED that has fewer side effects and unwanted side effects than opioids and NSAIDs in therapeutic doses (70). Studies have shown that injected paracetamol can have similar analgesic effects to injectable NSAIDs in ED, as well to morphine in some painful procedures, such as wisdom tooth extraction (71-74). It is also frequently used after orthopedic surgeries (71, 75). According to Bektas et al., the analgesic effect of paracetamol may comparable with injected morphine in the treatment of renal colic (76). This drug can also be a good alternative to reduce the pain of patients undergoing heart surgery as compared with tramadol infusion (77). The other advantages of this drug is that it is easy to access and its cheapness in comparison with opiates (78, 79). Comparing paracetamol and NSAIDs and their combination, it has been shown that the addition of paracetamol to NSAIDs increases the effect of analgesia compared with the use of NSAIDs alone (70).

- **Ketamine**

Ketamine is another analgesic drug that has been used in clinical interventions for more than 30 years and can be administrated via IV, IN, intramuscular (IM), subcutaneous (SC), oral, rectal, transdermal, epidural and intrathecal routes (80-82). Clinical trials have shown that IN ketamine can have similar analgesic effects to IN fentanyl. Due to fewer complications, comparable duration of action, and ease of use can be a good choice for controlling pain in children (83-85). In particular, even after oral administration, it has an appropriate effect and few side effects in different age groups (86). Therefore, IN ketamine can be used in people who are contraindicated in taking fentanyl or other opioids (83). Ketamine can also be effective in preventing the immediate and delayed effects of hyperalgesia and acute tolerance effects due to the use of morphine and fentanyl (87).

- **Magnesium sulfate**

magnesium sulfate ($MgSO_4$) has various applications in the clinic, including the treatment of eclampsia and pre-eclampsia, hypokalemia, premature delivery, myocardial protection after ischemia, asthma crises, hemodynamic stability during intubation, and postoperative acute pain control (88-93). Several studies have indicated the analgesic effect of this drug, especially after surgery and shown it can reduce the need for fentanyl after therapeutic procedures (92, 94-97). It is also effective in increasing local analgesia when lidocaine is used and for relieving acute migraine attacks (98, 99).

Regional blocks

- **Femoral block**

In the elderly with a femoral bone fracture, using a block of nerve branches for analgesia can

significantly reduce the need for opioid use (100, 101). This analgesic technique, especially under ultrasound guidance, is easily carried out and lower compilations are associated (102). In addition, this method of analgesia in combat and disaster settings can be very suitable because it requires the use of a low dose of medication (103-105).

- **Hematoma block**

Distal radial fracture is the most common upper limb fracture in children and adults (106). Feeling a lot of pain during manual reduction, as well as a lot of stress and discomfort by the patient, can reduce the success of the intervention (107). Drug strategies to reduce pain during reduction include the use of short-acting benzodiazepines or propofol with or without opioids (108, 109). However, all of these medicines have their own side effects and limitations. Studies have shown that direct injection of analgesia into the fracture site, known as hematoma block, can be considered to be a more rapid and relatively less complicated method (110). The results of controlled trials in recent years have shown that hematoma blocks can have a strong effect on manual reduction of distal radial fractures and they involve fewer risks in comparison with systemic analgesics, a higher cost-effectiveness, and reductions in the time spent to achieve analgesia for interventions (107, 111-113).

- **Beir block**

Using IV regional anesthesia (IVRA) is a simple, reliable, and cost-effective method for local anesthesia for short-term procedures on limbs (114-116). Chan et al. acknowledged that this method is more beneficial and cost-effective compared to general anesthesia (117). Of course, some studies have reported the disadvantages associated with IVRA's analgesia. These include topical anesthetic toxicity, slow start of the sensory and motor block, poor muscle relaxation, tourniquet pain, and only short-term analgesia after the procedure, along with arrhythmia and cardiac arrest in the event of a human error, and possible neurological damage and compartment syndrome (118-123).

- **Axillary block**

In order to reduce the use of opioids, various methods of peripheral nerve blocking are used in upper limb procedures. The Instrascalene Brachial Plexus Block (ISB) is the most commonly used method for this purpose, because it can produce effective analgesia for 6 to 12 hours (124). However, this method is associated with a 100% probability of paralysis of the diaphragm and consequently, it is contraindicated in patients with underlying respiratory problems (125-127). In addition, this method can cause unwanted unilateral numbness and motor weakness (128). Price considered supra-scapular nerve blocks (SSNB) and axillary nerve blocks (ANB) as an alternative to ISB (129). However, studies by Pitombo et al. and Dhir et al. have shown that the efficacy of the ISB method is significantly greater than SSNB (130, 131). Checcucci et al. have shown that ANB can be an effective way to achieve analgesia but using ANB with SSNB has greater efficacy and patient satisfaction, and, if used correctly, can have fewer side effects than systemic analgesics (132).

- **Occipital block**

Studies have shown that large and small occipital nerve blocks can cause temporary headache relief (133, 134). Currently, the most effective treatment for cervicogenic headaches is blocking pain transfer through the greater occipital nerve (GON) and lesser occipital nerves (LON) (135). A study by Naja et al. showed that analgesia through the GON and LON blocks significantly reduced the need for the use of medications and systemic complications such as nausea, vomiting, appetite loss and recurrent pain (136). In the study by Ashkenazi and Young, GON block analgesia caused 89.5% relief of migraine in patients; the effect of this method on allodynia was also high and reported to be 100% (137). The success of this method for the relief of cluster headaches and drug-resistant cluster headaches has also been reported in some studies (138, 139).

- **Alveolar block**

The lower alveolar nerve block is the most common mandibular injection technique for analgesia in elective and emergency endodontic treatments. The study by Claffey et al. showed that analgesia using an inferior alveolar nerve block (IANB) with two lidocaine and articaine drugs did not have a significant difference (140, 141).

- **Intercostal nerve block**

Pain is the most common symptom of rib fractures, which can also reduce the respiratory effort and, consequently, reduce pulmonary compliance, atelectasis, and pneumonia (142). One of the appropriate anesthetic methods is an intercostal nerve block, which is an effective method that can increase lung compliance. Nevertheless, to reach the appropriate level of analgesia, it should be repeated every 4 to 6 hours, which can cause iatrogenic pneumothorax (143). This method is also used to relieve thoracotomy pain. However, the results have shown that its efficacy under the

best conditions is marginal and does not show a preference over a systemic narcotic (144). In addition, the usefulness of this method of analgesia in chronic pain syndrome has also been proven (145).

- **Periosteal Block**

In most patients, pain due to a fracture is induced by periosteal stimulation in the fracture site (146). Studies have shown that opioid receptors are present in the periosteum, and blocking them can have an analgesic effect (147-149). A study by Tageldin et al. showed that the use of a periosteal block in reduction of the distal radius fracture could be more effective than other analgesic methods, such as a hematoma block, neural network brachial block, or the use of systemic analgesics, and can have fewer side effects, a shorter hospital stay and greater patient satisfaction. Also, since the time and facilities needed to achieve the desired level of analgesia using this method are less than with other methods, it can be considered to be an effective action in initial emergency management (150).

Discussion

Non-opioids analgesics such as NSAIDS and acetaminophen are commonly used in the treatment of acute pain. However, the relief of acute moderate to severe pain usually requires opioid agents (151). The four primary parenteral opioids that are used in the treatment of acute pain in the ED are morphine, meperidine, fentanyl, and hydromorphone (32). Morphine and meperidine are the most common parenteral opioids used in the ED (152). Due to the short duration of action, fentanyl is primarily used for procedural sedation; hydromorphone is still not used extensively in the ED (32, 152).

NSAIDs are the other commonly used drugs, and although they are less effective during the first 10 minutes, they have an equal effect to opioids within 20–30 minutes and are well tolerated for short-term use (58, 153-155). Heldigit showed that pain control using NSAIDs is better than for morphine, and the need for rescue treatment and complications in NSAIDs is lower (156, 157). The anti-inflammatory effects of NSAIDs are due to inhibition of prostaglandins, which reduce the dilatation of the vessels, increase their permeability, increase diuretic effects on the kidneys, and increase pelvic pressure and the urine collection system (158). They also reduce swelling and inflammation and contractions of the ureter muscles. The gastrointestinal and renal side effects of NSAIDs have limited their use. However, their injectable generation such as ketorolac has minimized this complication (16).

Because of the side effects of systemic drugs and the restrictions on the use of analgesics, especially opioids, regional blocks of pain as part of a multimodal analgesic strategy, especially for fractures, joint reductions, complex lacerations, chest tube placement, and even paraphimosis reduction can be helpful (159-170).

With an increasing population and people's awareness and advancement of medical knowledge, selecting and proper use of pain killer medications are important. This is a great challenge for healthcare professionals because many patients in pain have complex conditions with multiple comorbidities and causes of pain.

Conclusions

This study was designed to investigate and identify the disadvantages and advantages of using each drug to be able to make the right choices in different clinical situations for patients while paying attention to the limitations of the use of these analgesic drugs.

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Authors' contribution

All authors passed four criteria for authorship contribution based on recommendations of the International Committee of Medical Journal Editors.

Conflict of interest

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