THE DENTAL CLINICS OF NORTH AMERICA

Dent Clin N Am 46 (2002) 707–717

Dental postoperative pain management in children

Anupama Rao Tate, DMD[a,*], George Acs, DMD, MPH[b]

[a]*Department of Dentistry, Children's National Medical Center, 111 Michigan Avenue Northwest, Washington, DC 20010, USA*
[b]*Department of Pediatrics, George Washington University School of Medicine, 2300 Eye Street Northwest, Washington, DC 20037, USA*

In the past 20 years nearly all healthcare professional groups have evolved their understanding of childhood pain. Surgeons, anesthesiologists, and nursing professionals have reassessed commonly held beliefs that children somehow differed from adults in their response to noxious stimulus and their need to relieve them of such stimuli, as may have accompanied invasive procedures [1]. During this time, significant controversies existed over the use of only paralytic drugs for general anesthesia techniques, the use of narcotic agents in postoperative management of children, and even preoperative and postoperative management of children undergoing circumcision [2].

Interest in pain control in children has blossomed over the past decade, but there remains an incongruity between pain management theory and clinical practice. Possible reasons for this difference include incorrect assumptions about pain and children, individual and social attitudes toward pain, and the complexity of assessing pain in children.

The pain experience in children is not necessarily a response to tissue damage. Children may experience pain in the absence of tissue injury and are also capable of experiencing multiple types of pain from the same injury because of the plasticity of a child's nociceptive system [3]. The child's pain system also allows the practitioner to modify the pain experience of the child. Many clinicians do not give serious consideration to postoperative pain relief for children because of the unfounded beliefs that children do not experience pain to the same degree as adults and that children are perceived to bounce back from painful procedures. Furthermore, in the weeks that

* Corresponding author.
E-mail address: atate@cnmc.org (A.R. Tate).

PII: S 0 0 1 1 - 8 5 3 2 (0 2) 0 0 0 2 8 - 9

elapse between invasive dental procedures and subsequent appointments, there is infrequent effort to query the child or parent about the post-treatment experience. The passage of time certainly serves to heal and forget.

There are many pain reducing strategies available to clinicians who are willing to accept that children do experience pain following dental procedures and can benefit from its relief. Strategies may include preoperative and postoperative approaches. Ultimately, pain assessment and its treatment in children should be an integral part of clinical practice for every dental professional.

Changing philosophy of pain management

The first studies of pain management in children found that children often did not receive any medication after surgery. In 1974, Eland conducted a study of 25 children after surgery, of which 16% had no prescription for pain medication after surgery, and 52% received pain medication [4]. In 1983, Mather and Mackie conducted a study with 170 children and also found that 16% did not have analgesic prescriptions for postoperative pain [5]. Over time the views about children and the need for postoperative pain management improved. By 1994, Asprey replicated Eland's 1974 study. With all 25 children matched by type of surgery and age, all children had a prescription for and received pain medication after surgery [6].

Historically, when comparing pain management in children with adults, children have been less likely to have narcotic medication prescribed. In 1968, in a 4-month study, Swafford and Allan reported that only 26 of 180 pediatric patients in the intensive care unit received narcotics and that no pain medications were given to children in the recovery room [7]. At the same time, however, 54 injections of pain medication were given to 107 adult patients in the recovery room in 1 week. In 1977, Eland and Anderson reported that 18 adults with identical diagnoses as 25 children who had surgery received 671 doses of pain medication, whereas the children received only 24 doses [4]. In 1983, Beyer studied postoperative pain management in 50 children and 50 adults after cardiac surgery. Six children received no pain prescriptions [8]. Overall, children were prescribed significantly fewer potent narcotics. During the observation period, children received 30% of all analgesic administrations, whereas adults received 70%. In 1992, Elander et al reported the mean number of pain medication doses administered to infants, children, and adults during the 5 days after heart surgery [9]. They reported that on average, infants had fewer doses (10 doses) when compared with children (15 doses) and adults (26 doses).

When researchers compared doses of analgesic prescribed it was noted that children often received subtherapeutic doses compared with adults. A study by Burokas in 1985 found that 38% of 40 children who had major surgery had subtherapeutic doses of analgesics prescribed and only two children received all the pain medication that had been prescribed [10].

Definition of pain

Pain is a highly personalized state accompanying tissue damage as a result of an adequate stimulus. It is a construct including an individual's past experiences, learned responses, and expectations in addition to species-specific physiologic responses. Pain may fluctuate in intensity and quality as a consequence of the passage of time. Pain is a signal of enormous biologic importance. A measure of the biologic and social importance of pain is evident in the more than 300 commercially available over-the-counter analgesics [11]. Physiologically, pain involves signals that are transmitted over specialized neural pathways. When these signals terminate, they induce a host of secondary responses that may become organized in the central nervous system. At the physiologic level, some of these responses involve further transmission of neural signals and the releases of neurotransmitters and humorally active chemicals (gamma-aminobutyric acid, GABA) and endogenous opioids [11].

The spinothalamic tract is the anatomic system designed for the central transmission of pain information. It is often thought of as a conduit for sensory messages from pain-specific receptors in the periphery. Two classes of afferent nerve fibers convey pain information. Small, lightly myelinated nerve fibers (A-delta class) carry afferent sensory information at 5–30 m/second. Unmyelinated C fibers, less than 2 μm in diameter, conduct at only 0.5–2.0 m/second. The cell body for all primary sensory afferents lies in the dorsal root ganglion, and the proximal axon segment enters the spinal cord to synapse. Substance P is believed to be the neurotransmitter for the C fibers. Physiologists often speak of two kinds of pain: fast pain and slow pain. Appreciation of a pinprick is rapid, quick to decay, and fairly localizable; this is followed by a persistent, noxious sensation that is usually more diffuse. Often, this is the pain that keeps people awake at night. The slow pain resides in the C fibers and the spinoreticular pathway [11].

In 1965 Melzak and Wall introduced the gate theory that was an important step forward in the understanding of pain control [12]. The gate theory proposed that a gate control system modulated sensory input from the skin before it evoked pain perception and response. The gate theory suggests that pain phenomena are determined by interactions among different neurologic systems. Control over transmission is postulated to be affected by the afferent impulses acting on a gating mechanism and by impulses descending from the brain. Impulses in large diameter fibers were assumed to decrease the effectiveness of afferent volleys, whereas small afferents increase it. The substantia gelatinosa was suggested as the actual control mechanism and the presynaptic terminals of afferent fibers as the site of action. It was also proposed that the signal that triggered the action system responsible for pain perception and response occurred when the output of transmission cells reached or exceeded a preset threshold level. Since the introduction of this theory, revisions have been made in recognition of new or better understanding of physiology. Perhaps the most significant addition to the gate control theory is a level of control that is proposed to be through higher central nervous system processes, such as the evolution of input in past experiences, that may exert control over activity in discriminative and motivational systems. Melzack clearly stated that physiologic processes alone are inadequate to explain the perception of pain. Their work lead to investigations into the "emotional" components involved in the perception of pain [13].

A major advance in the understanding of pain came in 1975 when the mechanism of narcotic analgesia became better understood. Derivatives of the opium poppy such as morphine have been available for the relief of pain since the mid-nineteenth century. The discovery of the opiate receptor lead to the discovery of endogenous opiates such as the enkephalins and endorphins. The receptor-mediated effect helped in the understanding of the relationship of morphine and reversal agents such as naloxone [11].

Children and pain

Numerous lines of evidence suggest that even in the human fetus, pain pathways and cortical centers necessary for pain perception are well developed late in gestation. Anand showed in 1987 that marked nociceptive activity clearly constitutes a physiologic and perhaps even a psychologic form of stress in neonates [14]. Studies suggest that developmental changes in response to painful stimuli occur early in infancy. In fact, anticipatory fears of sharp objects can be seen in children approximately 1 year of age [15]. As a child matures, develops a broader vocabulary, and witnesses a variety of environments, the ability to communicate feelings becomes increasingly adept and sophisticated. In general, pain sensitivity increases and self-management of pain becomes more effective with increasing age [16].

It was not until recently that the dental literature started to discuss the presence of pain and its management in children. In 1986, Acs reported that 37.6% of children ages 6 to 13 years reported postoperative pain after having dental extractions [17]. In 1992, in a more broad study evaluating dental postoperative pain in children, 31.5% of the children treated reported pain following routine restorative dentistry procedures. There were no age-related differences in the report of pain, and female patients were significantly more likely to report pain following invasive restorative treatment [18].

The extent of injury caused by the surgical procedure is also a key factor in evaluating the need for postoperative pain management [19]. In 1988, a postextraction pain study in children indicated that as the "degree of difficulty," as measured by the amount of remaining unresorbed root structure of the extracted tooth increased, the report of pain increased. Therefore the dentist may consider the number of teeth extracted together with the degree of difficulty in determining the potential for postextraction pain and the need for analgesia [20].

Local anesthetics

Local anesthesia has been important to "painless" dentistry ever since cocaine local anesthesia in 1886 and procaine in 1904 were introduced. In the 1940s a new group, the amides, were introduced [21]. The first amide, lidocaine, changed the course of pain management in dentistry worldwide. The primary role of local anesthetic is to block the propagation of nerve impulses. Each anesthetic varies in its potency, onset time, and duration of action. Procaine has the lowest intrinsic potency; lidocaine, prilocaine, and mepivacaine have intermediate potency. Duration of anesthesia is one of the most important clinical properties to consider when choosing an appropriate agent. Lidocaine and prilocaine (with epinephrine) have an intermediate duration of 60–90 minutes of pulpal anesthesia and 3–5 hours of soft tissue anesthesia. Mepivacaine plain is often reported to have a shorter duration of soft tissue anesthesia, although a recent investigation suggests that anesthetic duration of mepivacaine plain and lidocaine with epinephrine are nearly identical [22].

A study done by Kohli surveyed pediatric dentists about their use of local anesthetics; 83% of the responding dentists stated that lidocaine was used most often, whereas mepivacaine was used most frequently by 11% of the dentists [23]. Articaine was first prepared in 1969, and recent reports by Wright show articaine's excellent pediatric safety and efficacy profile [24]. A study done by Malamed in 2000 comparing lidocaine with articaine indicated that articaine was a safe and effective local anesthetic in children. Articaine 4% with epinephrine 1:100,000 was demonstrated to have a time to onset and duration appropriate for clinical use in children, although no significant difference in pain relief was observed between articaine and lidocaine [21]. Previous reports of longer pulpal anesthesia and duration of articaine with vasoconstrictor when compared with lidocaine with vasoconstrictor have not been demonstrated [25]. Articaine has recently been approved for use in the United States and may be considered part of the armamentarium for use with pediatric dental patients in appropriate cases.

Analgesics

Since its introduction in 1899, aspirin, a salicylate, has been used widely for its analgesic, antipyretic, and anti-inflammatory properties. The most significant side effects of aspirin include alteration of coagulation by inhibition of platelet aggregation. The anticoagulation properties of aspirin are rarely a problem for children; however, because a single dose can increase bleeding time, aspirin should not be used before any surgical procedure. The possible association of aspirin with certain viral illnesses and the development of Reye syndrome has resulted in many practitioners opting for aspirin substitutes [16].

Acetaminophen is the most common analgesic used in pediatrics in the United States. Unlike aspirin it does not inhibit platelet function and causes less gastric upset. The primary disadvantage is that it has no clinically significant anti-inflammatory properties. Toxicity as a result of overdose may result in acute liver failure. Allergic reaction is rare [16].

The newer nonsteroidal anti-inflammatory drugs (NSAIDs) are principally derivatives of phenylalkanoic acid and exert their analgesic effects peripherally by inhibiting prostaglandin synthetase. These agents possess analgesic and anti-inflammatory properties that are superior to those of aspirin and are effective for the treatment of acute pain following minor surgery or trauma [16]. Ketorolac tromethamine and ibuprofen are common examples of NSAIDs. In 1987, McGraw studied the efficacy of ibuprofen suspension and acetaminophen elixir in children after dental extractions. The ibuprofen elixir was superior in the management of postextraction pain in children [26]. Most pain associated with dental procedures is inflammatory in nature; therefore usually agents with anti-inflammatory properties are most desirable for the treatment of dental pain.

Tramadol hydrochloride is a synthetic, centrally acting analgesic agent with spinal and supraspinal sites of action. Tramadol has been found to be effective and well-tolerated when administered postoperatively to children older than 1 year of age. Its negligible effect on respiration, despite equi-analgesic potency to morphine shown in adults would suggest that tramadol offers advantages over traditional opioids such as morphine for the relief of postoperative pain in children [27]. Pendeville reported on the post-tonsillectomy use of tramadol drops (2.5 mg/kg) versus acetaminophen suppositories (15 mg/kg) in children and showed postoperative pain scores to be significantly lower in patients managed with tramadol [28]. Roelose studied preoperative tramadol efficacy in children following multiple dental extractions. In children 4–6 years of age, 19.4% of the tramadol group required postoperative agents, compared with 82.8% of the placebo control group [29]. As further studies validate the pediatric use of tramadol, its use might increase.

Recent literature suggest that the preoperative administration of an analgesic, rather than the traditional postoperative use on an as-needed basis, was more effective in reducing postextraction pain, because the drug preceded rather than followed the inflammatory response and subsequent pain [30–32]. In 1995, however, Primosch compared preoperative ibuprofen, acetaminophen, and placebo administration on the parental report of postextraction pain in children [33]. Although there was a trend toward reduced postextraction pain reported by the parents, the preoperative administration of neither analgesic was found to be statistically superior to the placebo in children.

Narcotic analgesia such as opioids has been shown to act on opioid receptors in the central nervous system. These actions result in analgesia, sedation, and cough suppression. They carry the serious drawback of respiratory depression. Codeine is the standard oral narcotic used most commonly in children for moderate to severe pain. It is indicated for severe pain that is not responsive to acetaminophen or NSAIDs. Codeine is best used when combined with optimum analgesic doses of acetaminophen or ibuprofen. When choosing an analgesic agent in the management of postoperative dental pain in children, it is rare that the recommended dose of acetaminophen or NSAIDs does not control the dental pain. In fact, in a study evaluating the use of postextraction analgesics in children, few reported severe pain. In that study, when pain was reported, it was equally well relieved by ibuprofen or acetaminophen with codeine [34]. The combination of codeine and acetaminophen usually provides the needed relief in the rare cases when acetaminophen and NSAIDs are not sufficient to manage the pain. Rarely is the pain refractory to these agents; in these limited cases meperidine may be indicated [16].

Recommendations

The pain experience often determines whether an individual seeks or avoids healthcare. The thoughtful management of pre- and postoperative pain can increase the use of dentistry for routine care.

The first goal of the caregiver should be management of preoperative fears and anxieties. Acs reported on the effect of age and postoperative pain reporting. When comparing children of different ages, 6–9 years versus 10–13 years, it has been seen that the older group reports pain more frequently, yet the use of analgesic agents is the same for both groups. The report of postoperative pain is therefore tied to the mental awareness that comes from maturity. The postoperative pain of these older children is also affected by their past experiences and fears and even the expectations of their parents. The use of preoperative antianxiolytics, such as nitrous oxide and midazolam, can be helpful for children. Nitrous oxide can play a role in modifying perception of fear that may be related to anticipation of pain. This heightened preoperative perception of pain can affect postoperative pain relief needs; therefore the use of preoperative antianxiolytics can be critical to a pain management protocol. The use of these drugs should reduce the anxiety by decreasing awareness of the patient during the procedure. In addition, the appropriate use of topical and local anesthesia is critical for the management of pain during the procedure and after.

The selection and dosage of analgesics varies because of the changes in body weight and composition that occur throughout childhood. The first choice in most cases is the least potent analgesic with the fewest side effects. When postoperative pain is expected in young children, the analgesic agent should not be given on an "as needed" basis because of the difficulty in childhood reporting of pain. Table 1 shows common pediatric pain management agents and the appropriate dosage schedule. All medications should be prescribed in sufficient dosage and for an adequate duration to alleviate postoperative pain for the child. By being familiar with the duration of the

Table 1
Medications and dosage for oral pediatric postoperative pain management

Medication	Availability	Dosage	40 lb child	80 lb child
Acetaminophen	Elixir 160 mg/5 cc 325-mg tabs, 160 mg chewable	10–15 mg/kg/dose given at 4–6 h intervals	160 mg = 1 tsp 160 mg = 1 chewable	325 mg = 1 tab 320 mg = 2 chewables
Ibuprofen	Suspension 100 mg/5 cc 200-,300-,400-, 600-,800-mg tabs	4–10 mg/kg/dose given at 6–8 h intervals	100 mg = 1 tsp	200 mg = 2 tsp 200 mg = 1 tab
Tramadol	50 mg, 100 mg tabs	1–2 mg/kg/dose given at 4–6 h intervals—maximum: 100 mg	25 mg = ½ tab	50 mg = 1 tab
Codeine and acetaminophen	Suspension 12 mg/ 5 cc	0.5–1.0 mg codeine/kg/dose given at 4–6 h intervals	12 mg = 1 tsp	24 mg = 2 tsp
Meperidine	Syrup 50 mg/5 cc 50-mg, 100-mg tabs	0.5–0.8 mg/lb given at 4–6 h intervals	25 mg = ½ tsp	50 mg = 1 tsp

local anesthetic, the dentist can advise the parent to administer any analgesics before loss of local anesthesia-induced analgesia.

The practitioner should choose their pre- and postoperative pain management plan based on the type of procedure done. Table 2 categorizes common pediatric dental procedures based on their invasiveness. In general, pediatric dental procedures range from simple operative not requiring local anesthesia to the extraction of abscessed permanent teeth. Each case should be considered individually. For simple restorative dental procedures, one might choose a shorter-acting local anesthetic to reduce the chance of postoperative soft tissue damage by cheek or lip biting, although clinical research has not proven this relationship to be true. The use of a quick onset local anesthetic with shorter duration is appropriate when there is little anticipation for postoperative discomfort. Additionally, quick onset provides potential practice efficiencies. When considering lengthy procedures such as stainless steel crown and pulpotomies, the use of nitrous oxide and an intermediate duration anesthetic followed by ibuprofen might be indicated.

Table 2
Dental postoperative pain management protocol

	Local anesthesia	Preoperative medication	Postoperative medication[a]
Restorative procedures			
Simple operative	None		Acetaminophen
Operative	Mepivacaine/ articaine/lidocaine		Acetaminophen
Complex—SSC/pulp	Articaine/lidocaine		Acetaminophen
Extractions			
Primary, nonabscessed	Articaine/lidocaine		Ibuprofen
Primary, abscessed	Articaine/lidocaine		Ibuprofen
Multiple primary	Articaine/lidocaine	Ibuprofen	Acetaminophen or ibuprofen
Permanent teeth, Ankylosed teeth	Articaine/lidocaine	Ibuprofen	Acetaminophen with/without codeine

[a] Additional risk factors, such as patient age, previous report of pain, or use of analgesics should be considered before the decision to prescribe any analgesics is made.

More invasive procedures, such as extractions, should be categorized and considered based on the degree of difficulty of the procedure. Simple extraction of nonabscessed primary teeth with only half of the root structure remaining likely does not require the same management compared with the extraction of multiple abscessed primary teeth. In emergent cases there is often no opportunity to give preoperative analgesics; however, if one is going to extract multiple nonabscessed teeth then the use of preoperative ibuprofen might help alleviate or minimize the postoperative pain. Although the adult oral surgery literature supports treatment protocol that uses presurgical nonsteroidal anti-inflammatory agents, there is no evidence that such protocols are necessary in the pain management of children undergoing dental extractions [32,33].

It has been reported that 17% of children undergoing invasive restorative treatment and 22% of children needing tooth extraction require postoperative analgesia [18]. Studies have shown that children feel pain much the same way as adults and experience the need for postoperative pain management. It is also known that pain medications alleviate pain successfully in children. Therefore, one must have a plan for pain management in all pediatric patients. It is recognized that in a dental setting most pediatric procedures are less invasive or extensive compared with adult procedures. One must start with the unquestioned effectiveness of any administered local anesthesia, with sufficiently long lasting duration. In addition, instructions must be clearly given to the caregiver regarding postoperative medication. One should also note that certain factors may affect the need for postoperative medication: extent of invasiveness of procedure, age of the patient, and child's past pain history, along with parental expectations for pain.

Summary

Misconceptions about the need for pain management in pediatric patients have been shown to be wrong. We now understand that children feel pain and respond to pain medication in much the same way as adults. With this new understanding, practitioners must recognize all the factors that affect the feeling of pain. Pain can be variable and each patient brings a unique set of characteristics to be evaluated. The first objective should be to assess the patient's previous treatment history, medical condition, extent of treatment needed, and age. An effective pain management protocol begins with preoperative pain and anxiety control, with the use of agents such as nitrous oxide and local anesthetics. Postoperative pain medication should be given at the correct dosage and time intervals for the appropriate duration. With our commitment to pain management in children, these protocols should easily translate into improved clinical practice.

References

[1] Helgadottir HL. Pain management practiced in children after surgery. J Pediatr Nurs 2000;15(5):334–40.

[2] Walco GA, Cassidy RC, Schechter NL. Pain, hurt, and harm—the ethics of pain control in infants and children. N Engl J Med 1994;331(8):541–4.

[3] Barrett EJ. Pain management for children. Ont Dent 1997;74(8):34–6.

[4] Eland JM, Anderson JE. The experience of pain in children. In: Jacox A, editor. Pain: a source book for nurses and other health professionals. Brown & Compan: Boston: Little; 1977. p. 453–76.

[5] Mather L, Mackie J. The incidence of postoperative pain in children. Pain 1983;15:271–81.

[6] Asprey JR. Postoperative analgesic prescription and administration in a pediatric population. J Pediatr Nurs 1994;9(3):150–7.

[7] Swafford LI, Allan D. Pain relief in the pediatric patient. Med Clin N Am 1968;52(1): 131–6.

[8] Beyer JE, Degood DE, Ashley LC, Ressell GA. Pattern of postoperative analgesic use with adults and children following cardiac surgery. Pain 1983;17(1):71–81.

[9] Elander G, Hellstrom G. Analgesic administration in children and adults following open heart surgery. Scand J Caring Sci 1992;6:17–21.

[10] Burokas L. Factors affecting nurses' decision to medicate pediatric patients after surgery. Heart Lung 1985;14(4):373–9.

[11] Sudarsky L. Pathophysiology of the nervous system. Boston: Little, Brown & Company; 1990. p. 79–91.

[12] Melzack R, Wall PD. Pain mechanisms: a new theory. Science 1965;150:971.

[13] Melzack R, Casey KL. Sensory, motivational and central control determinants of pain: a new conceptual model. In: Kenhalo D, editor. The skin sense. Spingfield (IL): Thomas; 1968.

[14] Anand KJS, Phil D, Hickey PR. Pain and its effect in the human neonate and fetus. N Engl J Med 1987;317(21):1321–9.

[15] Barr RG. Pain in children. In: Wall PD, Melzack R, editors. Textbook of pain. New York: Churchill Livingstone; 1989.

[16] Pinkham JR. Pediatric dentistry. In: Pinkham JR, Fields Jr HW, editors. Infancy through adolescence. 2nd edition. Philadelphia: WB Saunders Company; 1994. p. 98–105.

[17] Acs G, Moore PA, Needleman HL, Shusterman S. The incidence of post-extraction pain and analgesic usage in children. Anesth Prog 1986;33:147–51.

[18] Acs G, Dranzner E. The incidence of postoperative pain and analgesic usage in children. ASDC J Dent Child 1992;59:48–52.
[19] Levine JD, Gordon NC, Smith R, Fields HL. Post-operative pain: effect of extent of injury and attention. Brain Res 1982;234:500–4.
[20] Acs G, Moore PA, Shusterman S, Needleman HL. The extent of trauma and post-extraction pain in children. Pediatr Dent 1988;10(3):210–4.
[21] Malamed SF, Gagnon S, Leblanc D. A comparison between articaine HCL and lidocaine HCL in pediatric dental patients. Pediatr Dent 2000;22(4):307–11.
[22] Hersh EV, Hermann DG, Lamp CL, Johnson PD, MacAfee K. Temporal assessment of soft tissue anesthesia following mandibular block injection. J Am Dent Assoc 1995;126: 1531–5.
[23] Kohli K, Ngan P, Crout R, Linscott CC. A survey of local and topical anesthesia use by pediatric dentists in the United State. Pediatr Dent 2001;23(3):265–9.
[24] Wright GZ, Weinberger SJ, Friedman CS, et al. The use of Articaine local anesthesia in children under 4 years of age—a retrospective report. Anesth Prog 1989;36:268–71.
[25] Malamed SF, Gagnon S, Leblanc D. Articaine hydrochloride: a study of the safety of a new amide local anesthetic. J Am Dent Assoc 2001;132(2):177–85.
[26] McGraw T, Raborn W, Grace M. Analgesics in pediatric dental surgery: relative efficacy of aluminum ibuprofen suspension and acetaminophen elixir. J Dent Child 1987;54:106–9.
[27] Bosenberg AT, Ratcliffe S. The respiratory effects of tramadol in children under halothane anaesthesia. Anaesthesia 1998;53(10):960–4.
[28] Pendeville PE, Von Montigny S, Dort JP, et al. Double-blind randomized study of tramadol vs paracetamol in analgesia after day-case tonsillectomy in children. Eur J Anaestesiol 2000;17(9):576–82.
[29] Roelofse JA, Payne KA. Oral tramadol: analgesic efficacy in children following multiple dental extractions. Eur J Anaestesiol 1999;16(7):441–7.
[30] Jackson JL, Moore PA, Dionne RA, Hargreaves KM. Prophylactic ibuprofen for the prevention of postoperative dental pain. J Am Dent Assoc 1989;119:641–7.
[31] Moore PA, Werther JR, Seldin E, Stevens CM. Timing of preoperative and postoperative analgesics for third molar surgery. J Am Dent Assoc 1986;113:739–44.
[32] Dionne RA, Cooper SA. Evaluation of preoperative ibuprofen for postoperative pain after removal of third molars. Oral Surg 1978;45(6):851–6.
[33] Primosch RE, Nichols DL, Courts FJ. Comparison of preoperative ibuprofen, acetaminophen, and placebo administration on the parental report of postextraction pain in children. Pediatr Dent 1995;17(3):187–91.
[34] Moore PA, Acs G, Hargreaves JA. Postextraction pain relief in children: a clinical trial of liquid analgesics. Int J Clin Pharmacol Ther Toxicol 1985;23(11):573–7.