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MULTIMODAL ANALGESIA IN PERIOPERATIVE SETTINGS: IMPROVEMENT PERSPECTIVES

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The aim of this study was to evaluate the intensity of pain in orthopaedic hospital patients and to identify unsatisfactory pain management and possibilities for improvements in the future. Data collection included Numeric Rating Scale (NRS) scores, which characterised the intensity of pain. Maximum pain on the day of surgery, mean pain on the day of surgery (D0), and mean pain on first (D1) and second (D2) postoperative days were documented. The pain of an intensity from 0 to 3 was defined as mild pain, 4 to 6 as moderate pain, and 6 to 10 as severe pain. Maximum severe pain intensity on the day of surgery was experienced by 20.5% of patients, moderate by 45.8%, and mild by 33.6%. The reported mean pain intensity according to type of surgery was as follows: hip replacement— 2.79 ± 1.6 (D0), 2.09 ± 1.4 (D1), and 1.35 ± 1.2 (D2); knee replacement — 3.39 ± 1.7 (D0), 2.98 ± (D1), 1.82 ± 1.36, and (D2); upper extremity surgery — 3.59 ± 1.9 (D0), 3.4 ± 1.7 (D1), and 2.1 ± 1.5 (D2); lower extremity surgery — 4.1 ± 2.1 (D0), 3.49 ± 1.42 (D1), and 2.58 ± 1.4 (D2); spine surgery — 3.31 ± 1.58 (D0), 2.88 ± 1.96 (D1), and 1.83 ± 1.74 (D2). Patients in the lower extremity group experienced unacceptable mean pain. The maximum pain intensity on day of surgery was experienced by patients after single-shot plexus brachialis block anaesthesia (5.24 ± 2.4). Well-designed multimodal analgesia with special attention to single shot techniques may improve pain management and functional outcomes after orthopaedic surgery.

Key words: *orthopaedic surgery, multimodal analgesia, pain.*

INTRODUCTION

Postoperative pain management is of great importance in orthopaedic surgery. However, pain control can be complex due to the diversity of pain management options and specific groups of patients with different pain control needs after various orthopaedic procedures (Gandhi *et al.*, 2009; Sinatra *et al.,* 2010; Ekstein *et al.*, 2011; Parvizi *et al.*, 2013). Total knee replacement requires around 50 days for rehabilitation, and it may take even much longer with inadequate pain control (Gandhi *et al.,* 2009). Generally, pain remains under-treated (Apfelbaum *et al.*, 2003; Joshi *et al.*, 2005; Cullen *et al.*, 2009; White *et al.,* 2010). If the pain is treated insufficiently, it brings major consequences: longer recovery time, late mobilisation, more surgery-related complications, prolonged stay in the hospital, chronic pain development, etc. (Apfelbaum *et al.*, 2003; Ashburn *et al.,* 2010). It is well known that the current guidelines insist on a humanitarian need to reduce pain and suffering, and poor pain control can adversely affect outcomes. Patients are more knowledgeable about new forms of pain therapy. Hospitals in the European Union and worldwide are being rated on how well or poorly they manage pain and the quality of pain management they provide (Taylor *et al.,* 2010; Crews *et al.,* 2013; Eldor *et al.*, 2013).

The actual practice of pain control in many Latvian medical institutions often consists of singular intramuscular or intravenous drug strategies in the case of severe pain. This may lead to significant patient deterioration. Using non-steroidal anti-inflammatory drugs (NSAIDs) or opioids alone intensifies their familiar side effects: gastrointestinal pain, bleeding, healing problems from NSAIDs, and respiratory depression (up to 2%), pruritus (up to 18%), postoperative nausea and vomiting (up to 30–50%) from narcotics

Table 1

PAIN CONTROL DRUGS AND THEIR ACTION SITES

Location	Medication
Site of surgical incision	Local anaesthetics, NSAIDs, COX2 inhibitors, ice
Peripheral nerves, joints	Local anaesthetics, steroids
Spinal Cord	Local anaesthetics, opioids, anticonvulsants, α2-agonists; NMDA antagonists
Central nervous system	Opioids, anticonvulsants; α2-agonists; NMDA antagonists, paracetamol, NSAIDs, steroids

(Wheeler *et al.*, 2002; Oderda *et al.*, 2007; Horlocker *et al.,* 2010).

Multimodal pain treatment consists of a combination of multiple analgesics and techniques in the perioperative period. Pain control may be achieved with a combination of drugs used during the preoperative, intra-operative (opioids, local anaesthetics) and post-operative (opioids, NSAIDs, cycloxygenase-2 (COX-2) inhibitors, paracetamol, opioids, local anaesthetics, steroids, α2-gamma-ligands, N-methyl-D-aspartate (NMDA) antagonists, etc.) periods (Buvanendran *et al.*, 2007, 2009; Gandhi *et al.*, 2009) (Table 1).

A number of studies have established the effectiveness of multimodal techniques for postoperative analgesia, and large-scale meta-analyses found significantly improved pain control, lower narcotic consumption and fewer side effects resulting from such techniques.

The American Society of Anaesthesiologists (ASA) recommends the use of multimodal pain management therapy: patients should receive an around-the-clock regimen of COX2 inhibitors, NSAIDs, or paracetamol (Ashburn *et al.,* 2010). The American Society for Pain Management Nursing recommends for nurses to be strong advocates of pain management plans that incorporate opioid dose-sparing strategies initiated early in the course of treatment, even before the surgery. Multimodal analgesic therapy that combines opioids with paracetamol, NSAIDs, anticonvulsants and antidepressants has proven efficacy in the treatment of pain (Jarzyna *et al.,* 2011). The Society of Critical Care Medicine (SCCM) suggests that non-opioid analgesics should be considered to decrease the amount of opioids administered or to eliminate the need for IV opioids altogether (Barr *et al.,* 2013). The Joint Commission (TJC) recommends a multimodal approach, which combines strategies such as psychosocial support, coordination of care, promotion of healthful behaviours, non-pharmacologic approaches and non-opioid pain medications (Anonymous, 2012).

In addition to the principles of multimodality, we can use pre-emptive strategies for the management of pain: patient education to expect some pain after surgery; individualised care, taking into account each patient's pain threshold; nurse assistance; and decreasing reliance on narcotics (Ashburn *et al*., 2010). However, even protocols for multimodal analgesia and catheter protocols cannot completely solve the problem of unsatisfactory pain control after surgical procedures (Elia *et al.,* 2005). In spite of diverse multimodal analgesia protocols designed for surgery, up to 30 % of patients were observed to have NRS pain scores ≥ 6 for 24 hours postoperatively (Azim *et al.,* 2013).

We performed a survey among patients undergoing different kinds of orthopaedic surgery in different areas. We divided the respondents by their primary area of surgery: total hip or knee replacement, upper extremity procedures, lower extremity procedures and spine surgery.

Pain management guidelines have been developed by the senior anaesthesiologists of the department, although their use cannot guarantee any special results in pain management. They just provide basic recommendations for different orthopaedic procedures based on the analysis of current literature and expert opinion. The guidelines may be revised as a result of the current study.

Anaesthesiologists performing analgesia should ensure effective and safe use of the treatment options available within a medical institution. Doctors are familiar with simple and sophisticated pain management techniques, including epidural analgesia, various peripheral nerve and *plexus* catheters, and patient-controlled regional and intravenous analgesia. Anaesthesiologists, surgeons and ward nurses should be able to control pain intensity corresponding to different pain intensity scales, evaluate and document pain intensity, and switch to a better pain management approach in cases of unsatisfactory analgesia (Sinatra *et al.,* 2002).

Our research was aimed at identifying problems associated with postoperative analgesia from two viewpoints: unsatisfactory pain management according to surgical procedure and analgesia protocols. This information will be further used to determine the critical areas where development and improvement of procedure is needed, along with education.

MATERIALS AND METHODS

After receiving approval from the Ethical Committees of the Hospital of Traumatology and Orthopaedics (Latvia) and Rīga Stradiņš University, and signed patient informed consent forms, 262 male and female patients scheduled for orthopaedic procedures in the period from January 2014 to May 2014 were randomly included in the study.

The survey was performed by 5th year anaesthesiology residents with assistance of nurses from the orthopaedic department and a survey consultant in the framework of acute pain service education.

Patients with a history of use of narcotic medications, history of postoperative nausea and vomiting (PONV), allergic reaction to the drugs and with deviations from the analgesia protocol used in the study were excluded from the study. Patients who refused analgesia offered were excluded as well. The study protocol and the Numeric Rating Scale (NRS) for pain intensity were explained to each patient during the visit.

Table 2

ANAESTHESIA/ANALGESIA PROTOCOLS ACCORDING TO THE TYPE OF SURGERY

Type of surgery	Anaesthesia regimen	Analgesic drugs	Rescue analgesic (VAS 4)
Hip replacement	SA + i/t morphine	PCT+COX-2/NSAID or PCT+metamizol	Morphine
Knee replacement	SA+ EA, SA+FNB	PCT+COX-2/NSAID or PCT+metamizol	Morphine
Upper extremity procedures	PBB+GA	PCT+COX-2/NSAID or PCT+metamizol	Morphine
Lower extremity procedures	SA	PCT+COX-2/NSAID or PCT+metamizol	Morphine
Spine procedures	GA	Phenthanyl infusion PCT+COX-2/NSAID or PCT+metamizol	Morphine

SA, spinal anaesthesia; i/t, intrathecal; EA, epidural anaesthesia; FNB, femoral nerve block; PBB, *plexus brachialis* block; GA, general anaesthesia; PCT, paracetamol; COX2, cycloxygenase inhibitors 2; NSAIDs, non-steroidal anti-inflammatory drugs.

All patients were pre-medicated with oral midazolam 3.75 mg 30–60 min before the surgery. In the operating room, an intravenous cannula was inserted and Ringer's lactate was infused. Electrocardiogram, pulse oximetry, and non-invasive arterial blood pressure measurements were performed at 5 min intervals. Surgical analgesia and postoperative analgesia were chosen according to the institutional guidelines: spinal analgesia with intrathecal morphine for hip replacement or without it for lower extremity procedures, combined spinal-epidural analgesia or spinal analgesia combined with femoral nerve block for knee replacement surgery, general anaesthesia followed by fentanyl infusion for spine procedures, single-shot *plexus brachialis* anaesthesia combined with general anaesthesia for upper arm and shoulder procedures.

All patients received multimodal oral analgesics, including NSAIDs or COX2 inhibitors, paracetamol, metamisol alone or in combination with opioid analgesics, peripheral nerve or *plexus* blockades, epidural analgesia or peripheral nerve catheters (Table 2).

Patients were asked to describe the maximum pain level in the evening of the surgery, and their pain intensity was recorded corresponding to the NRS (Numeric Rating Scale) score four times a day. The data collection forms included demographic data, NRS pain scores from the post-anaesthesia care unit (PACU), and those reported by the patients four times a day until the 3rd postoperative day.

The maximum pain intensity on the day of surgery, mean pain on the day of surgery (DO) and mean pain on the first (D1) and second (D2) postoperative days (if the patient still stayed in the hospital) were documented. Pain with intensity from 0 to 3 was defined as mild pain, from 4 to 6 – as moderate pain, and from 6 to 10 — as severe pain (Fig. 1).

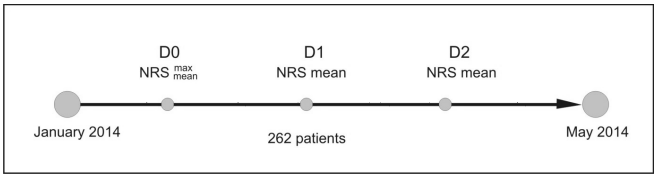

Fig. 1. Flowchart of the study design. D0, surgery day; D1, first postoperative day; D2, second postoperative day; NRS, Numeric Rating Scale.

The data were entered into an electronic database (Microsoft Excel 2010) and exported to Statistical Package for the Social Sciences (SPSS) software for processing and analysis. As our clinical intention was to maintain the pain score at ≤ 4, we divided the patients into three groups: low pain group (0–3), moderate pain group (4–6), and severe pain group (7–10). The groups defined by surgery type and anaesthesia/analgesia type were then compared in regard to differences in the NRS pain scores over time using Repeated-Measures Analysis of Variance (ANOVA). *P* values below 0.05 were considered significant.

RESULTS

The pain management survey was completed for 262 patients. The study population consisted of 165 (63%) female and 97 (37%) male patients. Ninety-five (36.3%) patients were undergoing hip replacement surgery, 56 (21.4%) — knee replacement surgery, 58 (22.4%) — upper extremity surgery, 37 (14.1%) — lower extremity surgery, and 22 (8.4%) — spine surgery. The distribution according to the type of surgery generally corresponded to the patient population in the hospital during the given period of time. Since patients were selected at random, we may conclude that there is a prevalence of female patients in the Hospital of Traumatology and Orthopaedics (Table 3).

From all patients included in the study, the maximum pain intensity on the day of surgery (at least once) was described as severe by 20.5%, as moderate by 45.8%, as mild by 33.6%. The frequency distributions of average NRS pain scores from all patients demonstrate that 56.5% of patients had average NRS pain scores < 4 (mild pain) and 38.5% had average NRS pain scores from 4 to 6 (moderate pain) and only 5% had pain scores more than 6 (severe pain) on the day of surgery (D0) ($p < 0.05$). The frequency distributions of the average NRS pain scores from all patients demonstrate that 69.1 % of the patients had average NRS pain

Table 3

PATIENT CHARACTERISTICS

Type of surgery	Age (years ±SD)	Sex (m/f)
Hip replacement	64.7 ± 13.4	56/40 (58.9/41.1)
Knee replacement	68.77 ± 9.94	40/16 (71.4/28.6)
Upper extremity surgery	58.76 ± 17.03	41/17 (70.7/29.3)
Lower extremity surgery	58.46 ± 20.19	20/17 (54.1/45.9)
Spine surgery	54.44 ± 15.21	8/8 (50.0/50.0)
All	61.05 ± 13.15	165/97 (63/37)

scores < 4 (mild pain) and 29% had average NRS pain scores from 4 to 6 (moderate pain) and only 1.9% had average pain scores more than 6 (severe pain) on the day after surgery (D1) ($p < 0.05$). The frequency distributions of the average NRS pain scores from all patients showed that 80.2% of the patients had average NRS pain scores < 4 (mild pain) and 14.1% had average NRS pain scores from 4 to 6 (moderate pain) and none had scores more than 6 (severe pain) on the day after surgery (D2) ($p < 0.05$).

The reported mean pain intensities according to the type of surgery were as follows: for hip replacement – 2.79 ± 1.6 (D0), 2.09 ± 1.4 (D1), and 1.35 ± 1.2 (D2); for knee replacement — 3.39 ± 1.7 (D0), 2.98 ± 1.5 (D1), and 1.82 ± 1.36 (D2); for upper extremity surgery — 3.59 ± 1.9 (DO), 3.4 ± 1.7 (D1), and 2.1 ± 1.5 (D2); for lower extremity surgery — 4.1 ± 2.1 (D0), 3.49 ± 1,42 (D1), and 2.58 ± 1.4 (D2); and for spine surgery — 3.31 ± 0.58 (D1), 2.88 ± 1.96 (D1), and 1.83 ± 1.74 (D2). The study results showed that more unacceptable severe pain intensity was experienced by patients in the lower extremity surgery group (16.2%, compared to 2–8% in the other groups, $p < 0.05$). This may be explained by the anaesthesia/analgesia regimen, which consisted of single-shot spinal anaesthesia with postoperative oral medication (Fig. 2). The change in pain over time did not differ between the groups (group × time interaction effect, $p > 0.05$), and median NRS pain scores in the groups did not significantly differ at D1 and D2 times postoperatively.

We did not find any differences in pain intensity between the female and male populations. Nor did we find any statistically significant differences between the type of anaesthesia, the analgesia regimen and the mean pain intensity, which varied from 3.68 ± 1.78 NRS for spine surgery under general anaesthesia followed by fentanyl infusion and oral analgesics to 3.26 ± 1.8 NRS for combined spinal-epidural anaesthesia ($p > 0.05$). Increasingly important, if we consider the maximum pain intensities on the day of surgery, the absolute leader was the single-shot *plexus brachialis* block, followed by oral medication, which might be explained by sudden cessation of the effect of local anaesthetics and insufficient pre-emptive role of around-the-clock oral analgesics (5.24 ± 2.4 NRS), compared to 4.27 ± 2.4 for spinal anaesthesia, 4.79 ± 2.0 for combined spinal-epidural analgesia, 4.14 ± 2.1 for spinal anaesthesia combined with *Nervus femoralis* blockade and 5.14 ± 2.3 for general anaesthesia ($p < 0.05$) (Fig. 3).

DISCUSSION

Our study of 262 orthopaedic patients demonstrated that the multimodal analgesia protocols implemented in our hospital for patients undergoing different orthopaedic procedures did not provide excellent pain control over the first days postoperatively. It was acceptable for individual surgery types, such as hip or knee replacement surgery, but needs further improvement for upper and lower extremity surgery, where regional anaesthesia is mainly performed as a bolus action once. If following the literature we assume that pain less than 4 NRS is acceptable, 56.5% of patients fell into this category. At the same time, 13% of all patients had NRS pain scores ≥ 6, in spite of the multimodal approach, and this is unacceptable. The overall number of patients experiencing immediate maximally severe postoperative pain within the entire group of 262 was 54 (20.6%).

Comparison with a Norwegian study conducted with orthopaedic patients, where the average pain intensity was 4.2 ± 2.2 on a 0–10 numeric rating scale and 60% reported moderate/severe pain during the entire hospital stay, indicates that we are in a better position. Shoulder surgery patients in that study reported significantly higher pain intensities, compared to other surgical groups, which is similar to our study (Lindberg *et al.,* 2013).

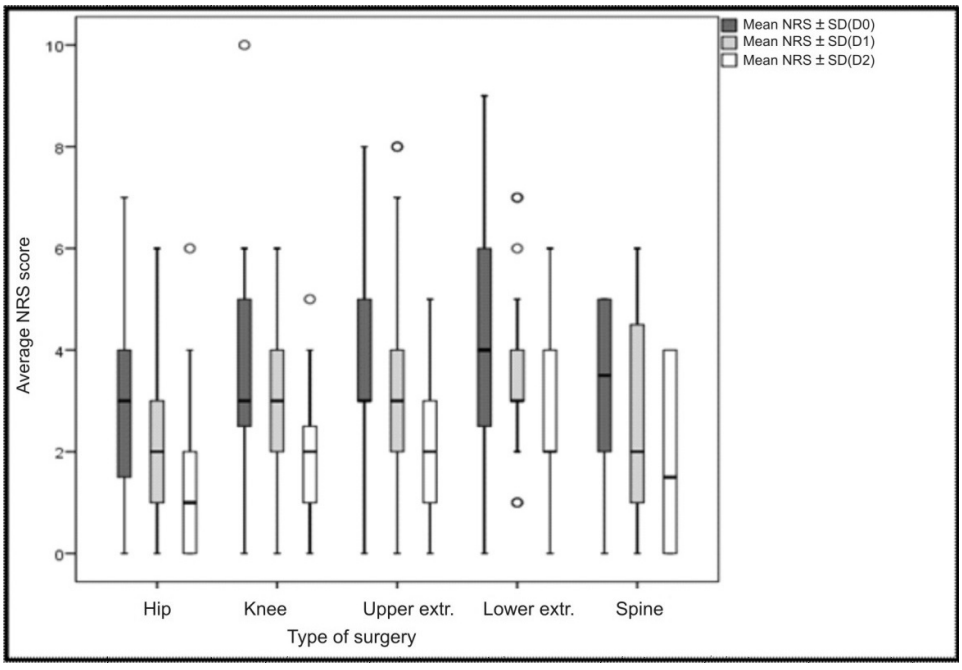

Fig. 2. Distribution of the mean pain intensities according to the type of surgery on the day of surgery, first postoperative day, and second postoperative day. Hip, hip replacement surgery; Knee, knee replacement surgery; Upper extr., upper extremity surgery; Lower extr., lower extremity surgery; Spine, spine surgery.

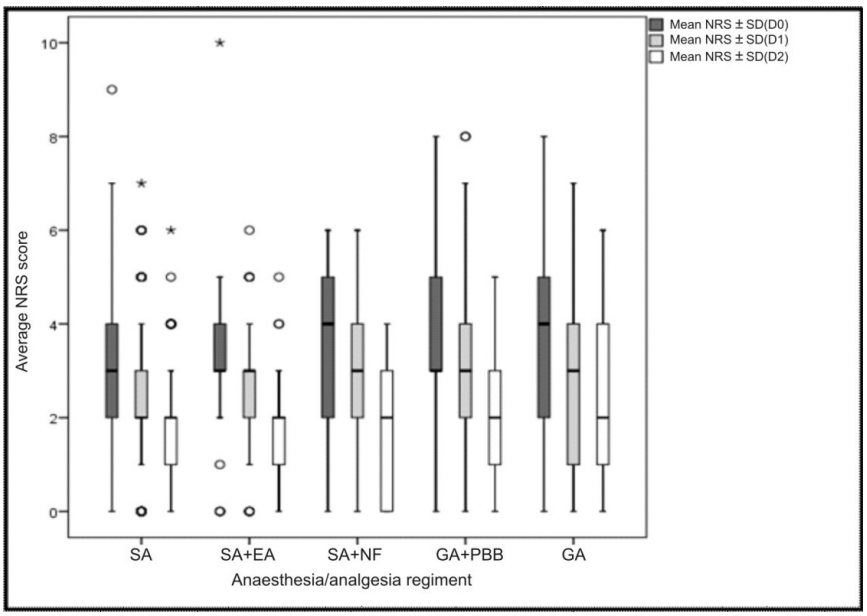

Fig. 3. Distribution of the mean pain intensities according to the type of anaesthesia/analgesia on the day of surgery, first postoperative day, and second postoperative day. SA, spinal anaesthesia; SA + EA, spinal anaesthesia followed by epidural analgesia;

SA+ NF, spinal anaesthesia followed by *N. femoralis* catheter analgesia; GA+ PBB., general anaesthesia combined with *Plexus brachialis* blockade; GA, general anaesthesia followed by fentanyl infusion.

Table 4

FREQUENCY DISTRIBUTIONS OF THE MEAN NRS PAIN SCORES IN PATIENTS ON THE DAY OF SURGERY

Type of surgery	Mild pain (0–3 NRS)	Moderate pain (4–6 NRS)	Severe pain (7–10 NRS)
Hip replacement	48 (50.5%)	41 (43.2%)	6 (6.3%)
Knee replacement	29 (51.8%)	26 (46.4%)	1 (1.8%)
Upper extremity surgery	32 (55.2%)	21 (36.2%)	5 (8.6%)
Lower extremity surgery	15 (40.5%)	16 (43.2%)	6 (16.2%)
Spine surgery	8 (50%)	8 (50%)	0
All	148 (56.5%)	101 (38.5%)	13 (5%)

In terms of pain intensity in the orthopaedic surgery with multimodal pain treatment, there was a predominance of mild pain on the day of surgery and on the second postoperative day (35/39.7% and 10/55.5%, respectively), whereas moderate pain prevailed on the first postoperative day (12/36.3%) among patients in a Brazilian study (Barbosa *et al.*, 2014). Usichenko *et al.* (2013) conducted a study of pain intensity before and after implementation of a quality management system. The maximum pain intensities after surgery reported by patients after the implementation of the system were lower than those reported before the implementation: 4.6 (4.3–4.9) vs. 6.0 (5.7–6.3); likewise, pain while in movement on the first postoperative day was reported as being less after the implementation, compared to that before this time: 3.6 (3.3–3.8) vs. 4.9 (4.6–5.2). The analysis of weak, moderate, and severe pain intensities on movement on the first postoperative day demonstrated that 43% of the patients from the first group vs. 13% of the patients from the second group had reported severe pain (defined as higher than 6 on the 10-point verbal rating scale (Usichenko *et al.,* 2012). Elia *et al.* (2005) performed a meta-analysis of 52 randomised controlled trials concerning multimodal analgesia, which comprised around 5000 patients; the main results were the following: in the trials without paracetamol and isolated NSAIDs and COX2 inhibitors, there was a small decrease in pain intensity by 1 point in the VAS scale, the PONV incidence also decreased, from 28 to 22%, while renal failure increased from 0 to 1.7%. Hence, we cannot rely on regimens that exclude some multimodal analgesia components.

There are also many other factors potentially explaining our findings, which were not included in the study. Additional prospective studies that evaluate new pain relief protocols should be performed particularly in orthopaedic surgery.

In conclusion, ultimodal analgesia that combines features of regional anaesthesia and oral medications offers many benefits to patients after orthopaedic surgery. At the same time, we cannot exclude opioids, even if the peripheral or central catheters are working properly. We should pay more attention to patients with single-shot regional blocks in the lower and upper extremity surgery, as the period after the local anaesthetic action is extremely painful and the multimodal analgesia scheme does not work properly. Optimal analgesia could be achieved only with regular feedback from patients and staff and by improving institutional guidelines accordingly.

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MULTIMODĀLA ANALGĒZIJA PERIOPERATĪVAJĀ PERIODĀ: UZLABOŠANAS IESPĒJAS

Šī pētījuma mērķis bija novērtēt pēcoperācijas sāpju intensitāti Traumatoloģijas un ortopēdijas slimnīcas pacientiem, un, noteicot neapmierinošo sāpju vadību, identificēt iespējamos turpmākos uzlabojumus. Datu iegūšanai izmantota Numeriskā sāpju skala (NRS) kura raksturo sāpju intensitāti. Tika dokumentētas maksimālās sāpes operācijas dienā, vidējās sāpes operācijas dienā (D0), un vidējās sāpes pirmajā (D1) un otrajā (D2) pēcoperācijas dienās. Sāpju intensitāte no 0 līdz 3 tika definēta kā vieglas sāpes, no 4 līdz 6 — kā vidējas sāpes, no 6 līdz 10 — kā neciešamas sāpes. Maksimāla sāpju intensitāte operācijas dienā tika novērota 20,5% pacientu; vidēja sāpju intensitāte 45,8% pacientu; vieglas sāpes 33.6% pacientu. Vidējo sāpju intensitāte atkarībā no operācijas veida bija šāda: gūžas locītavas endoprotezēšana — 2,79 ± 1,6 (D0), 2,09 ± 1,4 (D1), 1,35 ± 1,2 (D2); ceļa locītavas endoprotezēšana — 3,39 ± 1,7 (D0), 2,98 ± (D1), 1,82 ± 1,36 (D2); rokas un pleca ķirurģija — 3,59 ± 1,9 (D0), 3,4 ± 1,7 (D1), 2,1 ± 1,5 (D2); kājas operācijas — 4,1 ± 2,1 (D0), 3,49 ± 1,42 (D1), 2,58 ± 1,4 (D2); mugurkaula ķirurģija — 3,31 ± 1,58 (D0), 2,88 ± 1,96 (D1), 1,83 ± 1,74 (D2). Pacienti apakšējo ekstremitāšu grupā piedzīvoja nepieņemamu vidējo sāpju līmeni 16.2% gadījumu. Maksimālā sāpju intensitāte operācijas dienā tika novērota pacientiem pēc vienmomenta pleca pinuma anestēzijas (5,24 ± 2,4). Labi izstrādāta multimodāla atsāpināšanas shēma, īpašu uzmanību pievēršot vienmomenta reģionālās anestēzijas metodēm, var uzlabot sāpes pārvaldību un funkcionālos rezultātus pēc ortopēdiskām operācijām.