MEDICAL UNIVERSITY
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ABSTRACT

of doctoral thesis for acquiring educational and scientific degree

"Doctor"

INTRAOPERATIVE AND POSTOPERATIVE ANALGESIA WITH   TAP-BLOCK IN PATIENTS WITH LOWER MIDLINE LAPAROTOMY

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The dissertation contains a total of 157 pages, along with 36 figures, 49 tables, and 8 pictures . The List of References contains 230 titles, 10 of which are in the Cyrillyc and 220 in Latin alphabet. The research, examinations, operative interventions and monitoring are carried out in the Clinics of University General Hospital for Active Treatment "Sveta Marina" in the city of Varna.

The PhD. candidate works at the Clinic of anaesthesiology and intensive care at the University General Hospital for Active Treatment "Sveta Marina" and is an assistant at the Department of Anaesthesiology, emergency and intensive medicine at the Medical University of Varna.

The dissertation has been discussed, accepted and scheduled for presentation in front of scientific panel of experts from the Department Council at the Department of Anaesthesiology, emergency and intensive medicine at the Medical University "Prof. Paraskev Stoyanov", on Octoebr 10th, 2022 with protocol №.9

The dissertation public presentation will be held online on December 15th 2022 at 02:00 p.m.

Note: The numbering of the figures, graphs and pictures to those in the dissertation work.

ABBREVIATIONS USED

AIM   - American Institude of Medicine
ASA   – American Society of Anesthesiologists
ASRA - American Society of Regional Anaesthesia and Pain Therapy
CAS   - Color Analog Scale
CGRP – Calcitonin Gene-Related Peptide
CNS – Central Nervous System
COPD – Chronic Obstructive Pulmonary Disease
COX – Cyclooxygenase
CT – Computer Tomography
DB – Diabetes Mellitus
DBP - Diastolic Blood Pressure
ECG - Electrocardiographic
ERAS – Enhanced Recovery After Surgery
ESRA – European Society of Regional Anaesthesia and Pain Therapy
GABA - Gama Amino Butyric Acid
HBP – High Blood Pressure
HR – Heart Rate
IASP   – International Association for the Study of Pain
ICD – Ischemic Cerebral Disease
IHD – Ischemic Heart Disease
INR   – International Normalised Ratio
MAP – Mean Arterial Pressure
LAST – Local Anesthetic Systemic Toxicity
NMDA - N-methyl-D-aspartate
NOL   - Nociception Level Index
NRS   - Numeric Rating Scale
NSAIDs – Nonsteroid Antinflamatory Drugs
PCA   – Patient Controlled Analgesia
PONV – Postoperative Nausea and Vomiting
PPP   – Persistant Postoperative Pain
REC - Research Ethics Committee
RVM   – Rostral Ventromedial Medulla
SBP – Systolic Blood Pressure
SNS - Sympathetic Nervous System
TAP-block - Transversus abdominis plane block
TOF   - Train-of-four
US – Ultrasound
VAS   - Visual Analogue Scale
VCV   – Volume Controlled Ventilation
VRS   - Verbal Rating Scale
WHO - World Health Organisation

ABBREVIATIONS USED

CONTENT

INTRODUCTION

Pain is the most common symptom reported by patients. It is among the main and perhaps the most common reason for seeking medical attention (19). It is a major contributor to poor quality of life, loss of productivity and ability to work. All of this results in significant financial damage to suffering ones, their relatives and the whole society.

In the 21st century the WHO (World Health Organisation) is still searching for an effective solution of the problems such a correct diagnosis, classification and treatment of pain (29). Nowadays the pain is referred to as the "fifth vital sign" (31), along with temperature, blood pressure, pulse and respiration. Acute pain is a normal physiological response to tissue injury that is adaptive in nature and alerts to impending or occurring damage. In most cases it is treatable or preventable, especially when it occurs in a hospital setting. However the underestimation and ineffective treatment of it could lead to progression and development of chronic pain syndrome as well as compromiseing the healing process of any patient.

Many attempts have been made over time to define pain. The most popular definishen is made by the International Association for the Study of Pain (IASP). In 2020 it was revised and now pain is defined as "an unpleasant sensory and emotional experience associated with or resembling actual or potential tissue damage". It also introduces further clarifications and concepts such as:

- pain is always a personal experience that is influenced to varying degrees by biological, psychological and social factors;

- pain and nociception are different phenomena;

- pain cannot be linked solely to the activity of sensory neurons but it has four components: sensory, emotional, motor and autonomic;

- people change their perception of pain through their life experience;

- although pain usually plays an adaptive role, it can have adverse effects on the body's function as well as on the individual's social and psychological well-being;

- an individual's reporting of pain should not be ignored;

- verbal description is only one of many ways of expressing feelings of pain;

- the inability to communicate does not negate the possibility that one is experiencing pain;

- the definition is valid for acute and chronic pain, as well as for all pain conditions, regardless of their pathophysiology (e.g., nociceptive, neuropathic, and nociplastic). This definition is applicable to both humans and animals (39).

Pain caused by damaging stimuli is a stress that can threaten and disrupt the body's homeostasis. The body's adaptive response to pain involves physiological changes that are beneficial and potentially life-saving in the initial stages. Harmful and life-threatening effects may ensue if the pain stimulus and response by the body continues. Pain is a sense that has a powerful protective power.

Development of surgery, the increasing number and complexity of surgical interventions challange anaesthesiologists to control and even prevent the occurrence of perioperative pain.

The body responds to pain through multiple interrelated physiological processes from the sympathetic, neuroendocrine and immune systems, as well as through emotions (1). The endocrine and nervous systems are linked through the pituitary gland. It is located at the base of the hypothalamus. Pain responses are mediated primarily through the hypothalamic-

pituitary-adrenocortical axis and the sympatomedullary pathway and involve the release of mediators such as cortisol, adrenaline, noradrenaline, growth factor and cytokines.

The sympathetic nervous system (SNS) is involved in the immediate response of organs and systems to emergencies, including surgical intervention and pain. This response to pain or fear is known as "fight or flight". The release of noradrenaline and serotonin is stimulated. SNS is involved in the regulation of vascular tone, blood flow, blood pressure, etc. Pain accelerates heart and respiratory rates and raises blood pressure. This leads to increased oxygen flow and consumption by the cells. If these physiological responses are prolonged, especially in a person with impaired functional reserve, it may result in ischemic heart damage (27). The association between ineffectively treated intra- and postoperative pain and increased incidence of complications from various organs and systems, greater overall morbidity and mortality, and longer hospital stay has been demonstrated. Uncontrolled acute pain poses a risk of chronicity and creates serious, socially significant consequences.

Pain is a subjective sensation that can be described in several aspects: haracter, location, intensity, emotional impact and frequency. The intensity (severity) of pain is most indicative of the patient's perception of it (12).

In the postoperative period, pain assessment is performed statically (at rest) and dynamically (coughing, sitting up in bed). Static measurement can be associated with sleep disturbances while dynamic measurement serves to assess the quality of analgesia and whether it corresponds to recovery of function (10).

Numerous scales and questionnaires have been developed based on various indices in practice to assess pain (35, 97).

Pain received after surgical intervention is still a major challenge for medicine worldwide. Current knowledge allows a better understanding of the physiology, pharmacology, and mechanism of pain. However, the percentage of patients suffering from postoperative pain remains significant. According to published data for the USA, it is as high as 80% and only half of the patients receive adequate pain relief (24).

The classical analgesia regimen is based on the WHO established "analgesic ladder" in the treatment of carcinoma pain. Subsequently, this concept has been adopted in acute pain treatment protocols but applied in reverse order, as is shown in Figure 1.
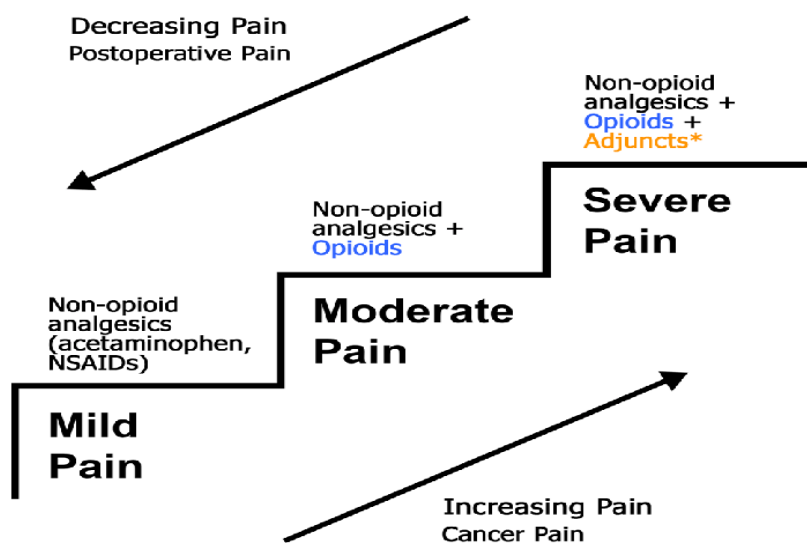

Figure 1. Pain management ladder adapted from WHO recommendations (5).

The multimodal approach includes the components pre-emtive, systemic and regional analgesia.

The classic approach to treating acute surgical pain is by systemic administration of opioids. Despite very good analgesic properties, adverse drug reactions of opioids such as: suppression of consciousness and respiration, postoperative nausea and vomiting, delayed intestinal motility, spasm of the sphincter of Oddi, modulation of immune function, urinary retention, opioid-induced hyperalgesia, pruritus, and so on, limit their use. Opioid-free anaesthesia/ opioid-sparing analgesia is becoming increasingly popular worldwide.

Despite the many proven side effects, which can range from subjectively unpleasant such as itching and constipation, to life-threatening such as depression of consciousness and respiration, the use of opioids is even increasing recently for both inpatients and outpatients (41). A retrospective study based on more than 300 000 surgical patients in the USA showed that about 95% receive opioid analgesics (37). Their extremely high use is associated with the development of the so-called opioid crisis nowadays (16).

Additional difficulties in dealing with the problem of postoperative pain in Bulgaria are: the lack of postoperative wake-up rooms; the lack of standardized, national and local protocols for intra- and postoperative pain management; the shortage of medical staff and monitoring equipment; and insufficient training in pain management. Consequently, strategies are being developed for the use of so-called opioid-sparing analgesia and anaesthesia, aiming to reduce the doses of opioids used and the occurrence of their side effects during the intra- and postoperative period (21). However, their widespread use continues due to the fact that they have good efficacy in the treatment of moderate and severe pain, can be used in different pharmacological forms and are well known in clinical practice (40).

The multimodal approach is the current solution to the problem of effective pain control with minimal side effects and complications of therapy. It involves a combination of different pharmacological groups of drugs as well as non-pharmacological techniques (regional blocks, physical methods, etc.). Regional analgesic techniques are a good alternative to systemic analgesia but are not routinely advocated in practice. Lower abdominal surgical interventions are associated with the need of significant intra- and postoperative analgesia. Epidural analgesia was until recently considered as a "gold standard" for these operations. But it has limited use nowdays due to the widespread use of anticoagulants, the significant number of complications and technical difficulties in its implementation, and the need for skilled staff to maintain.

Since the introduction of ultrasound into routine clinical practice, the popularity of local anaesthetic administration techniques has increased. They are easier to perform, associated with significantly fewer contraindications and milder side effects, higher success rates and comparable analgesic effect. An example of such technique is the TAP-block (Transversus Abdominis Plane block). Although first described in 2001 by Rafi, this analgesic technique is still not well known to anesthesiologists and is not routinely used in perioperative analgesia for open or laparoscopic surgery.

Some of the reasons for that are:

- there are no established protocols for the implementation of the technique;

- the most appropriate local anaesthetics, concentration and volume of solutions administered, and the combination with different adjuvants are not known;

- the role of the TAP-block on the quality of postoperative analgesia, opioid requirements, incidence of side effects and complications and the duration of effect and rate of patient recovery in the early postoperative period are not yet fully understood;

- few studies have investigated the effect of TAP-block on intraoperative pain relief, hemodynamic stability and opiate consumption during surgery.

All of the above defines the need for local studies in the field of perioperative analgesia and the incorporation of regional techniques such as TAP-block into the usual multimodal analgesia protocols.

In the present study we focused on lower abdominal surgical interventions in which access to the abdominal cavity is performed by lower median laparotomy.

Our team found no studies regarding the use of TAP-block in such surgeries by Bulgarian authors. All of the above gives us reason to believe that the topic is current and the thesis is unique in its nature.

2. AIM AND OBJECTIVES

Based on the analysis of the literature, we have formed the thesis that TAP-block has a number of advantages over conventional analgesia in some groups of patients. To prove or reject this thesis, we formed the main objectives of our study.

The aim is to evaluate the efficacy, feasibility and safety of TAP-block for intra- and postoperative analgesia in patients undergoing surgical interventions using inferior midline laparotomy.

To achieve this aim, we set the following objectives:

1) to apply ultrasound-guided, bilateral, TAP-block preoperatively to patients who are undergoing inferior midline laparotomy;

2) to form two main groups of patients, with and without TAP-block, and to perform a comparative analysis of some intra- and postoperative hemodynamic parameters between the two groups;

3) to evaluate the intra- and postoperative analgetics used in both groups;

4) to determine the effectiveness and duration of postoperative analgesia in both groups;

5) to observe the incidence and nature of some common side effects and complications associated with analgesic therapy in both groups;

6) to observe and analyze the nature and frequency of complications related to the technique of administration of TAP-block and the drug combination used.

3. SUBJECT AND METHODOLOGY

3.1. Subject of the clinical study

The data in this study were obtained by two methods, retrospective analysis and prospective study. It was carried out in the structures of the University Hospital "St. Marina"-Varna. The subjects were patients treated in the clinics of Urology and General Surgery, who underwent elective surgical intervention with inferior midline laparotomy.

The study was approved by the Research Ethics Committee (REC) №101/24.03.2021 at the Medical University „Prof. Dr. Paraskev Stoyanov" - Varna. Due to the emergency epidemiological situation and the health COVID - crisis it was necessary to change the original design, which was approved by decision of REC №.115/31.03.2022.

According to the requirements of REC we formulated three groups of patients:

Group I - control, retrospective (n = 89) included patients who passed through the facility from 2016 to 2020, who met the inclusion criteria for this study and to whom the usual protocol of analgesia with systemic drugs was applyed.

Group II - experimental, prospective (n = 37) included patients who passed through the institution between 2021 and 2022, who met the inclusion criteria for this study and to whom peripheral nerve blockade, TAP-block, was applied in addition to the usual intra- and postoperative analgesia protocol.

Due to scheduling constraints during the national epidemic emergency, in order to increase the scientific value of the results, we formed Group III, an experimental, retrospective (n = 45), in which we included patients who passed through the institution from 2017 to 2019, who met the inclusion criteria for this study and to whom peripheral nerve blockade, TAP-block, was applied in addition to the usual analgesia protocol.

Clinically, practically and scientifically, the patients in the study were divided into two groups, experimental (with TAP-block) and control (without TAP-block).All subsequent analyses and comparisons were performed between the experimental and control groups.

Inclusion criteria:
- age ≥ 18 years;
- patients hospitalized at Universal Hospital of St. Marina, Varna, signed the hospital General Declaration of Informed Consent and explicit informed consent for the administration of anesthesia;
- patients undergoing surgical intervention with lower midline laparotomy;
- ASA I - III;
- patients who have signed an informed consent for the application of the loco-regional technique – TAP-block and a privacy notice (for Groups II and III);

Exclusion criteria:
- age < 18 years;
- patients from populations in risk (pregnant, incarcerated, etc.)
- patient's non-consent to participate;
- patients with a history of sensitivity or allergy to the drugs used in the analgesia protocol;
- ASA > III;
- patients suffering from chronic pain and/or taking therapy with opioids, NSAIDs, antidepressants or other known pain modulators;
- patients with laboratory evidence of significant renal or hepatic insufficiency ;
- infection at the site of the TAP-block (for Groups II and III);
- patients with cognitive impairment who cannot adequately perceive pain scales;
- patients with laboratory evidence of severe haemostasis disorders;
- patients with alcohol or opioid abuse;
- patients with intraoperative complications related to surgical technique and/or evidence of profuse bleeding and shock in whom the immediate postoperative period was spent in intensive care unit;

3.2. Methods of clinical examination:

3.2.1. Documentary method

We collected anthropometric, demographic and clinical data for each patient in an individual clinical chart.

We obtained all data for the retrospective groups (Groups I and III) by processing and analyzing information from documentary sources: complete medical history of each patient; discharge summaries; anesthesia lists; operative reports; laboratory, imaging, and histological results; and journals.

In processing the materials, we complied with all legal provisions relating to the protection of personal data.

3.2.2 Clinical methods

We performed a preoperative anaesthetic consultation on all patients. We took the medical history using a standardized questionnaire in order to determine the presence of concomitant diseases, medications taken so far, especially those affecting the haemostatic system and analgesics, data on allergies.

During the pre-anesthesia consultation, we performed a standard physical examination on all patients to assess their functional status before surgical intervention. If necessary, we scheduled additional consultative examinations with other specialists (internist, cardiologist, endocrinologist and/or others).

We provided patients with additional explanations regarding the upcoming anesthesia and analgesia, as well as instructions for preoperative preparation. Subjects in the experimental groups additionally received an explanation of the loco-regional technique (TAP-block).

We concluded the preoperative consultation by determining the anesthetic risk according to the American Society of Anesthesiologists (ASA) Physical Status Classification.

All study participants signed the mandatory consent declarations, and patients in the experimental groups signed the additional consent to perform the block.

3.2.3 Instrumental methods

We performed electrocardiographic (ECG) diagnosis preoperatively in all patients.

If necessary, we ordered additional imaging studies in some patients: chest radiography; ultrasonography of the abdominal cavity and/or pleura; computed tomography of the abdominal cavity and/or pelvis minora.

In both experimental groups, we performed the TAP-block under ultrasound guidance.

In all patients, we intraoperatively used a standard automated vital signs monitoring system. We placed three chest electrodes for ECG monitoring in order to monitor the electrical function of the heart perioperatively. For plethysmogram and perioperative peripheral saturation monitoring, we used a pulse oximeter placed on the last phalanx of either finger of the left or right hand. We took the heart rate from the pulse oximeter data, except in cases of pulse deficit. This was due to interference with the frequency read from the ECG image when using the electrocautery intraoperatively. We measured arterial blood pressure noninvasively, automatically, by an oscillometric method at 3-min intervals with a cuff placed on the left or right arm. The mean arterial pressure (MAP) value was measured directly, and the indicated values for systole (SBP) and diastole (DBP) were calculated according to a mathematical algorithm of the monitor system manufacturer. The make and model of the monitor systems varied from operating room to operating room, but all were certified for perioperative monitoring and were maintained in good working order.

We investigated postoperative hemodynamic parameters by manual, noninvasive measurement of arterial pressure with an arm cuff using the Korotkoff method. In this case, the

values of SBP and DBP were directly measured, and MAP was calculated using the formula MAP=(2xDBP+SBP)/3 . Heart rate was measured by manual reading of radial artery pulsations for one minute.

3.2.4. Laboratory methods

In all patients, we performed standard laboratory tests preoperatively: complete blood count, hemostasis parameters, biochemical parameters (blood sugar, creatinine, urea, GOT, GPT, electrolytes, etc., according to concomitant diseases). We optimally corrected the detected abnormalities before surgery.

Laboratory parameters were assessed by the study team, used as exclusion criteria, but were not subject to further data processing and were not part of the outcome formation.

3.2.5. Treatment methods
3.2.5.1. Surgical methods.

In the present study, we included surgical interventions that were performed with access to the abdominal cavity by inferior median laparotomy, i.e., an incision along the midline between the symphysis and a maximum of 3 cm above the umbilicus. There are two main groups of operations: laparoscopic surgery followed by an open phase and totally open surgery.

Laparoscopic surgery:
- Total cystoprostatectomy with pelvic lymph node dissection and uretero-uretero-ileocutaneostomy according to the Bricker method (in men)/ Total cystohysterovarectomy with pelvic lymph node dissection and uretero-uretero-ileocutaneostomy according to the Bricker method (in women).

Open surgery:
- Rectum/sigma resection with anastomosis;
- Radical prostatectomy with pelvic lymph node dissection.

The surgical teams in the clinical cases included in the study varied.

3.2.5.2. Anaesthetic methods.
3.2.5.2.1. Pre-anaesthetic period.

Before anesthesia, patients were prepared with preoperative fasting 6 hours for solid foods, 4 hours for nonabsorbent fluids and 2 hours for clear fluids. Those taking beta-blockers in their regular therapy received half the usual morning dose at 06:00 on the day of surgery. One hour preoperatively, subjects with evidence of drug allergy or bronchial asthma were administered Methylprednisolone 40 mg and an H2-blocker (Famotidine 20 mg) intravenously. Patients enrolled in the study were not administered PONV prophylaxis medication.

In the operating theater, patients occupied a horizontal supine position on the operating table. They were fitted with electrodes, cuff and pulse oximeter for standard perioperative monitoring. They were then placed on a peripheral venous line.

Standard immediate premedication was performed with Midazolam 0.02 mg/kg intravenously.

Preoxygenation was performed with a gas mixture with FiO2 1.0 through a face mask with a flow rate of 6-8 l/min for three minutes.

3.2.5.2.2. Anaesthetic period

In all cases, for the purpose of surgical intervention, we used balanced, multimodal, general, intubation anaesthesia according to the rules and protocols adopted in the clinic of anaesthesiology and intensive care at Hospital St. Marina - Varna.

For induction of anaesthesia we used usual doses of Propofol 2-3 mg/kg with titration and Fentanyl 1 µg/kg. Neuromuscular relaxation for intubation was performed with depolarizing myorelaxant Suxamethonium 1 mg/kg. We performed endotracheal intubation after reaching optimal muscle relaxation under direct visual control with a Macintosh-type laryngoscope or a videolaryngoscope.

We administered a TAP-block to the patients of experimental groups II and III immediately after the introduction. The detailed performance protocol is described in Section 3.2.6.

After verification of successful endotracheal intubation by auscultation and capnography, patients were switched to volume-controlled artificial lung ventilation. Ventilation parameters were: prosthetic tidal volume 6-8 ml/kg; PEER 5 cmH2O; respiratory rate and inspiratory to expiratory ratio according to EtCO2, aiming to maintain values within 30-40 mmHg. Artificial pulmonary ventilation was performed using an anaesthetic machine, with a low fresh gas flow of 0.8-1.2 l/min and FiO2 according to SpO2 maintaining target values of 96-100%.

The models of anaesthetic machines varied for different operating rooms, but all were certified for perioperative monitoring and were in good working order. One of them is presented in Image 1.

Image 1. Datex-Ohmeda S/5 Aspire anaesthesia machine (personal archive).

Three minutes before the surgical incision, we administered Fentanyl at a dose of 1 µg/kg intravenously. We maintained anesthesia with inhalational anesthetics Sevoflurane or Isoflurane at a minimum alveolar concentration MAC of 1.0, recalculated according to age group. We performed intraoperative neuromuscular blockade with intermittent bolus doses of a nondepolarizing muscle relaxant when evidence of muscle activity was restored.

For intraoperative analgesia, we used intermittent bolus doses of Fentanyl 50 µg intravenously every 10 minutes until effect. The criterion for application was a rise in arterial pressure and/or heart rate values by more than 20% of the measured values 10 minutes after premedication excluding other cause such as: insufficient depth of anaesthesia; insufficient neuromuscular block; cuff pinch. We also monitored for other clinical signs of insufficient anaesthesia such as the appearance of sweating and/or lacrimation. We selected blood pressure and heart rate values as a sign of endogenous catecholamine activity, a sign of insufficient analgesia.

At the end of surgery, after recovery of consciousness, reflexes, and muscle tone, all patients were extubated in the operating theater. Ketoprofen 100 mg intravenously was administered to each before extubation.

We used crystalloid solutions to compensate for preoperative and intraoperative water losses and to maintain adequate cervical blood volume. When necessary, we also applied colloid ones.

In the patient's clinical chart, for the purpose of the study, we entered the hemodynamic indices SBP, DBP, MAP and HR, which we monitored from the time of premedication until 10 min after extubation. We also tracked the total amount of opiate (Fentanyl) used. We obtained the data from the anaesthesia sheets for each operation. Anesthesia was managed by different anesthesia teams according to the described rules.

3.2.5.2.3. Period after anaesthesia

After full recovery of consciousness and muscle tone, with stable haemodynamics and independent, effective breathing (SpO2 on room air above 95%), patients were transported to the Urology or General Surgery clinic, respectively, for postoperative follow-up and treatment.

All participants received usual care from the surgical ward team. Postoperative pain management was performed by staff in the surgical units according to established protocols. If the patient reported moderate pain (VAS = 4-6) at rest, a single Ketoprofen 100 mg intravenous was administered, and if the first step failed within 30 minutes or if he/she defined the pain as severe (VAS = 7-9), Pethidine 50 mg was administered. If complaints did not resolve within 30 minutes of opioid administration, consultation with the on-call physician was sought to rule out a surgical complication.

We visited patients in Group II at specific intervals (30th minute, 3rd, 6th, 12th, 18th and 24th hour after surgery). At these visits, we assessed and filled in each participant's clinical chart objective and subjective data on pain intensity, effectiveness of analgesia, analgesics administered, and presence of side effects.

Data on the postoperative period of patients in Groups I and III were collected in the clinical chart of the present study by the same research team in conjunction with another, previous study.

3.2.6. Implementation of TAP-block

In all patients of the experimental groups II and III, we performed the TAP-block according to the same protocol, immediately after induction of anaesthesia and endotracheal

intubation and before surgical incision. We applied a single shot technique to infiltrate the solution into the transversal abdominal plane under constant ultrasound control. We used a lateral approach to the plane, which is demonstrated in Photo 5. We performed the infiltration bilaterally symmetrically.

We performed the technical execution of the block in strict compliance with the rules of asepsis and antisepsis. We performed a thorough disinfection of the anterior abdominal wall skin with iodine solution (Braunol) using sterile gauzes, gloves and instruments. This is demonstrated in Image 2 and Image 3.

Image 2. Tools and instruments used in the application of TAP-block (personal archive).
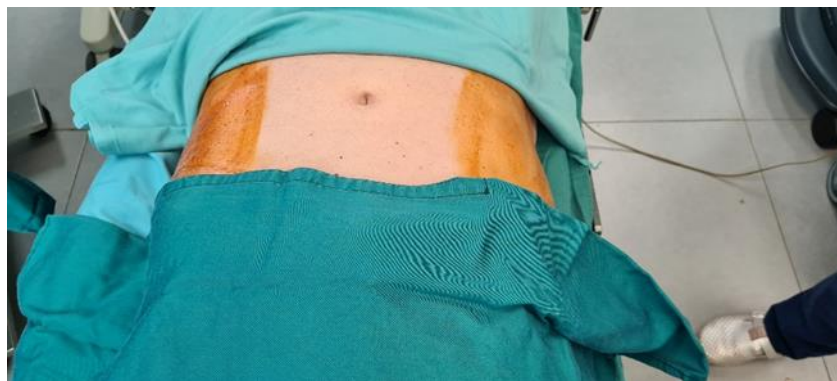
Image 3. Preparation for application of TAP-block (personal archive).

Ultrasound navigation was performed with a MyLab™Gamma - Ultrasound Systems - Esaote L38x ultrasound transducer with a 5 - 10 MHz 38 mm linear transducer, shown in Image 4. We performed the application of the anesthetic solution with a Stimuplex ultra (B-Braun Medical, Bethlehem, PA, USA) G22 echo needle, 50 or 80 mm long, depending on the patient's abdominal wall thickness. We kept the transducer and infiltration needles sterile during the procedure.

Image 4. MyLab™Gamma sonograph - Ultrasound Systems - Esaote (personal archive).

We placed the transducer transversely along the mid-axillary line, between the iliac crest and the subcostal arch. We visualized the three anterior abdominal wall muscles (m. obliquus externus abdominis, m. obliquus internus abdominis, m. transversus abdominis) and the peritoneum as shown in Image 5 and Image 6.

Image 5. Lateral access TAP-block application (personal archive).

Image 6. Layered visualization of fascia and muscle during application of TAP-block (personal archive).

We used an "in plane" technique in which the needle is introduced in the same plane as the long axis of the transducer and is fully visualized as it advances into the tissue. This is demonstrated in Image 7.
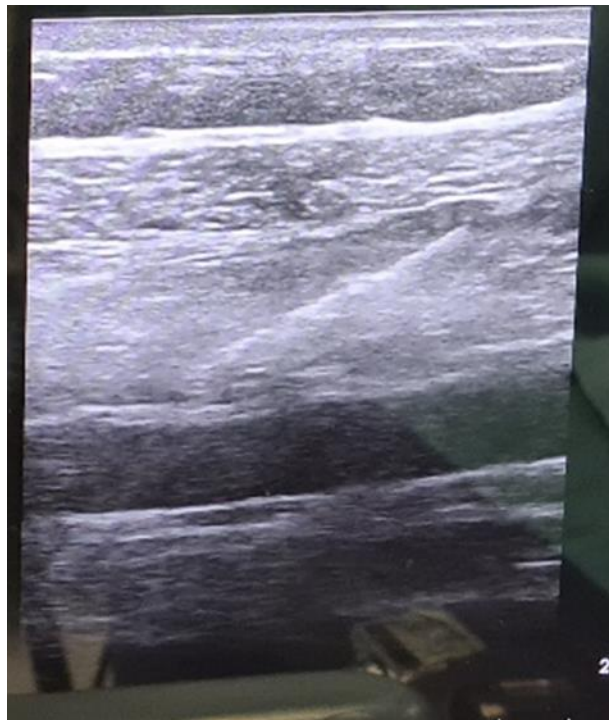

Image 7. Insertion of the ultrasound needle through the different structures of the abdominal cavity (personal archive).

When the needle tip reached the transversus abdominis plane (between the internal oblique and transversus abdominis muscles), with the help of an assistant, we performed an aspiration test for air or blood. If it was negative, we infiltrated the prepared solution. We

verified correct needle position by initially injecting 2 ml of the solution and observed for muscle detachment, then continued until the entire amount was aspirated. Every 5 ml of injected solution, we performed repeated aspiration to prevent direct entry into the bloodstream. We monitored the spread of the solution continuously in real time by ultrasound. When the TAP-block was performed correctly, we ultrasonographically observed a distinct separation between m. obliqus internus and m. transversus abdominis and the appearance of a hypoechogenic zone as shown in Image 8. We used the same technique for the infiltration of the contralateral side.
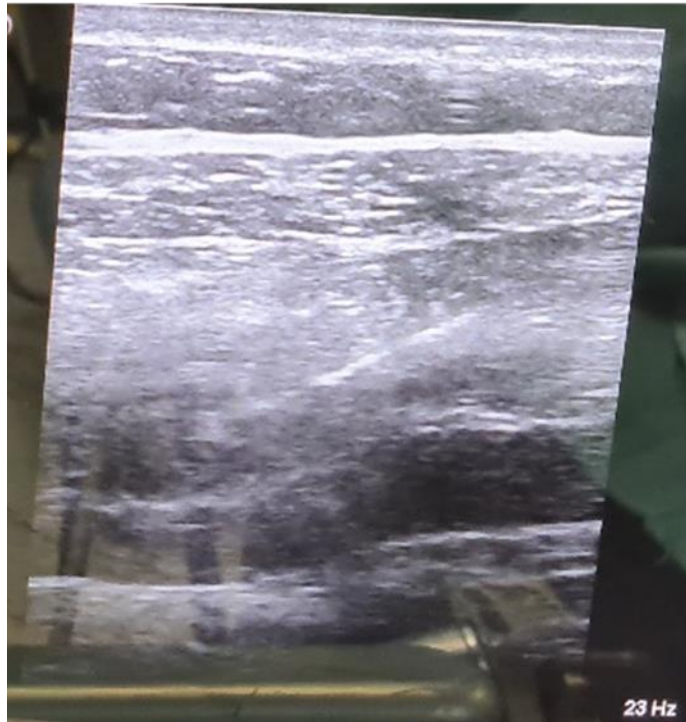
Image 8. Infiltration of local anesthetic between m. obliqus internus and m. transversus abdominis (personal archive).

Our team chose a solution of Ropivacaine 0.375% to perform the TAP-block. We added Dexamethasone to it in order to increase the duration of the effect. We used a total volume of 40 ml (20 ml per side). We prepared the solution immediately before the procedure observing all sterility rules. In a 20 ml syringe we drew 15 ml of Ropivacaine 5 mg/ml ready solution, 4.5 ml of NaCl 0.9% and 0.5 ml of Dexamethasone 4 mg/ml. We prepared two identical syringes for the left and right blocks. The total dose of local anesthetic administered was 150 mg and that of adjuvant 4 mg. We provided a reduction in the volume administered in patients with a body weight less than 50 kg in order not to exceed the maximum permissible dose of Ropivacaine 3 mg/kg.

In all clinical cases included in the study, the TAP-block was performed by the same person, the principal investigator.

3.2.7. Evaluation of the effectiveness of analgesia
We evaluated the effectiveness of analgesia in the two periods, intra- and postoperatively, according to different criteria for objective reasons.

During anaesthesia, we monitored systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and heart rate (HR), which indicate catecholamine activation and indirectly inadequate analgesia.

Immediately after recovery of consciousness and extubation, we also used a verbal pain rating scale in which patients self-reported, subjectively categorized their sensations as no, mild, moderate, and intolerable pain. The verbal scale is listed in Table 8. This scale is routinely used by the unit team to assess the need for additional medication before transferring the patient from the operating room to the postoperative care unit.

Verbal raiting scale	Interpretation
0	No pain
1	Mild pain
2	Moderate pain
3	Severe pain

Table 8. Verbal raiting scale (9).

In the postoperative period, we used a combination scale to determine pain intensity. It applies the principle of visual analogue scale (VAS) as the patient himself indicates on the shown line where he would place his sensation at the moment of the examination. In contrast to the classical VAS, where only a straight line with a beginning and an end is provided, we preferred the combination with numbers (NPRS), colors (CAS) and images of emotions (Wong-Baker Faces Scale). This is shown in Figure 7.

Figure 7. Pain rating scale used in our study.

Table 9 shows the subjective interpretation of the VAS.

Subjective interpretation of the VAS	Interpretation
0	No pain
1-3	Mild pain
4-6	Moderate pain
7-9	Severe pain
10	The wors possible pain

Table 9. Subjective pain expression scale (43).

Pain rating on the visual analog scale was used as a criterion for administering analgesic therapy and assessing the effect of medication. We monitored the VAS at specific time intervals during the first postoperative day: 30th minute, 3rd, 6th, 12th, 18th and 24th hour. In this study,

the patient subjectively self-reported the degree of pain from none (VAS = 0) to the worst pain ever experienced (VAS = 10).

We also recorded the values in different body positions: lying at rest, coughing and turning in bed. At the same time intervals, we also recorded the hemodynamic parameters, the presence of side effects of the anesthesia such as nausea and vomiting and consciousness suppression.

The main results of the study were related to the effectiveness of analgesia and the amount of opiates used intra- and postoperatively. Since the drugs used in the two periods were different, Fentanyl and Pethidine, respectively, we aligned their doses to Morphine according to an international standardized schedule presented on Table 10. This also assists in comparing the results with other published studies.

Drugs	Equianalgesic doses (*mg*)
Morphine	10
Fentanyl	0,1
Pethidine	100

Table 10. Standardization of administered opioid analgesics (15).

3.2.8. Evaluation of some complications of opioid administration

Opiates are a major risk factor for postoperative nausea and vomiting (PONV). We performed the assessment using the scale indicated in Table 11.

PONV	Patient status
0	No any complaint
1	Mild degree nausea
2	Moderate degree nausea and vomit
3	Frquently vomit
4	Severely(continuously) vomit

Table 11. Postoperative nausea and vomiting rating scale (25).

Another common and serious complication of opiate analgesia that we have followed is postoperative sedation. For this purpose, we used a simplified four-level Filos scale, presented in Table 12.

Postoperative sedation	Patient status
1	Awake and alert
2	Drowsy, responds to verbal stimuli
3	Drowsy, responds to physical stimuli
4	Unarausable

Table 12. Postoperative sedation rating scale (46).

We recorded the results of PONV appearance and sedation level of the patients postoperatively in the clinical chart at the designated follow-up time intervals (30th minute, 3rd, 6th, 12th, 18th, and 24th hour). We obtained the data from the medical records (for the

retrospective groups) or directly from a member of the research team at the patients' examinations (for the prospective group).

3.2.9. Statistical methods

Analysis of quantitative variables

The quantitative characteristics used for the experimental and control groups were demographics (age and sex), weight, hemodynamic indices of the patients (systolic, diastolic, mean arterial pressure and heart rate intra- and postoperatively), amount of opioid analgesics administered (Fentanyl intraoperatively and Pethidine postoperatively), NSAIDs. Data were analyzed using descriptive statistics, and groups were compared using tests of difference.

Descriptive statistics

The main sample statistics are presented tabulated with the following measures of central tendency and variance:

Mean

SD - standard deviation

Me - median

Q1 - 1st quartile

Q3 - 3rd quartile

IQR - range of the data from the 25th and 75th percentile

MIN - minimum value

MAX - maximum value

RANGE - span

SE - standard error of the mean

Tests for difference

All indicators were tested with the Kolmogorov-Smirnov test for symmetric data distribution. For $p>0.05$, parametric tests were used, while for $p<0.05$, nonparametric tests were used to analyze the data in the sample.

Comparisons between experimental and control groups on mean values of quantitative traits were performed using Student's parametric t-test or the non-parametric Mann-Whitney U-test for independent samples. The choice depended on the conditions for application of the parametric tests, namely normal distribution and equal variances. If both conditions hold, the groups are compared using Student's t-test. If one or both conditions are not met a Mann-Whitney U-test is applied. A 2 (Chi-square) was used to compare proportions and frequency data.

We assumed a significance level of $\alpha = 0.05$. Observed differences between patient groups were considered significant when the calculated probability $p < \alpha$.

Analysis of qualitative variables

The qualitative characteristics of the patients included in the study were presented in types of surgical interventions, ASA score, pain scales (verbal scale and VAS) , NSAIDs used, and postoperative nausea and vomiting (PONV) and Filos postoperative sedation scales. Patient frequencies in number and percents were calculated, tabulated and analyzed. Pearson's exact test or Fisher's exact test was used to compare the experimental and control groups of patients and the significance level for both groups was $\alpha = 0.05$. Spearman's rank correlation coefficient (Rho) was used to examine correlations.

Graphical representation

The data are presented with bar and column plots with overlays to represent the distribution and structure of the phenomena under study. To track dynamics we used line graphs. Box plot type diagrams visualize median and Q1 and Q3.

Statistical software

We performed the biostatistical analysis and graphical representation using SPSS Statistics 25.0 and Microsoft Office 2013.

4. RESULTS AND DISCUSSION

4.1. Preoperative indicators of the studied groups

A total of 171 patients were included in the present study. Out of them 31 were females and 140 were males. From a practical, clinical and scientific point of view, the participants were divided into two main groups: group I with TAP-block (experimental group - 82 patients) and group II without TAP-block (control group - 89 patients). In relation to the requirement of REC and the extraordinary epidemiological situation, 45 patients with retrospective follow-up and 37 with prospective follow-up were included in the experimental group.

Statistical treatment of demographic parameters was performed and shown in Table 13 and Figure 8.

Gender	Frequency	%	Frequency	%	χ^2	p
	TAP - block	*TAP* - block	No *TAP* block	No *TAP* block		
Women	14	17,1	17	19,1		
Men	68	82,9	72	80,9	0,12	0,730
Total	82	100,0	89	100,0		

Table 13. Descriptive statistics of gender indicators in experimental and control groups.
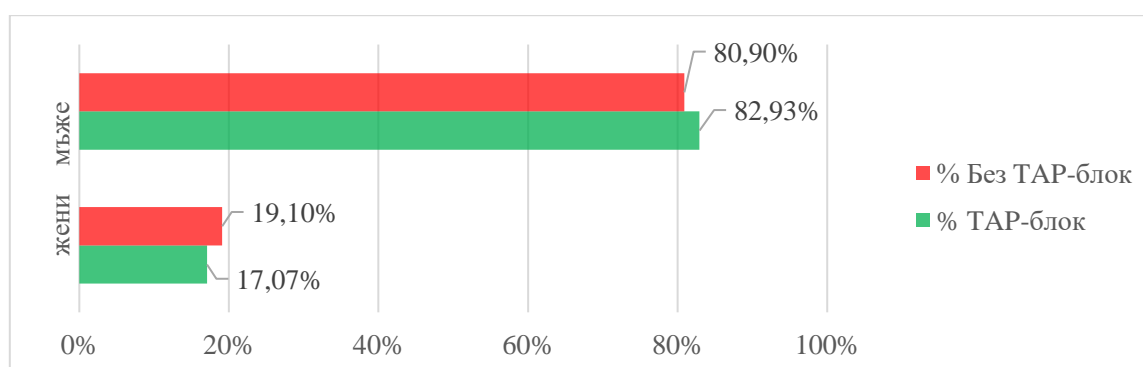
Figure 8. The percentage of women and men in the two groups.

There were 14 (17.1%) women in the experimental group and 17 (19.1%) in the control group. The greater participation in the sample was of men, but they were similarly distributed. There were 68 (82.9%) males in the experimental group and 72 (80.9%) males in the control group. These minimal frequency differences of the participating patients between the two groups were statistically insignificant (2 = 0.12, p = 0.73).

The higher number of male patients compared to female patients was determined by the type of surgical interventions included in the study.

The number, type and distribution of surgical interventions in our study are presented in Table 14 and Figure 9.

Surgery	Frequency TAP - block	% TAP - block	Frequency No TAP block	% No TAP block	χ^2	p
Open prostatectomy	30	36,6	30	33,7		
Rectal/sigma resection	27	32,9	33	37,1	0,33	0,84
Laparoscopic cystectomy	25	30,5	26	29,2		
Total	82	100,0	89	100,0		

Table 14. Type and frequency of surgical interventions performed in the experimental and control groups.
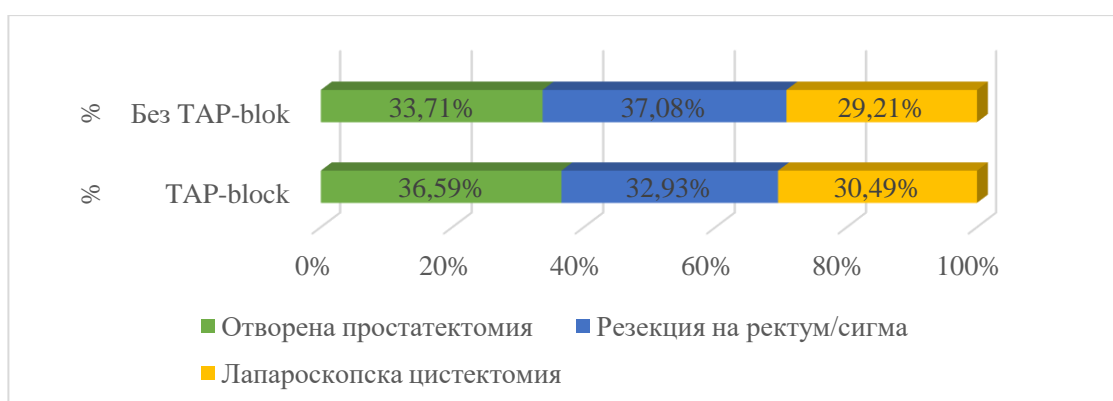
Figure 9. Percentage structure of transactions.

Regarding the types of surgery included in the study, 30 (36.6%) were open prostatectomies in the experimental group and 30 (33.7%) in the control group. Rectum/sigma resection was performed in 27 (32.9%) patients in the experimental group and 33 (37.1%) in the control group. Laparoscopic cystectomy was performed in 25 (30.5%) patients in the experimental group and 26 (29.2%) in the control group. The difference in surgical interventions performed between the two main groups did not show a statistically significant result (2 = 0.33, p = 0.84).

Gender distribution in our study largely matched the data from the epidemiological distribution of the main diseases causing the surgical treatment. Anatomical differences between the sexes account for the fact that prostatectomies are performed only in men. Additionally, the incidence of colorectal cancer, according to literature data, is higher in men than in women (11). Bladder neoplasia is 3 to 4 times more common again in males (14). This also explains the predominantly male population in our study.

We also did a comparative analysis in terms of age and weight indices between the two groups. The results are shown in Table 15, 16,17 and Figure10,11.

Indicators	N	Mean	SD	Median	Q1	Q3	IQR	Min	Max	Range
Age [years]	82	66,78	8,19	67,00	61,75	72,25	10,50	47,00	87,00	40,00
Weight [kg]	82	78,02	11,92	76,00	69,00	84,00	15,00	55,00	110,00	55,00

Table 15. Descriptive statistics of indicators of the preoperative status of the experimental group /TAP-block/.

Indicators	N	Mean	SD	Median	Q1	Q3	IQR	Min	Max	Range
Age [years]	89	68,64	5,76	68,00	66,00	72,00	6,00	57,00	83,00	26,00
Weight [kg]	89	79,03	8,43	79,00	73,50	84,00	10,50	65,00	105,00	40,00

Table 16. Descriptive statistics of preoperative status parameters of the control group /Without TAP-block/.

Indicators	Difference	Test	Value	*p*
Age [years]	-1,86	U	4 028	0,24
Weight [kg]	-1,01	U	4 070	0,192

Table 17. Comparison between age and weight in patients with and without TAP-block.
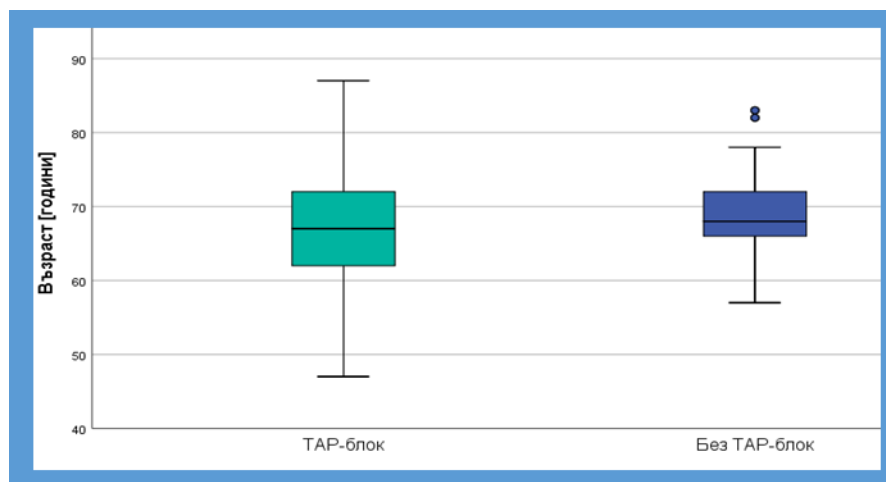
Figure 10. Age distribution (in years) of patients in the two main groups.
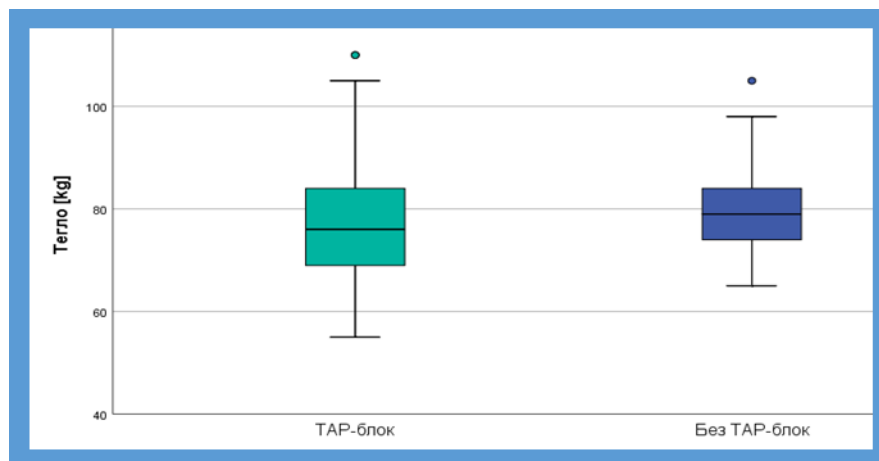
Figure 11. Weight distribution (in kg) of patients in the two main groups.

The results showed that the median age in the experimental group was 67 years (with IQR = 10.5) with the youngest patient being 47 years and the oldest 87 years. For the control group, the median age was 68 years (with IQR = 6) with the youngest patient here being 57 years and the oldest 83 years. These minimal differences in age between the two groups were statistically insignificant (U = 4,028, p = 0.24).

Regarding the weight of the patients in the experimental group - median equal to 76 kg (with IQR = 15), the patient with the lowest weight here was 55 kg and the highest 110 kg. The median weight in the control group was 79 kg (with IQR = 10.5), the patient with the lowest weight was 65 kg, and with the highest 105 kg. The difference obtained for this parameter also showed no statistical significance (U = 4 070, p = 0.192).

The relatively high age of the studied patients was determined by the nature of their underlying disease, which is why they underwent surgical intervention. Prostate carcinoma is more common in men over 65 years of age (13), colorectal carcinoma over 70 years of age (11), and bladder carcinoma mainly affects the population between 65 and 84 years of age (42). In recent years, however, there has been a decline in the age of patients in these groups (53), with the youngest patient being 47 years old and 22 patients (12.9%) under 60 years of age.

In the process of preparing the thesis, we also collected data on socially significant, chronic, comorbidities in our patient groups. The results are shown in Table 18 and Figure 12.

Comorbidity	Presence/ absence	Frequency TAP block	% TAP block	Frequency No TAP-block	% No TAP-block	χ^2	P
HBP	no	28	34.1	30	33.7		
	yes	54	65.9	59	66.3	0,003	0,95
	total	82	100	89	100		
DM	no	61	74.4	64	71.9		
	yes	21	25.6	25	28.1	0,133	0,71
	total	82	100	89	100		
IHD	no	65	79.3	68	76.4		
	yes	17	20.7	21	23.6	0,202	0,65
	total	82	100	89	100		
ICD	no	64	78	61	68.5		
	yes	18	22	28	31.5	1,962	0,16
	total	82	100	89	100		
COPD	no	75	91.5	81	91		
	yes	7	8.5	8	9	0,010	0,91
	total	82	100	89	100		
Obesity	no	55	67.1	60	67.4		
	yes	27	32.9	29	32.6	0,002	0,96
	total	82	100	89	100		

Table 18. Distribution of the main concomitant diseases in the experimental and control groups.
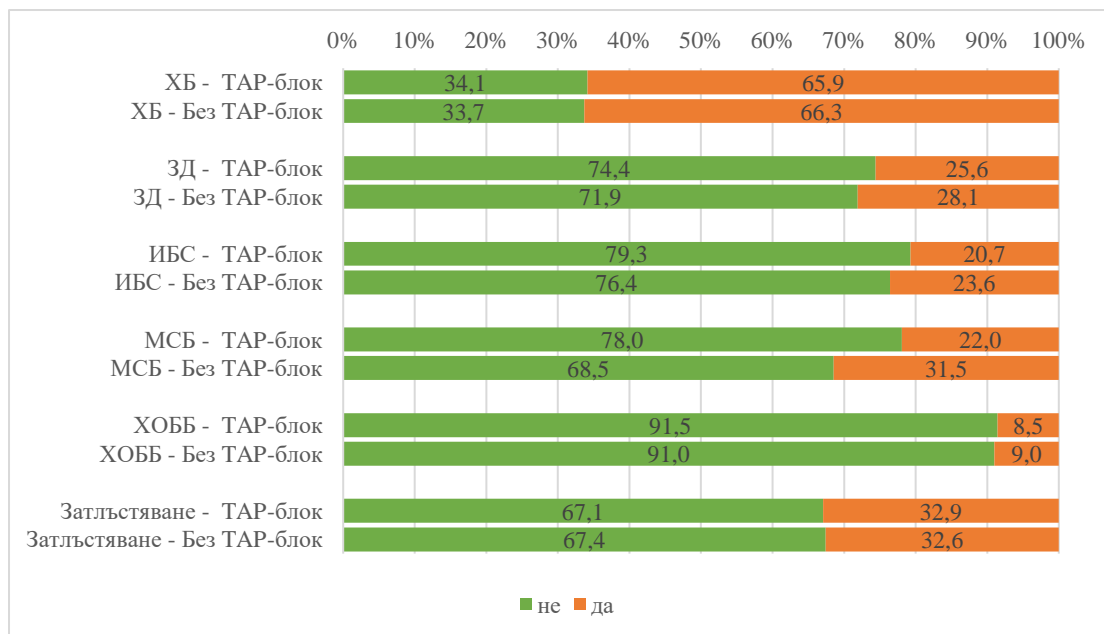
Figure 12. Percentage ratio of major comorbidities in patients in the experimental and control groups.

In the experimental group there were 54 (65.9%) patients with HBP, 21 (25.6%) with DM, 17 (20.7%) with IHD, 18 (22%) with ICD, 7 (8.5%) with COPD and 27 (32.9%) with obesity. Correspondingly, in the control group there were 59 (66.3%) patients with HBP, 25 (28.1%) with IHD, 21 (23.6%) with CHD, 28 (31.5%) with MS, 8 (9%) with COPD and 29 (32.6%) with obesity.

From the results obtained, it is noteworthy that there was no statistically significant difference in comorbidities between patients with TAR - block and those without TAR - block as presented in Table 18.

On the basis of the patients' comorbidities, we also determined the preoperative ASA functional status for the two study groups, respectively. The data from the analysis are shown in Table 19 and Figure 13.

ASA	Number TAP block	% TAP block	Number No TAP-block	% No TAP-block	χ^2	P
ASA II	44	53,7	35	39,3		
ASA III	38	46,3	54	60,7	3,52	0,060
Total	82	100,0	89	100,0		

Table 19. ASA distribution of patients in the two main groups.
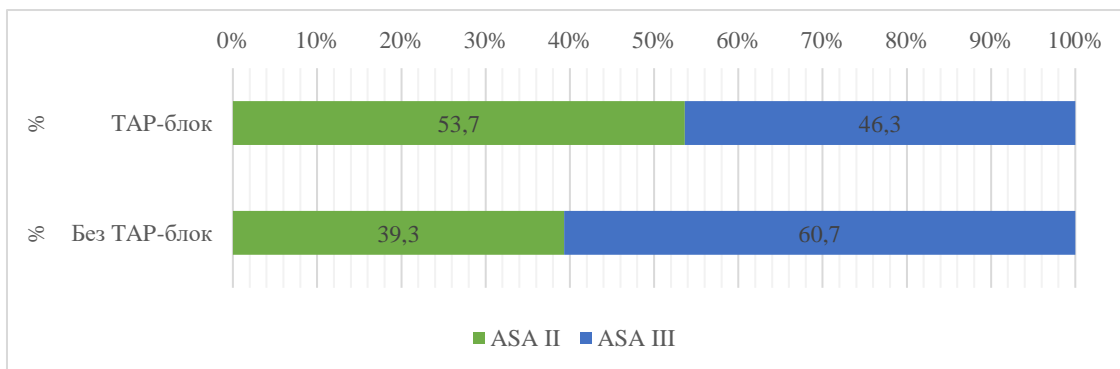
Figure 13. Percentage of patients according to ASA in the two main groups.

The results showed that 44 patients (53.7%) of the experimental group and 35 patients (39.3%) of the control group were ASA II. As ASA III, 38 patients (46.3%) of the experimental group and 54 (60.7%) of the control group were identified. Regarding perioperative status, the two groups showed no statistically significant difference between each other (2 = 3.52, p = 0.060).

Data on the duration of surgical interventions performed in the study groups are shown in Table 19 and Figure 14.

Duration [*min*]	*N*	*Mean*	*SD*	*Me*	*Q1*	*Q3*	*Min*	*Max*	Diff	*U-Тест*	*p*
TAP-block	82	172,96	17,73	174	160	188	135	208	4,14	3 203	0,167
No *TAP*-block	89	168,82	18,77	170	155	180	125	206			

Table 20. Descriptive statistics of the indicator duration of surgical intervention (in min.) for the experimental and control groups.
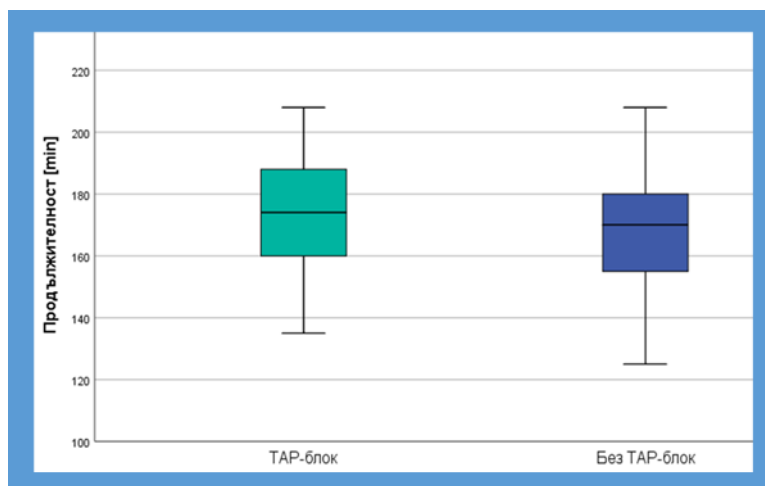
Figure 14. Duration of surgical intervention (in min) for the experimental and control groups.

From the results obtained, the median duration of operations for the experimental group was 174 min (IQR = 28). The shortest operation was 135 min and the longest 208 min. For the control group, the median was 170 min (IQR = 25). The shortest operation here was 125 min and the longest 206 min. The resulting differences between the surgical durations for the two study groups showed no statistical significance (U = 1.382, p = 0.167).

Based on all these results and the lack of statistically significant differences between the parameters in the two main groups, we concluded that they were comparable and comparable to each other. We can also assume that any significant difference in the follow-up was due to the block we performed.

For the purpose of the study, we divided the results into two main periods, namely, intraoperative and postoperative. We processed these data statistically and compared between the two main groups (with TAP-block and without TAP-block).

4.2 Intraoperative period

4.2.1. Dynamics of haemodynamic parameters in the intraoperative period

In task 2, we monitored the hemodynamic indices of SBP, DBP, MAP and HR at different time intervals, namely: after premedication, after anesthesia induction, at skin incision(SI), 30 min after SI, 60 min after SI, 90 min after SI, 120 min after SI, 150 min after SI, 180 min after SI and 10 min after extubation. We examined the penultimate two time ranges only in patients in whom the surgical intervention lasted longer than the respective times. As basal values, we took the readings at the 10th minute of premedication, when the catecholamine activity induced by mental stress in relation to the upcoming surgical intervention was overcome.

The results based on descriptive statistics and comparative analysis performed between the two groups are presented in Table 21, Table 22 and Table 23.

Intraoperative hemodynamic TAP -block	N	MEAN	SD	Range	Min	Max	Q1	Me	Q3	IQR
SBP 10 min after premed.	82	133,10	12,39	52,00	109,00	161,00	123,00	132,00	142,00	19,00
DBP 10 min after premed	82	77,99	9,70	36,00	62,00	98,00	70,75	76,50	82,25	11,50
MAP 10 min after premed.	82	89,98	10,28	47,00	69,00	116,00	82,75	88,50	99,00	16,25
HR 10 min after premed.	82	75,41	9,29	40,00	59,00	99,00	71,00	75,00	81,00	10,00
SBP 10 min after introduction	82	109,16	9,00	51,00	90,00	141,00	106,00	108,00	114,00	8,00
DBP 10 min after introduction	82	65,94	6,97	36,00	55,00	91,00	60,00	66,00	70,00	10,00
MAP 10 min after introduction	82	75,60	7,31	39,00	60,00	99,00	71,00	74,00	81,00	10,00
HR 10 min after introduction	82	66,60	5,52	24,00	55,00	79,00	62,00	66,00	71,00	9,00
SBP skin incision	82	125,02	14,97	61,00	91,00	152,00	116,00	122,00	138,00	22,00
DBP skin incision	82	74,04	11,86	50,00	56,00	106,00	63,75	72,50	79,00	15,25
MAP skin incision	82	85,74	12,92	50,00	66,00	116,00	76,00	85,00	98,00	22,00
HR skin incision	82	70,15	9,31	40,00	59,00	99,00	62,75	68,00	76,00	13,25
SBP 30 min after incision	82	123,70	13,98	65,00	96,00	161,00	114,00	121,00	132,00	18,00
DBP 30 min after incision	82	71,28	9,89	42,00	56,00	98,00	63,00	70,00	81,00	18,00
MAP 30 min after incision	82	79,60	11,95	45,00	66,00	111,00	70,00	75,00	90,00	20,00
HR 30 min after incision	82	71,39	10,90	42,00	59,00	101,00	63,00	68,00	77,00	14,00
SBP 60 min after incision	82	122,76	14,51	62,00	90,00	152,00	111,00	122,00	133,00	22,00
DBP 60 min after incision	82	70,59	12,03	51,00	55,00	106,00	61,00	68,00	78,25	17,25
MAP 60 min after incision	82	78,12	10,78	40,00	63,00	103,00	71,00	75,00	84,00	13,00
HR 60 min after incision	82	70,06	8,23	35,00	61,00	96,00	65,00	68,00	71,00	6,00
SBP 90 min after incision	82	123,57	14,00	65,00	96,00	161,00	114,00	121,00	132,00	18,00
DBP 90 min after incision	82	70,37	9,43	42,00	56,00	98,00	63,00	68,50	78,25	15,25
MAP 90 min after incision	82	77,27	9,15	33,00	66,00	99,00	69,00	75,00	81,00	12,00
HR 90 min after incision	82	71,16	7,66	32,00	61,00	93,00	66,00	68,50	77,00	11,00
SBP120 min after incision	82	118,21	13,81	56,00	95,00	151,00	107,50	116,00	126,00	18,50
DBP 120 min after incision	82	69,71	8,43	41,00	55,00	96,00	63,00	69,00	76,00	13,00
MAP 120 min after incision	82	71,91	8,61	43,00	53,00	96,00	66,00	72,00	78,00	12,00
HR 120 min after incision	82	69,32	6,00	39,00	59,00	98,00	65,75	69,00	72,00	6,25
SBP 150 min after incision	79	121,18	14,85	61,00	91,00	152,00	111,00	121,00	132,00	21,00
DBP 150 min after incision	79	71,41	10,63	50,00	56,00	106,00	63,00	69,00	78,00	15,00
MAP 150 min after incision	79	76,34	9,62	50,00	61,00	111,00	69,00	73,00	81,00	12,00
HR 150 min after incision	79	69,70	6,66	31,00	60,00	91,00	65,00	69,00	74,00	9,00
SBP 180 min after incision	24	120,21	10,28	42,00	101,00	143,00	112,25	121,00	126,00	13,75
DBP 180 min after incision	24	72,79	7,86	35,00	55,00	90,00	66,50	75,00	77,75	11,25
MAP 180 min after incision	24	75,38	8,79	31,00	61,00	92,00	69,25	77,00	81,00	11,75
HR 180 min after incision	24	69,17	5,81	22,00	61,00	83,00	65,00	68,50	71,75	6,75
SBP 10 min after ext.	82	131,61	12,30	70,00	91,00	161,00	122,50	131,00	141,00	18,50
DBP 10 min after ext.	82	77,61	9,65	39,00	61,00	100,00	68,75	76,00	82,00	13,25
MAP 10 min after ext.	82	94,98	11,51	58,00	60,00	118,00	90,00	95,00	103,00	13,00
HR 10 10 min after ext.	82	73,46	8,00	37,00	60,00	97,00	69,75	72,00	78,00	8,25

Table 21. Main intraoperative hemodynamic parameters in the TAP-block group.

Intraoperative hemodynamic without TAP -block	N	MEAN	SD	Range	Min	Max	Q1	Me	Q3	IQR
SBP 10 min after premed.	89	131,53	15,03	52,00	109,00	161,00	118,00	131,00	143,50	25,50
DBP 10 min after premed	89	78,42	13,18	41,00	60,00	101,00	67,00	72,00	91,00	24,00
MAP 10 min after premed.	89	93,24	15,80	70,00	66,00	136,00	78,00	96,00	101,00	23,00
HR 10 min after premed.	89	72,57	8,52	35,00	56,00	91,00	67,50	71,00	79,00	11,50
SBP 10 min after introduction	89	104,81	8,63	41,00	89,00	130,00	98,00	106,00	108,50	10,50
DBP 10 min after introduction	89	64,58	5,32	25,00	56,00	81,00	61,00	64,00	67,00	6,00
MAP 10 min after introduction	89	74,38	6,57	34,00	62,00	96,00	70,00	73,00	79,00	9,00
HR 10 min after introduction	89	66,74	8,24	42,00	54,00	96,00	61,00	67,00	70,00	9,00
SBP skin incision	89	141,84	10,78	63,00	103,00	166,00	139,00	144,00	146,00	7,00
DBP skin incision	89	87,25	14,85	51,00	61,00	112,00	76,50	90,00	99,00	22,50
MAP skin incision	89	101,02	17,10	64,00	65,00	129,00	88,00	107,00	113,00	25,00
HR skin incision	89	76,12	10,23	38,00	61,00	99,00	66,00	78,00	86,00	20,00
SBP 30 min after incision	89	130,61	14,57	60,00	101,00	161,00	118,00	132,00	141,00	23,00
DBP 30 min after incision	89	75,22	12,18	42,00	59,00	101,00	66,00	76,00	86,00	20,00
MAP 30 min after incision	89	88,20	14,61	54,00	67,00	121,00	74,00	88,00	98,00	24,00
HR 30 min after incision	89	74,83	7,07	30,00	61,00	91,00	69,00	74,00	81,00	12,00
SBP 60 min after incision	89	129,94	15,79	60,00	101,00	161,00	116,00	132,00	144,00	28,00
DBP 60 min after incision	89	76,64	12,51	50,00	61,00	111,00	66,00	71,00	86,00	20,00
MAP 60 min after incision	89	81,08	9,71	44,00	66,00	110,00	74,00	79,00	86,00	12,00
HR 60 min after incision	89	74,57	7,19	38,00	61,00	99,00	69,00	73,00	79,00	10,00
SBP 90 min after incision	89	130,33	14,96	60,00	101,00	161,00	117,00	132,00	141,00	24,00
DBP 90 min after incision	89	74,49	12,80	43,00	58,00	101,00	63,00	71,00	86,50	23,50
MAP 90 min after incision	89	80,60	8,02	33,00	66,00	99,00	74,00	82,00	85,00	11,00
HR 90 min after incision	89	76,25	6,72	30,00	66,00	96,00	72,00	74,00	80,50	8,50
SBP120 min after incision	89	126,03	16,45	60,00	101,00	161,00	114,00	124,00	144,00	30,00
DBP 120 min after incision	89	76,76	14,49	57,00	54,00	111,00	67,00	71,00	87,00	20,00
MAP 120 min after incision	89	78,65	7,83	30,00	66,00	96,00	72,00	77,00	84,50	12,50
HR 120 min after incision	89	74,76	5,23	23,00	65,00	88,00	69,00	74,00	78,00	9,00
SBP 150 min after incision	80	134,35	17,42	57,00	98,00	155,00	119,25	141,00	146,00	26,75
DBP 150 min after incision	80	80,76	14,45	50,00	61,00	111,00	69,00	77,00	91,00	22,00
MAP 150 min after incision	80	85,79	12,14	39,00	67,00	106,00	78,00	82,00	99,00	21,00
HR 150 min after incision	80	73,90	6,94	30,00	61,00	91,00	69,00	74,00	79,00	10,00
SBP 180 min after incision	12	126,33	12,47	31,00	113,00	144,00	113,00	127,00	136,00	23,00
DBP 180 min after incision	12	81,17	11,34	38,00	71,00	109,00	73,25	74,00	87,00	13,75
MAP 180 min after incision	12	80,67	7,75	23,00	66,00	89,00	79,00	81,00	87,00	8,00
HR 180 min after incision	12	75,75	3,57	10,00	71,00	81,00	72,00	77,00	78,75	6,75
SBP 10 min after ext.	89	144,45	11,39	54,00	111,00	165,00	139,00	148,00	152,00	13,00
DBP 10 min after ext.	89	86,74	9,27	37,00	69,00	106,00	81,00	88,00	91,00	10,00
MAP 10 min after ext.	89	107,65	7,96	35,00	87,00	122,00	101,50	109,00	113,00	11,50
HR 10 10 min after ext.	89	80,76	8,17	32,00	66,00	98,00	74,00	78,00	89,00	15,00

Table 22. Main intraoperative hemodynamic parameters in the group of patients without TAP-block.

Времеви интервал	Diff	Test	Value	*P*
SBP 10 min after premed.	1,00	U	3 349	0,353
DBP 10 min after premed	4,50	U	3 478	0,597
MAP 10 min after premed.	-7,50	U	4 035	0,233
HR 10 min after premed.	4,00	U	2 975	0,067
SBP 10 min after introduction	2,00	U	2 467	0,059
DBP 10 min after introduction	2,00	U	3 306	0,287
MAP 10 min after introduction	1,00	U	3 364	0,377
HR 10 min after introduction	-1,00	U	3 399	0,439
SBP skin incision	-22,00	U	5 936	<0,001
DBP skin incision	-17,50	U	5 414	<0,001
MAP skin incision	-22,00	U	3 367	<0,001
HR skin incision	-10,00	U	4 963	<0,001
SBP 30 min after incision	-11,00	U	4 700	0,001
DBP 30 min after incision	-6,00	U	4 238	0,068
MAP 30 min after incision	-13,00	U	4 912	<0,001
HR 30 min after incision	-6,00	U	4 782	<0,001
SBP 60 min after incision	-10,00	U	4 387	0,004
DBP 60 min after incision	-3,00	U	4 785	<0,001
MAP 60 min after incision	-4,00	U	4 462	0,012
HR 60 min after incision	-5,00	U	5 028	<0,001
SBP 90 min after incision	-11,00	U	4 618	0,003
DBP 90 min after incision	-2,50	U	4 193	0,092
MAP 90 min after incision	-7,00	U	4 633	<0,001
HR 90 min after incision	-5,50	U	5 308	<0,001
SBP120 min after incision	-8,00	U	4 618	0,003
DBP 120 min after incision	-2,00	U	4 627	0,002
MAP 120 min after incision	-5,00	U	5 133	<0,001
HR 120 min after incision	-5,00	U	5 667	<0,001
SBP 150 min after incision	-20,00	U	4 668	<0,001
DBP 150 min after incision	-8,00	U	4 411	<0,001
MAP 150 min after incision	-9,00	U	4 573	<0,001
HR 150 min after incision	-5,00	U	4 315	<0,001
SBP 180 min after incision	-6,125	t	-1,47	0,158
DBP 180 min after incision	1,00	U	1 945	0,090
MAP 180 min after incision	-4,00	U	203	0,045
HR 180 min after incision	-6,58	t	-4,19	0,000203
SBP 10 min after ext.	-17,00	U	5 719	<0,001
DBP 10 min after ext.	-12,00	U	5 479	<0,001
MAP 10 min after ext.	-14,00	U	6 079	<0,001
HR 10 10 min after ext.	-6,00	U	5 488	<0,001

Table 23. Comparison between intraoperative hemodynamic indices in the experimental and control groups.

The comparison of the intraoperative dynamics for the mean blood pressures (SBP, DBP and MAP) as well as the heart rates at different time intervals are shown in Figure 15 and Figure 16.
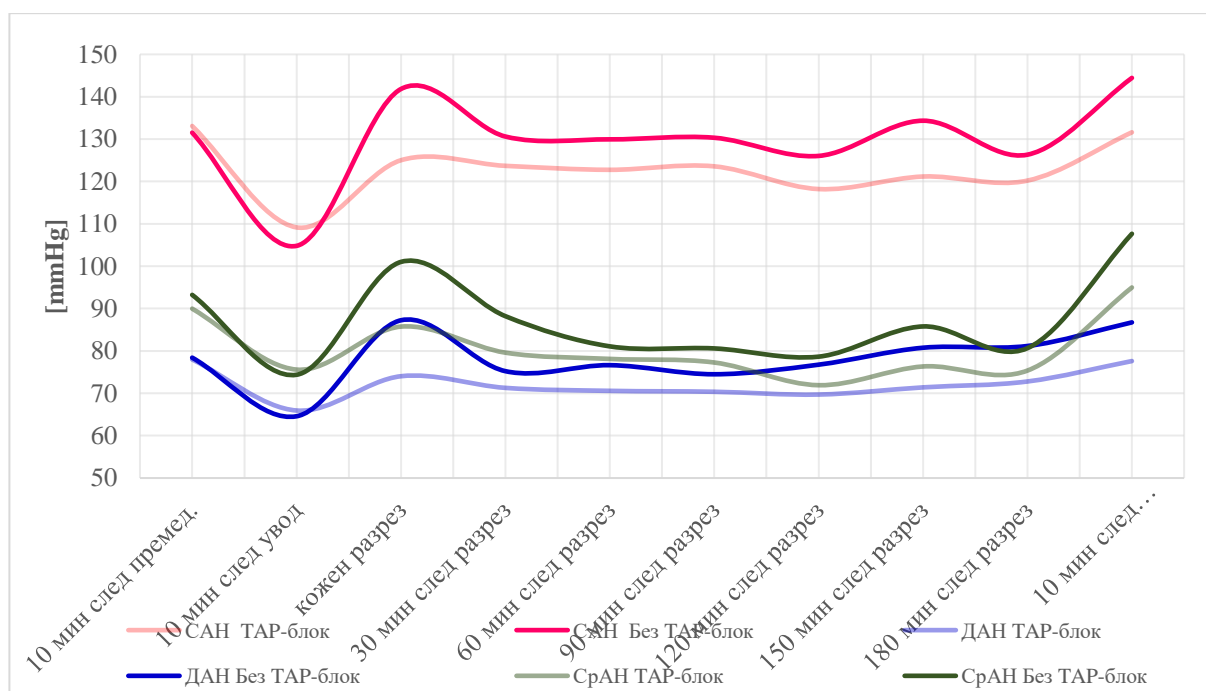

Figure 15. Comparison of the dynamics of mean blood pressure indices between the experimental and control groups in the intraoperative period.
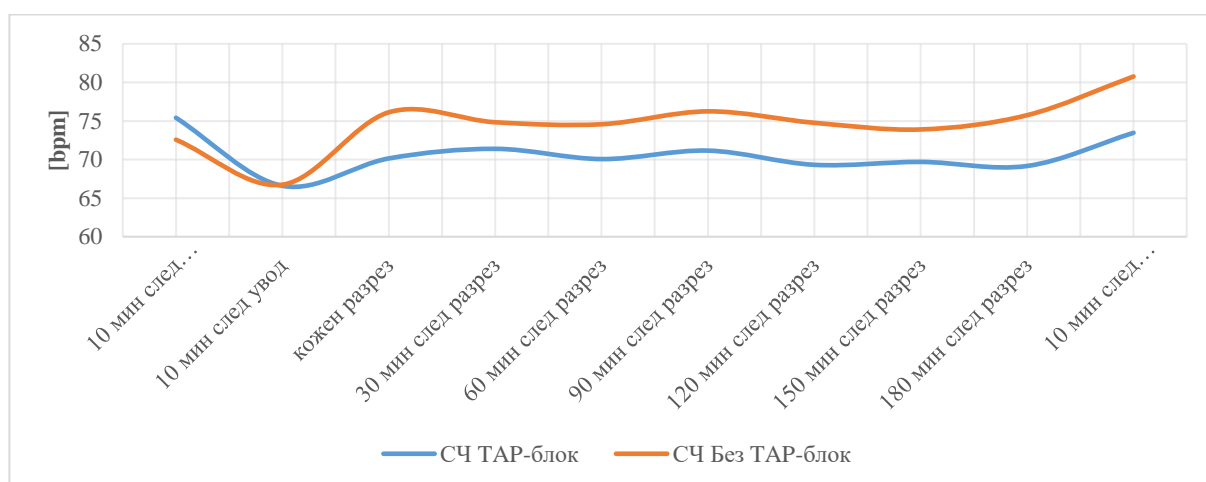

Figure 16. Comparison of the dynamics of the mean heart rate indices between the experimental and control groups in the intraoperative period.

Regarding the baseline level of the main hemodynamic parameters, which in our study were those after premedication, we found no statistically significant difference between the parameters in patients with TAP-block and those without TAP block as they were within the normal range. Median SBP in the experimental group was 132 mmHg (IQR = 19) and in the control group was 131 mmHg (IQR = 25) (U = 3349, p = 0.35). The median DBP in the experimental group was 76.5 mmHg (IQR = 11.5) and in the control group was 72 mmHg (IQR = 24) (U = 3478, p = 0.59). Median MAP in the experimental group was 88.5 mmHg (IQR = 16.25) and in the control group was 96 mmHg (IQR = 23) (U = 2975, p = 0.23). Median HR in

the experimental group was 75 wpm (IQR = 10) and in the control group was 71 wpm (IQR = 11.5) (U = 2467, p = 0.067).

As seen in Figure 15 and Figure 16, after induction of anaesthesia, there was a decrease in haemodynamic values in both groups. The median SBP in the experimental group dropped to 108 mmHg (IQR = 8) and in the control group to 106 mmHg (with IQR = 10.5), the median DBP in the experimental group to 66 mm/Hg (IQR = 10) and in the control group to 64 mm/Hg (IQR = 6), median CBP in the experimental group was 74 mm/Hg (IQR = 10) and for the control group was 73 mm/Hg (IQR = 9), median heart rate in patients with TAR block after induction of anesthesia was 66 ypm (IQR = 9) and in patients without TAR block was 67 ypm (with IQR = 9). However, none of the hemodynamic parameters in this time interval showed a statistical difference between the two groups (for each, respectively: U = 2467, p = 0.059; U = 3 306, p = 0.287; U = 3 364, p = 0.377; U = 3395, p = 0.439). The statistical significance of the differences is presented in Table 23.

The initial decrease in the mean values was due to the vasodilating and direct cardiodepressant effect of intravenous and inhalational anesthetics. Hypotension in noncardiac surgery is most commonly recorded in the period between induction into anesthesia and the start of surgery, the 5th-10th minute of induction (33).

Another distinct result is the rise in blood pressure values and heart rate after skin incision and the start of surgical intervention. The changes were attributed to surgical stress - pain and sympathetic activation resulting from inadequate analgesia. The difference in the degree of increase in patients of the two main groups is evident. After skin incision in the control group, the values exceeded the baseline levels, whereas those in the experimental group did not reach them. These results are shown in Figure 15 and Figure 16.

The mean SBP in the experimental group was 8 mm/Hg (SD $\pm$ 18.8) lower than the basal value (t = 3.88, p 0.0001), and that in the control group was 10.3 mm/Hg (SD $\pm$ 17.1) higher (t = 5.66, p 0.0001). The mean DBP in the experimental group was 3.9 mm/Hg (SD $\pm$ 14.5) lower than basal (t = 2.46, p < 0.0001) , and that in the control group was 8.8 mm/Hg (SD $\pm$ 18.6) higher than basal (t = 4.47, p < 0.0001). The mean MAP in the experimental group was 4.2 mm/Hg (SD $\pm$ 17.2) lower than basal (t = 2.22, p = 0.29), and that in the control group was 7.8 mm/Hg (SD $\pm$ 20.4) higher than basal (t = 3.59, p = 0.001). The mean HR in the experimental group was 5.2 wpm (SD $\pm$ 10.1) lower than basal HR (t = 4.72, p < 0.001), and that in the control group was 3.5 wpm (SD $\pm$ 9.6) higher than basal HR (t = 3.47, p = 0.001).

When comparing the hemodynamic indices of the skin section, the data showed distinctly higher values in the control group compared to the experimental group. In patients with TAP-block, the median SBP was 122 mmHg (IQR 22 mmHg), and in those without TAP-block, the median SBP was 144 mmHg (IQR 7 mmHg), a statistically significant result (U = 5414, p < 0.001). The median DBP at skin incision in the experimental group was 72.5 mmHg (with IQR 15.25 mmHg), and in the control group was 90 mmHg (IQR 22.5 mmHg). These values also showed a statistically significant difference (U = 5414, p < 0.001). In terms of MAP, the median was 85 mmHg (IQR of 22 mmHg) and 107 mmHg (IQR of 25 mmHg), respectively, and this result also showed a statistically significant difference (U = 5556, p < 0.0001). Heart rate changes also showed a statistically significant difference between each other with higher values in the control group. In the experimental group, the median heart rate was 68 y/min (with IQR 13.25) and in the control group 78 y/min (IQR 20), respectively (U = 4963, p < 0.001).

The differences in hemodynamics at skin incision are, in our opinion, due to the synergistic analgesic effect of preoperatively administered TAP-block and intravenous opiate (Fentanyl). In a study of healthy volunteers conducted by McDonnell et al. data on the onset of

sensory block were recorded approximately 90 min after infiltration of local anesthetic into the TAP-space (34), whereas in our study the time to skin incision was on average 18.36 min after administration of TAP-block.

Comparison in hemodynamic indices between the two main groups at skin incision are shown in Figure 17 and Figure 18.
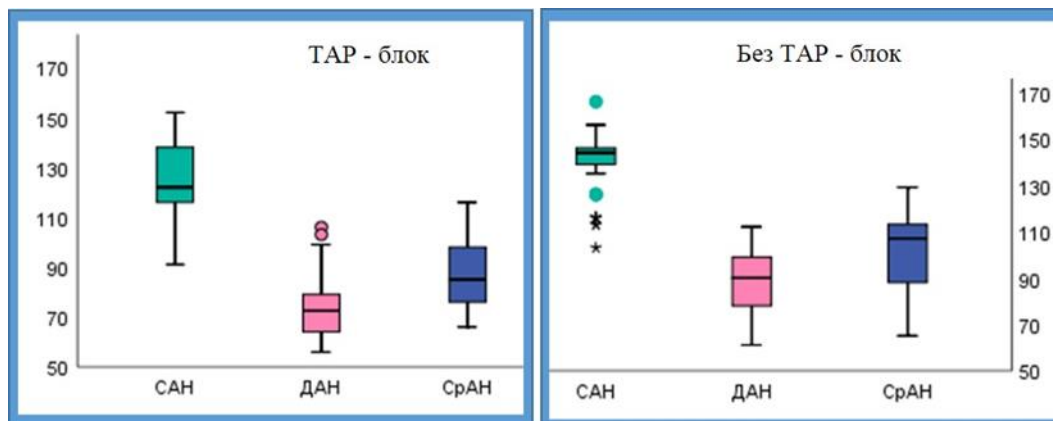

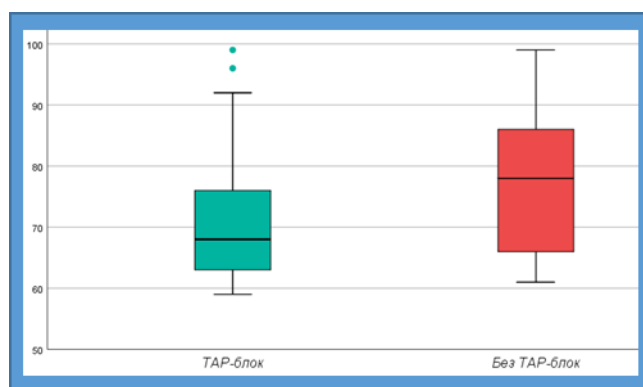Figure 17. Comparison of blood pressure indices after surgical incision in the two main groups.

Figure 18. Comparison of heart rate indices after surgical incision in the two main groups.

Figure 15 and Figure 16 also show that after the onset of surgery, there was again a slight decline and subsequent plateau in the curve of blood pressure (BP), heart rate (HR) and maintenance of stable vital signs during surgery in both groups. Values in the control remained higher throughout compared with the experimental group, but normotension and normofrequency were maintained in both cases. In the experimental group, the median values for MAP ranged between 72 and 77 mmHg and for HR between 68 and 75 y/min. In the control group, the median values for MAP were between 77 and 88 mmHg and for HR 73-77 y/min, respectively.

From the same figures, it can be seen that after the end of the surgical intervention and extubation of the patients, there was again a rise in the mean values of the blood pressure and HR indices. The data showed that in patients with TAP-block the median for SBP was 131 mmHg (IQR 18.5) and in those without TAP-block the median for SBP was 148 mmHg (IQR 13), a statistically significant difference (U = 5719, p < 0.001). The median for DBP after extubation in the experimental group was 76 mmHg (IQR 13.25) and for the control group 88

mmHg (IQR 10.00), also showing a statistically significant difference (U = 5479, p < 0.001). For MAP in the experimental group, the median was 95 mmHg (IQR 13) and for the control 109 mmHg (IQR 11.50), again showing a statistically significant difference (U = 6079, p < 0.001). Regarding heart rate, the median in the experimental group was 72 b.p.m. (IQR 8.25) and in the control group it was 78 b.p.m. (IQR 15.00), again showing a statistically significant difference (U = 5488, p < 0.001). This is shown in Table 23.

Comparison in hemodynamic indices between the two main groups after extubation are shown in Figure 19 and Figure 20.
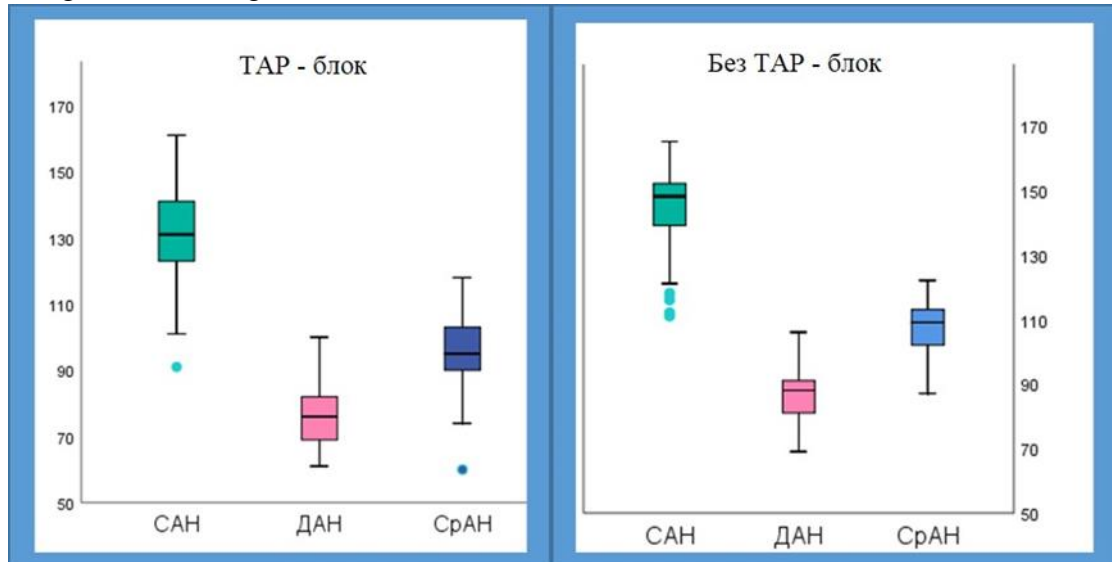
Figure 19. Comparison in blood pressure readings 10 minutes after extubation in the two main groups.
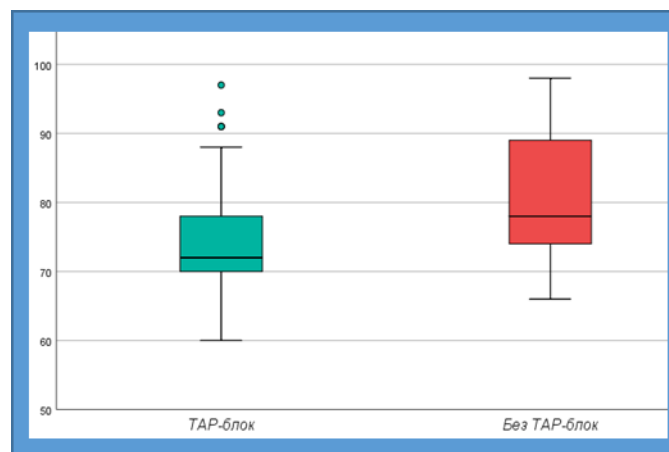
Figure 20. Comparison in heart rate indices 10 minutes after extubation in the two main groups.

The results clearly show the higher blood pressure and HR values in patients without TAP-block. This also predetermines a greater hemodynamic instability, especially with regard to HR in the early postoperative period. Similar results to those we obtained are found in studies by other authors such as Sekulovsky et al. and Liu et al. (9, 130). They also reported higher blood pressure, HR and generally more pronounced hemodynamic instability in patients without TAP-block compared with those with TAP-block. However, some studies such as that

of Bhattacharjee et al. (8) did not show statistically significant differences in hemodynamic indices immediately after extubation.

With the development of modern anesthesiology, the intraoperative period is becoming safer for patients. However, patients with cardiovascular disorders remain at high risk for perioperative cardiovascular complications, especially in major abdominal surgery (20). Furthermore, many patients undergoing abdominal surgery, especially oncologic surgery, are elderly and classified as ASA III or older. This determines the need and challenge for the anesthesiologist to maintain stable hemodynamics during the perianesthetic period in these patients. Under surgical stress, an imbalance between sympathetic and parasympathetic activity occurs. The changes that occur in this situation are most often related to increased sympathetic activity; a stress response is generated, most often reflected by hemodynamic changes - increased heart rate, blood pressure, pupillary dilation, sweating or lacrimation may occur (30). Patients with TAP-block show better hemodynamic stability intraoperatively.

4.2.2 Intraoperative opiate consumption

In task 3 regarding intraoperative opioid consumption, we found that in the experimental group the mean total dose of Fentanyl used was 302.13 µg (SD ± 61.26). The minimum dose administered was 200 µg (in two patients) and the maximum was 550 µg (in one patient). In the control group, the mean amount of Fentanyl used was 327.53 µg (SD ± 50.99). The minimum dose used here was 200 µg (in five patients) and the maximum was 450 µg (in one patient). These data are shown in Table 24.

Intraoperative *Fentanyl*	N	*Mean*	*SD*	*Me*	*Q1*	*Q3*	*IQR*	*Min*	*Max*	*Range*
TAP-block	82	302.13	61.26	300	250	350	100	200	550	350
no *TAP*-block	89	327.53	50.99	350	300	350	50	200	450	250

Table 24. Intraoperative administration of Fentanyl.

Despite the greater range of Fentanyl doses administered in the experimental group, the data indicate that the total dose of opiate used was 7.93% less than in the control group, a result of high statistical significance (t = 2.95, p = 0.003). Figure 21 shows the median dose of Fentanyl used intraoperatively.
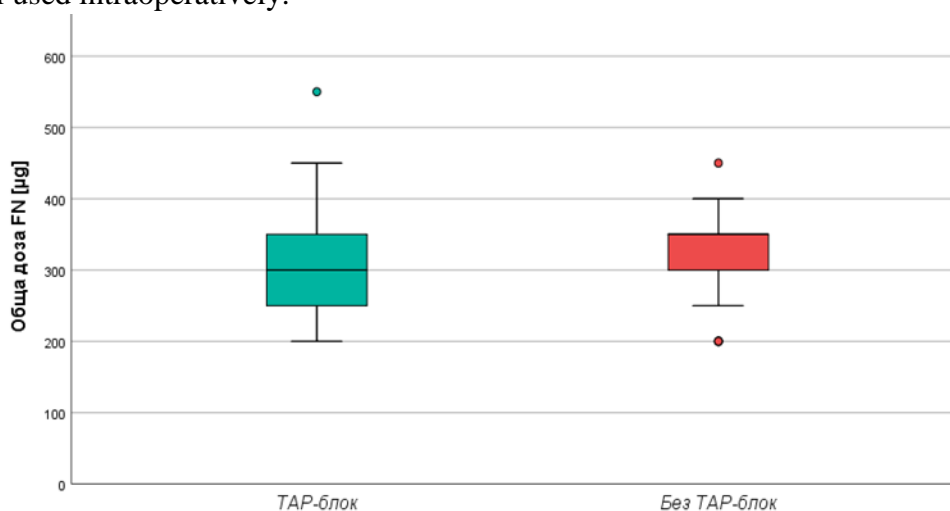

Figure 21. Comparison between the total dose of opiate (Fentanyl) used intraoperatively in the TAP-block group and the non-TAP-block group.

We compared the data we obtained with those of other authors who followed intraoperative opioid consumption in patients with and without TAP-block. Although it is believed that TAR-block does not affect visceral pain, our results on this indicator are similar to those of: M. Sekulowsky et al. Karaman et al. Liu et al. and Paul et al. (8, 111, 128, 154), who also showed reduced intraoperative opiate consumption. However, other authors reported no differences in the amount of intraoperative opiate use in patients with TAR block compared with those without TAP-block (63, 87).

FN [µg/kg]	N	Mean	SD	Me	Q1	Q3	IQR	Min	Max	Range	U-test	p
TAP-block	82	3,94	0,89	3,95	3,30	4,29	0,99	2,27	7,24	4,97	4 374,5	0,025
no TAP-block	89	4,18	0,77	4,17	3,80	4,63	0,83	2,70	5,88	3,18		

Table 25. Intraoperative use of Fentanyl[µg/kg].
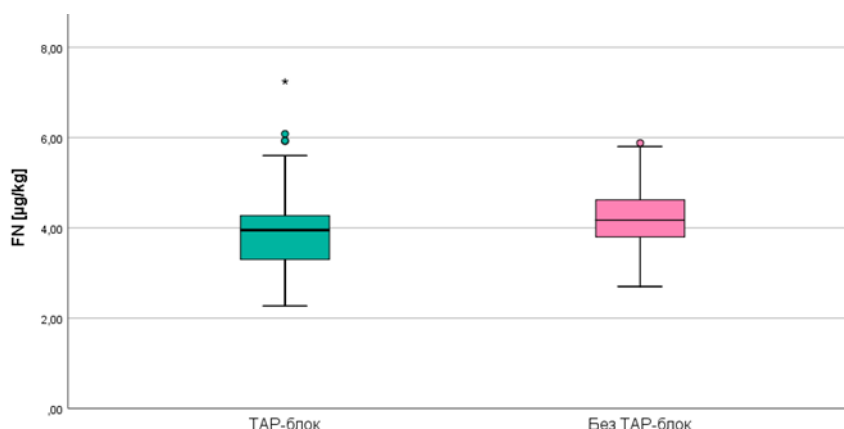
Figure 22. Comparison in intraoperative Fentanyl use [µg/kg] in patients with TAR block and those without TAP-block.

It is clear from the data shown in Table 25 and Figure 22 that there is a statistically significant difference in the administration of intraoperative Fentanyl not only in its absolute value but also in the dose per kilogram of body weight (U - test = 4 374.5, p = 0.025).

Adequate intraoperative analgesia in lower abdominal surgery can be achieved by several different means. One possibility is with epidural anesthesia. The increasing use of anticoagulants and antiaggregants, particularly in patients with cardiovascular disease in whom the maintenance of adequate hemodynamics is of paramount importance, may greatly reduce the indications for the use of neuroaxial techniques. In addition, episodes of hypotension or cardiac rhythm disturbances can often be observed during epidural anaesthesia. Another method of intraoperative analgesia is through the use of opiate analgesics. To achieve adequate analgesia and maintain stable hemodynamics, especially in major surgical interventions, the use of relatively high doses of opiates is often necessary. This in turn can lead to delayed recovery from anaesthesia and subsequent complications from opiate medications. The administration of TAR-block is accompanied by reduced opiate consumption, which we believe is due to the synergistic analgesic effect of the local anaesthetic and Fentanyl used. Therefore, its use as part of multimodal anaesthesia has advantages over these two methods.

4.2.3. Verbal pain scale

In Task 4, we chose to use the verbal pain scale to assess pain in the immediate period after completion of the surgical intervention. The results were compared for the two groups of patients and are shown in Table 26 and Figure 23.

Verbal Pain Scale	TAP - block		No TAP - block		Fisher's exact test	p
	Number	%	Number	%		
Липса на болка	52	63,4	7	7,9		
Лека болка	29	35,4	41	46,1		
Умерена болка	1	1,2	33	37,1	84,39	p<0,001
Нетърпима болка	0	0	8	9,0		
Общо	82	100,0	89	100		

Table 26. Comparison between patients in the experimental and control groups with respect to the verbal pain scale after extubation.
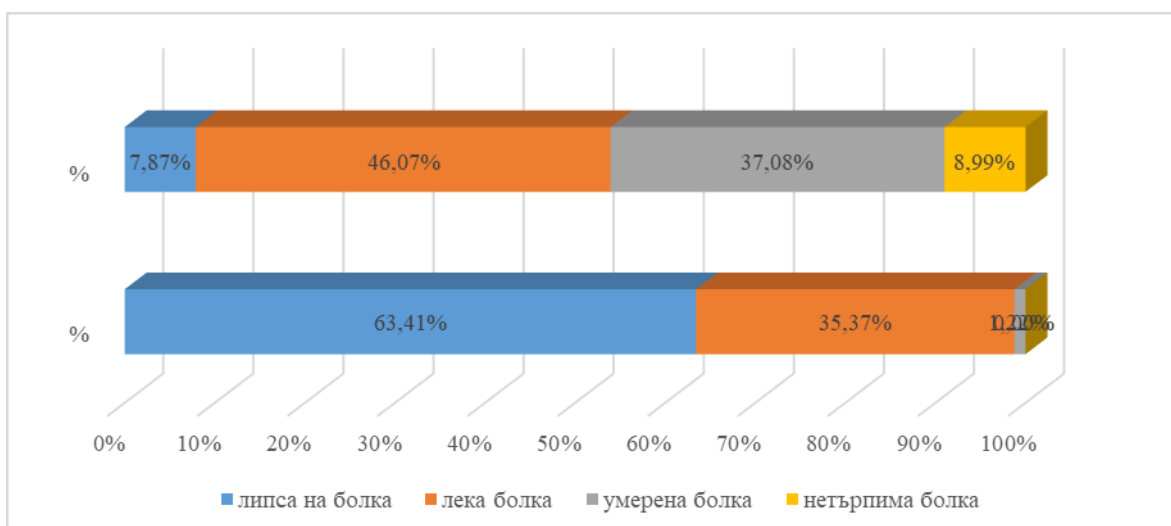
Figure 23. Distribution of patients according to pain severity after extubation.

The results showed that in the experimental group, 52 patients (63.4%) reported no postoperative pain and 29 patients (35.4%) reported mild postoperative pain. Only one patient of those with TAP-block reported moderate pain and none reported severe pain, while in the control group only 7 patients (7.9%) reported no pain, 41 (46.1%) reported mild pain, 33 (37.1%) reported moderate pain and 8 patients reported severe pain. The difference in pain sensation between the two groups was of very high statistical significance (Fisher's exact tes = 84.39, $p < 0.001$).

Regarding the mean value of the verbal pain scale in the experimental group it was 0.378 (SD $\pm$ 0.513) and in the control group it was 1.47 (SD $\pm$ 0.770) and this difference was statistically significant (U = 1040, p = 0.001). This is shown in Table 27 and Figure 24.

Verbal Pain Scale	Groups	N	Mean	Median	SD	SE
	TAP- block	82	0.378	0	0.513	0.0566
	No *TAP*-block	89	1.47	1	0.77	0.0816

Table 27. Mean values of the verbal pain scale in the two main groups.
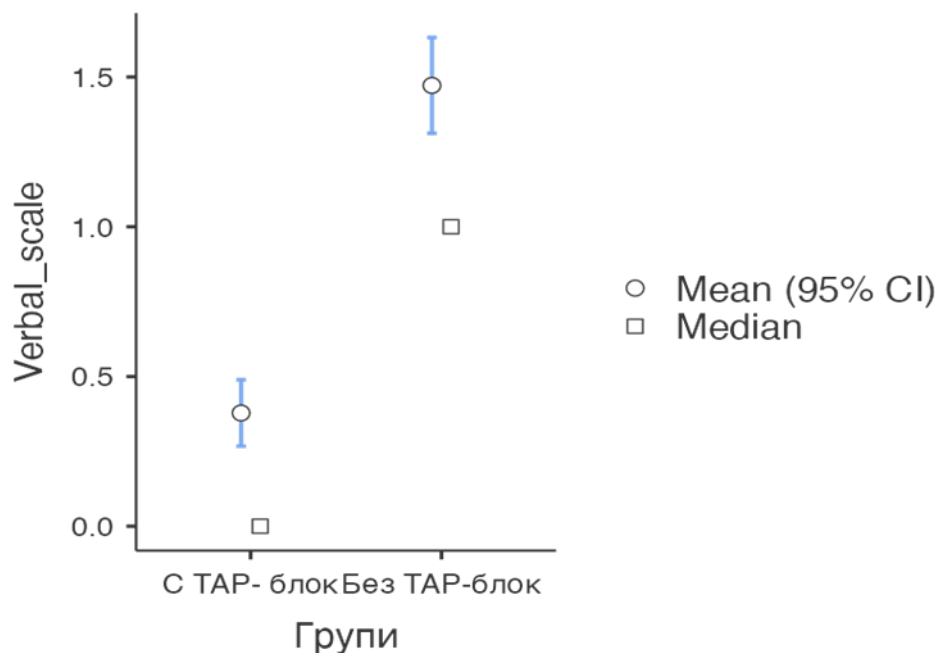
Фигура 24. Разлика между показателите на вербалната скала при двете основни групи.

Our data are similar to those obtained from other studies investigating pain in the earliest postoperative period (15, 63, 142), which showed lower levels of intensity in patients with TAR block compared with those without TAP-block. We believe that these results are due to the analgesic effect of TAR-block on the parietal abdominal surface, whose soreness is strongest in the early postoperative period.

However, other authors such as Griffits et al. (22) found no statistically significant difference in the pain scale immediately after surgery in the two groups of patients.

4.3. Postoperative period

Postoperatively, we monitored pain indices, hemodynamic indices, analgesic medications used and manifestations of complications from them. We compared the results between the two groups of patients with and without TAP-block.

4.3.1. Postoperative pain

In task 4, we monitored postoperative pain by assessing VAS. We performed the assessment for the experimental and control groups at rest, when coughing and when turning in bed and compared them with each other.

4.3.1.1. Postoperative pain at rest

From the time the patient was transported and transferred to the bed in the surgical ward, we used VAS to assess the level of pain. The data at rest in both groups are shown in Table 28.

VAS in rest	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block
	30min		3th h		6th h		12th h		18th h		24th h	
Mean	1.62	5.40	2.45	5.63	3.06	5.46	3.22	5.00	3.88	4.39	3.01	3.66
Me	2.00	5.00	3.00	6.00	3.00	5.00	3.00	5.00	4.00	4.00	3.00	4.00
SD	0.90	1.50	1.11	1.09	0.88	1.08	0.82	0.99	0.84	0.94	0.60	0.71
Min	0.00	2.00	0.00	3.00	1.00	4.00	1.00	4.00	3.00	3.00	2.00	3.00
Max	3.00	8.00	5.00	8.00	5.00	8.00	5.00	7.00	6.00	7.00	5.00	6.00
Range	3.00	6.00	5.00	5.00	4.00	4.00	4.00	3.00	3.00	4.00	3.00	3.00
Q1	1.00	5.00	2.00	5.00	3.00	5.00	3.00	4.00	3.00	4.00	3.00	3.00
Q3	2.00	7.00	3.00	6.00	4.00	6.00	4.00	6.00	4.00	5.00	3.00	4.00
IQR	1.00	2.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00	0.00	1.00

Table 28. VAS parameters at rest for patients with TAP-block and those without TAP-block in different time ranges.

We followed the results in the different time intervals.

30th postoperative minute at rest

At the 30th minute, the mean VAS in the experimental group was 1.66 (SD ± 0.9), here the minimum score given by the patients was 0 and the maximum was 3. In the control group, the mean value was 5.42 (SD ± 1.5) with the minimum score being 2 and the maximum being 8. These results show a significant statistical difference between the two groups studied (U = 7144, p < 0.001).

Pain assessment at 30 min		In rest			Pain assessment at 3th h		In rest		
		TAP-block	no *TAP*-block	**Total**			*TAP*-block	no*TAP*-block	**Total**
No pain	Number	11	0	11	No pain	Number	3	0	3
	%	13,4%	0%	6,4%		%	3,7%	0,0%	1,8%
Mild pain	Number	71	9	80	Mild pain	Number	71	5	76
	%	86,6%	10,1%	46,8%		%	86,6%	5,6%	44,4%
Moderate pain	Number	0	57	57	Moderate pain	Number	8	66	74
	%	0,0%	64,0%	33,3%		%	9,8%	74,2%	43,3%
Severe pain	Number	0	23	23	Severe pain	Number	0	18	18
	%	0,0%	25,8%	13,5%		%	0,0%	20,2%	10,5%
Total	Number	82	89	171	Total	Number	82	89	171
	%	100,0%	100,0%	100,0%		%	100,0%	100,0%	100,0%
Fisher's exact tes		168,67			*Fisher's exact tes*		142,01		
p		<0,001			*p*		<0,001		

Table 29. Subjective assessment of pain for the 30th minute and 3rd postoperative hour at rest.

Table 29 shows that in the experimental group 11 patients (13.4%) reported no pain (VAS - 0) from the surgical intervention, 71 patients (86.6%) reported little pain (VAS 1-3). None of the patients with applied TAR-block reported feeling moderate or severe postoperative pain in this period. In the control group, on the other hand, there were no patients who reported no postoperative pain in this period. Mild pain was experienced by 9 patients (10.1%), moderate pain (VAS 4-6) was reported by 57 patients (64%), and severe pain (VAS 7-9) was reported by 23 patients (25.8%). It is evident from the results that patients in the experimental group experienced less severe pain, and this was statistically significant (Fisher's exact tes - 168.67, p < 0.001).

3rd postoperative hour at rest

At the 3rd postoperative hour at rest, the mean VAS score in the experimental group was 2.5 (SD ± 1.23), here the minimum score was 0 and the maximum score was 5. In the control group, the median score was 5.63 (SD ± 1.19) with a minimum pain score of 3 and a maximum score of 8. These results indicate a significant statistical difference between the two groups (U = 6816, p < 0.001) .

Table 29 shows that in the experimental group, 3 patients (3.7%) reported no pain from the surgical intervention, 71 patients (86.6%) reported mild pain, and 8 patients (9.8%) reported moderate pain. None of the patients who underwent TAR-block reported feeling of severe surgical pain in this period. There were no patients in the control group who reported no postoperative pain. Mild pain was experienced by 5 patients (5.6%), 66 patients (74.2%) reported moderate pain and 18 patients (20.2%) reported severe pain. More severe pain in the control group in this time period as well as in the previous time period was statistically significant (Fisher's exact tes - 142.01, p < 0.001).

6th postoperative hour at rest

At the 6th postoperative hour at rest, the mean VAS score in the experimental group was 3.16 (SD ± 0.77), here the minimum score was 1 and the maximum score was 5. In the

control group, the mean value was 5.35 (SD ± 1.16) with a minimum score of 4 and a maximum score of 8. These results indicate a significant statistical difference between the two groups (U = 7078, p < 0.001).

Pain assessment at 6th h		In rest			Pain assessment at 12th h		In rest		
		TAP-block	no TAP-block	Total			TAP-block	no TAP-block	Total
No pain	Number	0	0	0	No pain	Number	0	0	0
	%	0,0%	0,0%	0,0%		%	0,0%	0,0%	0,0%
Mild pain	Number	60	0	60	Mild pain	Number	51	0	51
	%	73,2%	0,0%	35,1%		%	62,2%	0,0%	29,8%
Moderate pain	Number	22	70	92	Moderate pain	Number	31	79	110
	%	26,8%	78,7%	53,8%		%	37,8%	88,8%	64,3%
Severe pain	Number	0	19	19	Severe pain	Number	0	10	10
	%	0,0%	21,3%	11,1%		%	0,0%	11,2%	5,8%
Total	Number	82	89	171	Total	Number	82	89	171
	%	100,0%	100,0%	100,0%		%	100,0%	100,0%	100,0%
Fisher's exact tes		127,31			Fisher's exact tes		98,6		
p		<0,001			p		<0,001		

Table 30. Subjective pain assessment for the 6th and 12th postoperative hour at rest.

Table 30 shows that in the experimental group there were no patients who no longer experienced postoperative pain from the surgical intervention, 60 patients (73.2%) reported mild pain, and 22 patients (26.8%) reported moderate pain. In this period, none of the patients with applied TAR-block reported feeling of severe postoperative pain. There were no patients in the control group who experienced no or mild postoperative pain. Moderate intensity pain was reported by 70 patients (78.7%) and severe pain by 19 patients (21.3%). The more severe pain in the group without TAR-block was statistically significant (Fisher's exact tes - 127.31, p < 0.001).

12th postoperative hour at rest

At the 12th postoperative hour at rest, the mean VAS score in the experimental group was 3.28 (SD ± 0.66), here the minimum score was 1 and the maximum score was 5. In the control group, the mean value was 4.85 (SD ± 0.97) with a minimum score of 4 and a maximum score of 7. These results indicate a significant statistical difference between the two groups (U = 6720, p < 0.001).

Table 30 shows that there were no patients in the experimental group who did not experience postoperative pain, 51 patients (62.2%) reported mild pain, and 31 patients (37.8%) reported moderate intensity pain. Again, none of the patients who underwent TAP-block reported feeling of severe postoperative pain. There were no patients in the control group who reported no or mild postoperative pain. Moderate intensity pain was reported by 79 patients (88.8%) and severe pain by 10 patients (11.2%). More severe pain in the control group was statistically significant (Fisher's exact tes - 98.6, p < 0.001).

18th postoperative hour at rest

At the 18th postoperative hour at rest, the mean VAS score in the experimental group was 3.76 (SD ± 0.70) with a minimum score of 3 and a maximum score of 6. In the control group, the mean score was 4.26 (SD ± 0.87) with a minimum score of 3 and a maximum score of 7. These results indicate a statistical difference between the two groups (U = 4832, p = 0.034).

Pain assessment at 18th h		In rest			Pain assessment at 24th h		In rest		
		TAP-block	no *TAP*-block	Total			*TAP*-block	no *TAP*-block	Total
No pain	Number	0	0	0	No pain	Number	0	0	0
	%	0,0%	0,0%	0,0%		%	0,0%	0,0%	0,0%
Mild pain	Number	27	7	34	Mild pain	Number	75	41	116
	%	32,9%	7,9%	19,9%		%	91,5%	46,1%	67,8%
Moderate pain	Number	55	78	133	Moderate pain	Number	7	48	55
	%	67,1%	87,6%	77,8%		%	8,5%	53,9%	32,2%
Severe pain	Number	0	4	4	Severe pain	Number	0	0	0
	%	0,0%	4,5%	2,3%		%	0,0%	0,0%	0,0%
Total	Number	82	89	171	Total	Number	82	89	171
	%	100,0%	100,0%	100,0%		%	100,0%	100,0%	100,0%
Fisher's exact tes		19,55			χ^2		40,31		
p		0,038			*p*		0,028		

Table 31. Subjective pain score for the 18th and 24th postoperative hour at rest.

Table 31 shows that there were no patients in the experimental group who did not experience postoperative pain from the surgical intervention, 27 patients (32.9%) reported mild pain, and 55 patients (67.1%) reported moderate intensity pain. Again, none of the patients who underwent TAP-block reported feeling of severe postoperative pain. There were no patients in the control group who reported no postoperative pain. Slight pain intensity was experienced by 7 patients (7.9%), moderate pain by 78 patients (87.6%), and severe pain by 4 patients (4.5%). The more severe pain in the control group was statistically significant (Fisher's exact tes - 19.55, p = 0.038).

24th postoperative hour at rest

At the 24th postoperative hour at rest, the mean VAS score in the experimental group was 2.96 (SD ± 0.36), here the minimum score was 2 and the maximum score was 5. In the control group, the mean value was 3.61 (SD ± 0.5) with a minimum score of 3 and a maximum score of 6. These results indicate a statistical difference between the two groups (U = 5451, p = 0.026).

Table 31 shows that there were no patients in the experimental group who experienced no pain from the surgical intervention, 75 patients (91.5%) reported mild pain, and 7 patients (8.5%) reported moderate intensity pain. Again, none of the patients who underwent TAP-block reported feeling severe postoperative pain. In the control group, all patients reported pain of varying intensity. 41 patients (46.1%) reported mild pain and 48 patients (53.9%) reported moderate pain. The more severe pain in the control group was also statistically significant in this time period (2 = 40.3, p = 0.028).
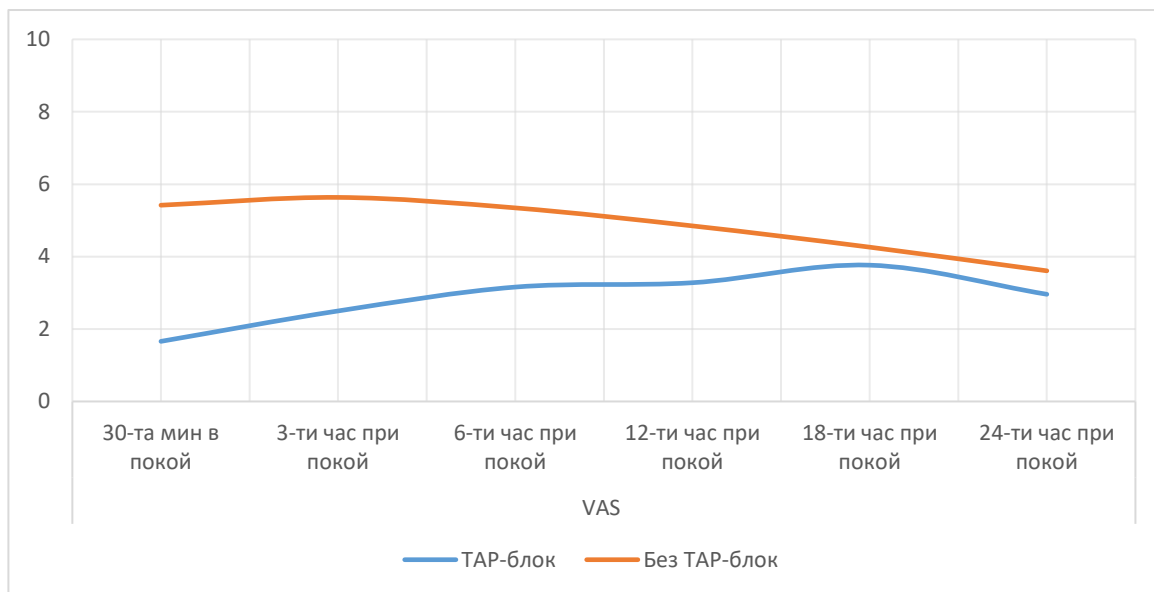
Figure 25. Comparison of mean VAS values at rest between the two main groups.

From the results presented above and from the curve of the mean VAS values shown in Figure 25, the distinct difference and higher degree of pain sensation in patients without a previously applied TAP-block compared to those with one is striking. At the 18th postoperative hour, the performance of the two curves converged significantly, but the differences nevertheless remained statistically significant. Although distinct, this difference has little clinical significance because in both cases subjectively pain was described as mainly mild or moderate. The situation was similar at the 24th postoperative hour. This gives us reason to believe that the effect of the TAR-block begins to diminish after the 18th hour. A similar claim has been made by other authors such as Liu et al. (32).

Assessment of the intensity and control of acute postoperative pain at rest are important to ensure patient comfort at the bedside. However, adequate relief of dynamic pain during mobilization, deep breathing, and coughing is more important to reduce the risks of cardiopulmonary and thromboembolic complications after surgery. Effective management of dynamic pain facilitates mobilization and may therefore improve long-term postoperative prognosis (10).

4.3.1.2. Postoperative pain on coughing and turning in bed

Data on the degree of dynamic pain in the postoperative period in patients with and without TAR block are presented in Table 32, 33 and Figure 26, 27.

VAS coughing	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block
	30min		3th h		6th h		12th h		18 th h		24 th h	
Mean	2.91	6.49	4.46	6.52	4.49	6.28	4.59	6.33	4.74	5.78	4.20	4.71
Me	3.00	6.00	5.00	6.00	5.00	6.00	5.00	6.00	5.00	6.00	4.00	5.00
SD	0.83	1.11	0.83	1.14	1.00	0.99	0.85	0.79	0.58	0.67	0.79	0.74
Min	1.00	4.00	3.00	3.00	3.00	4.00	2.00	5.00	4.00	5.00	3.00	3.00
Max	4.00	9.00	6.00	8.00	6.00	8.00	6.00	8.00	6.00	8.00	6.00	6.00
Range	3.00	5.00	3.00	5.00	3.00	4.00	4.00	3.00	2.00	3.00	3.00	3.00
Q1	2.00	6.00	4.00	6.00	3.75	6.00	4.00	6.00	4.00	5.00	4.00	4.00
Q3	4.00	7.00	5.00	7.00	5.00	7.00	5.00	7.00	5.00	6.00	5.00	5.00
IQR	2.00	1.00	1.00	1.00	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 32. Cough VAS scores for patients with TAP-block and those without TAR-block in different time ranges.

VAS movement	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block	TAP-block	no TAP-block
	30 min		3 th h		6 th h		12 th h		18 th h		24 th h	
Mean	2.91	7.31	4.77	6.87	4.63	6.83	4.67	6.18	4.76	5.61	3.87	4.69
Me	3.00	7.00	5.00	7.00	5.00	7.00	5.00	6.00	5.00	6.00	4.00	5.00
SD	0.93	0.81	0.76	0.93	0.94	0.97	1.02	1.03	0.53	0.49	0.73	0.70
Min	1.00	5.00	3.00	5.00	2.00	5.00	2.00	4.00	4.00	5.00	2.00	4.00
Max	5.00	9.00	6.00	9.00	6.00	9.00	6.00	8.00	6.00	6.00	5.00	6.00
Range	4.00	4.00	3.00	4.00	4.00	4.00	4.00	4.00	2.00	1.00	3.00	2.00
Q1	2.00	7.00	4.00	6.00	4.00	6.00	4.00	6.00	4.00	5.00	3.00	4.00
Q3	3.25	8.00	5.00	8.00	5.00	8.00	5.00	6.50	5.00	6.00	4.00	5.00
IQR	1.25	1.00	1.00	2.00	1.00	2.00	1.00	0.50	1.00	1.00	1.00	1.00

Table 33. VAS scores during turning in bed for patients with TAP-block and those without TAR-block in different time ranges.

We followed the results across the different time intervals.

<u>30th postoperative minute at coughing and turning in bed</u>

At the 30th minute, the mean VAS score in the experimental group during coughing was 2.91 (SD ± 0.83) with a minimum score of 1 and a maximum score of 4. In the control group, the mean value was 6.49 (SD ± 1.1) with a minimum score of 4 and a maximum score of 9. These results show a significant statistical difference between the two groups (U = 7276, p < 0.001). For movement, the mean VAS score in the TAR-block group was 2.91 (SD ± 0.93) with a minimum score of 1 and a maximum score of 5 here and for the non-TAR-block group it was 7.31 (SD ± 0.81) with a minimum score of 5 and a maximum score of 9. This result also showed a statistically significant difference between the groups (U = 7296, p < 0.001).

Pain assessment at 30 min		Coughing			Movement		
		TAP-block	no TAP-block	Totol	TAP-block	no TAP-block	Total
No pain	Number	60	0	60	62	0	62
	%	73.2%	0.0%	35.1%	75.6%	0.0%	36.3%
Mild pain	Number	22	51	73	20	9	29
	%	26.8%	57.3%	42.7%	24.4%	10.1%	17.0%
Moderate pain	Number	0	38	38	0	80	80
	%	0.0%	42.7%	22.2%	0.0%	89.9%	46.8%
Severe pain	Number	82	89	171	82	89	171
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Fisher's exact tes		138.62			191.3		
p		<0,001			<0,001		

Table 34. Subjective pain score for the 30th postoperative minute on coughing and turning in bed.

Table 34 shows that in the experimental group 60 (73.2%) patients experienced mild pain, 22 patients (26.8%) experienced moderate intensity coughing pain. In the control group,

51 patients (57.3%) reported having moderate coughing pain and 38 patients (42.7%) reported having severe coughing pain. There were no patients in the control group who reported no postoperative pain in this period. On movement, 62 (75.6%) reported mild pain and 20 (24.4%) patients in the experimental group reported moderate pain. In the control group, 9 patients (10.1%) reported moderate pain and 80 (89.9%) reported severe pain on turning in bed. In both cases, there was a statistically significant difference between patients with TAR block and those without TAP-block in coughing (Fisher's exact tes - 138.62, $p < 0.001$) and turning in bed (Fisher's exact tes - 191.3, $p < 0.001$), respectively.

3rd postoperative hour on coughing and turning in bed

At the 3rd postoperative hour when coughing, the mean VAS score in the experimental group was 4.46 (SD ± 0.83), here the minimum score was 3 and the maximum score was 6. In the control group, the mean value was 6.52 (SD ± 1.14) where the minimum score was 3 and the maximum score was 8. These results show a significant statistical difference between the two groups (U = 6801, $p < 0.001$). For movement, the mean value for VAS in the TAR-block group was 4.77 (SD ± 0.76) here the minimum score was 3 and the maximum score was 6. In the group without TAP-block the mean VAS score was 6.87 (SD ± 0.93) with a minimum score of 5 and a maximum score of 9. The result also showed a statistically significant difference between the groups (U = 6974, $p < 0.001$).

Pain assessment at 3th h		Coughing			Movement		
		TAP-block	no *TAP-block*	**Total**	*TAP-block*	no *TAP-block*	**Total**
No pain	Number	13	4	17	5	0	5
	%	15.9%	4.5%	9.9%	6.1%	0.0%	2.9%
Mild pain	Number	69	41	110	77	33	110
	%	84.1%	46.1%	64.3%	93.9%	37.1%	64.3%
Moderate pain	Number	0	44	44	0	56	56
	%	0.0%	49.4%	25.7%	0.0%	62.9%	32.7%
Severe pain	Number	82	89	171	82	89	171
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Fisher's exact tes		68.35			95.67		
p		<0,001			<0,001		

Table 35. Subjective pain score for the 3rd postoperative hour on coughing and turning in bed.

Table 35 shows that in the experimental group, 13 patients (15.9%) reported experiencing mild pain from the surgical intervention, and 69 patients (84.1%) reported moderate coughing pain. There were also no patients in the control group who reported no postoperative pain in this period. Mild pain was experienced by 4 patients (4.5%), medium intensity pain was reported by 41 patients (46.1%), and severe pain was reported by 44 patients (49.4%) when coughing. On movement, mild pain was reported by 5 (6.1%) patients in the experimental group and moderate pain by 77 (93.9%) patients. In the control group, 33(37.1%) patients reported moderate pain and 56 (62.9%) reported severe pain. In both cases, there was a statistically significant difference between patients with TAP-block and those without TAR block in coughing (Fisher's exact tes - 68.35, $p < 0.001$) and movement (Fisher's exact tes - 95.67, $p < 0.001$), respectively.

6th postoperative hour on coughing and turning in bed

At the 6th postoperative hour during coughing, the mean VAS score in the experimental group was 4.49 (SD ± 0.94), here the minimum score was 3 and the maximum score was 6. In the control group, the mean value was 6.28 (SD ± 0.99) where the minimum score was 4 and the maximum score was 8. These results show a statistical difference between the two groups (U = 6554, p < 0.001). For movement, the mean value for VAS in the TAP-block group was 4.63 (SD ± 0.93) here the minimum score was 2 and the maximum score was 6. In the patients without TAR-block, it was 6.93 (SD ± 0.97) with a minimum score of 5 and a maximum score of 9, respectively. The result showed a statistically significant difference between the groups (U=7029, p<0.001).

Pain assessment at 6 th h		Coughing			Movement		
		TAP-block	no TAP-block	Total	TAP-block	no TAP-block	Total
No pain	Number	20	0	20	15	0	15
	%	24.4%	0.0%	11.7%	18.3%	0.0%	8.8%
Mild pain	Number	62	58	120	67	40	107
	%	75.6%	65.2%	70.2%	81.7%	44.9%	62.6%
Moderate pain	Number	0	31	31	0	49	49
	%	0.0%	34.8%	18.1%	0.0%	55.1%	28.7%
Severe pain	Number	82	89	171	82	89	171
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Fisher's exact test		63.22			87.76		
p		<0,001			<0,0001		

Table 36. Subjective pain score for the 6th postoperative hour during coughing and turning in bed.

Table 36 shows that in the experimental group, 20 patients (24.4%) reported mild pain and 62 patients (75.6%) reported moderate pain. In this period, none of the patients with applied TAP - cough block still reported feeling of severe postoperative pain. There were no patients in the control group who reported no or mild postoperative pain. Moderate pain was reported by 58 patients (65.2%) and severe pain by 31 patients (34.8%) on coughing. On movement, 15 patients (18.3%) reported mild pain and 67 (81.7%) reported moderate intensity pain. In the control group, 40 (44.9%) patients reported moderate pain and 49 (55.1%) reported severe pain. In both cases, there was a statistically significant difference between patients with TAR block and those without TAP-block in coughing (Fisher's exact tes - 63.22, p < 0.001) and turning in bed (Fisher's exact tes - 87.76, p < 0.001), respectively.

12th postoperative hour on coughing and turning in bed

At the 12th postoperative hour during coughing, the mean VAS score in the experimental group was 4.59 (SD ± 0.84) with a minimum score of 2 and a maximum score of 6. In the control group the mean value was 6.33 (SD ± 0.79) here the minimum score was 5 and the maximum score was 8. These results show a significant statistical difference between the two groups (U = 7004, p < 0.001). For movement, the mean value for VAS in the TAR-block group was 4.67 (SD ± 1.01) as here the minimum score was 2 and the maximum score was 6. In patients without TAR-block, the VAS averaged 6.18 (SD ± 1.02) with a minimum score of

4 and a maximum score of 8. This result indicates a statistically significant difference between the groups (U = 6302, p < 0.001).

Pain assessment at 12 th h		Coughing			Movement		
		TAP-block	no TAP-block	Total	TAP-block	no TAP-block	Total
No pain	Number	5	0	5	8	0	8
	%	6.1%	0.0%	2.9%	9.8%	0.0%	4.7%
Mild pain	Number	77	66	143	74	67	141
	%	93.9%	74.2%	83.6%	90.2%	75.3%	82.5%
Moderate pain	Number	0	23	23	0	22	22
	%	0.0%	25.8%	13.5%	0.0%	24.7%	12.9%
Severe pain	Number	82	89	171	82	89	171
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Fisher's exact tes		33.73			35.57		
p		<0,001			<0,001		

Table 37. Subjective pain score for the 12th postoperative hour on coughing and turning in bed.

Table 37 shows that in the experimental group when coughing, 5 patients (6.1%) reported mild pain and 77 (93.9%) patients reported moderate intensity pain. Again, none of the patients with the applied TAP-block reported feeling of severe postoperative pain. There were no patients in the cough control group who reported no or mild postoperative pain. Moderate pain was reported by 66 patients (74.2%) and severe pain by 23 patients (25.8%). On turning in bed, 8 (9.8%) reported mild pain and 74 (90.2%) patients reported moderate pain. In the experimental group, 67 patients (75.3%) reported moderate pain and 22 (24.7%) patients reported severe pain. In both cases, there was a statistically significant difference between patients with TAP-block and those without TAR block in coughing (Fisher's exact tes - 33.73, p < 0.001) and turning in bed (Fisher's exact tes - 35.57, p < 0.001), respectively.

18th postoperative hour on coughing and turning in bed

At the 18th postoperative hour during coughing, the mean VAS score in the experimental group was 4.74 (SD ± 0.58), here the minimum score was 4 and the maximum score was 6. In the control group the mean value was 5.78 (SD ± 0.67) here the minimum score was 5 and the maximum score was 8. These results show a significant statistical difference between the two groups (U = 6251, p < 0.001). For movement, the mean value for VAS in the TAR-block group was 4.76 (SD ± 0.53) as here the minimum score was 4 and the maximum score was 6. Patients in the non-TAR-block group had a mean VAS score of 5.61 (SD ± 0.49) with a minimum of 5 and a maximum of 6. This result also showed a statistical difference between the groups (U = 6105, p < 0.001).

Pain assessment at 18th h		Coughing			Movement		
		TAP-block	no *TAP*-block	Total	*TAP*-block	no *TAP*-block	Total
Средна болка	Брой	82	83	165	82	89	171
	%	100.0%	93.3%	96.5%	100.0%	100.0%	100.0%
Силна болка	Брой	0	6	6	0	0	0
	%	0.0%	6.7%	3.5%	0.0%	0.0%	
Общо	Брой	82	89	171	82	89	171
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
χ2		5.72			-		
P		0.016					

Table 38. Subjective pain score for the 18th postoperative hour on coughing and turning in bed.

Table 38 shows that there were no patients in the experimental group who did not experience postoperative pain from the surgical intervention, and all 82 patients (100%) reported moderate intensity pain. There were also no patients in the control group who reported no postoperative pain in this period. Moderate pain was reported by 83 patients (93.2%) and severe pain by 6 patients (6.8%). On movement in both groups, all patients reported the presence of moderate intensity pain in this time range. Here, there was a statistically significant difference only in pain experienced during coughing (2 = 5.72, p = 0.016). Regarding the absolute value of the VAS during turning in bed, we found a statistically significant difference between the two groups, but from a clinical point of view, all patients defined the pain as average in intensity.

24th postoperative hour on coughing and turning in bed

At the 24th postoperative hour during coughing, the mean VAS score in the experimental group was 4.2 (SD ± 0.79), here the minimum score was 3 and the maximum score was 6. In the control group the mean value was 4.71 (SD ± 0.74) with the minimum score being 3 and the maximum score being 6. These results show a significant statistical difference between the two groups (U = 5050, p < 0.001). For movement, the mean value for VAS in the TAR-block group was 3.87 (SD ± 0.73) here the minimum score was 2 and the maximum score was 5. In the group without TAR-block, the mean VAS score was 4.69 (SD ± 0.7) with a minimum score of 4 and a maximum score of 6. This result also showed a statistically significant difference between the groups (U = 5560, p < 0.001).

Pain assessment at 24th h		Coughing			Movement		
		TAP-block	no *TAP*-block	Total	*TAP*-block	no *TAP*-block	Total
Лека болка	Брой	12	6	18	24	0	24
	%	14.6%	6.7%	10.5%	29.3%	0.0%	14.0%
Средна болка	Брой	70	83	153	58	89	147
	%	85.4%	93.3%	89.5%	70.7%	100.0%	86.0%
Общо	Брой	82	89	171	82	89	171
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
χ2		2.82			30.30		
p		0.133			<0,001		

Table 39. Subjective pain score for the 24th postoperative hour on coughing and turning in bed.

Table 39 shows that in the experimental group, 12 patients (14.6%) reported mild pain and 70 patients (85.4%) reported moderate pain. Again, none of the patients who had a TAP-block applied reported feeling severe postoperative pain. There were no patients in the control group who reported no postoperative pain. Six patients (6.7%) reported coughing pain that was mild in intensity and 83 patients (93.3%) reported coughing pain that was moderate in intensity. On movement, mild pain was reported by 24 (29.3%) and moderate pain by 58 (70.7%). In the control group, none of the patients reported mild pain and all 89 reported moderate pain. In this case, there was a statistically significant difference between patients with TAP-block and those without TAR-block only on movement ($2 = 30.3$, $p < 0.001$), and none on coughing ($2 = 2.82$, $p = 0.133$). In contrast to the mean VAS, where a statistical difference was found, no difference was found with respect to the subjective score.
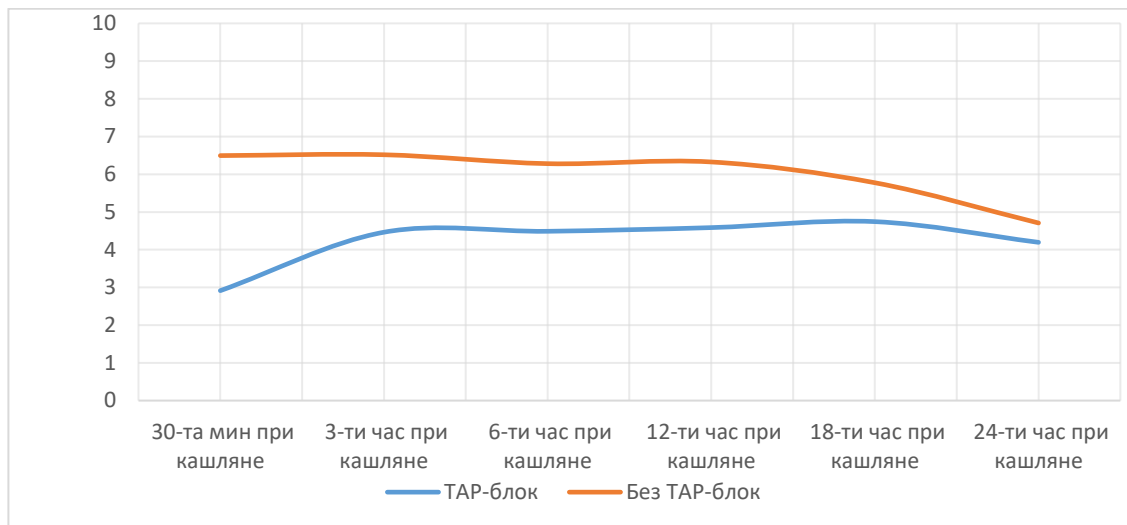

Figure 26. Comparison of mean VAS in coughing between the two main groups.
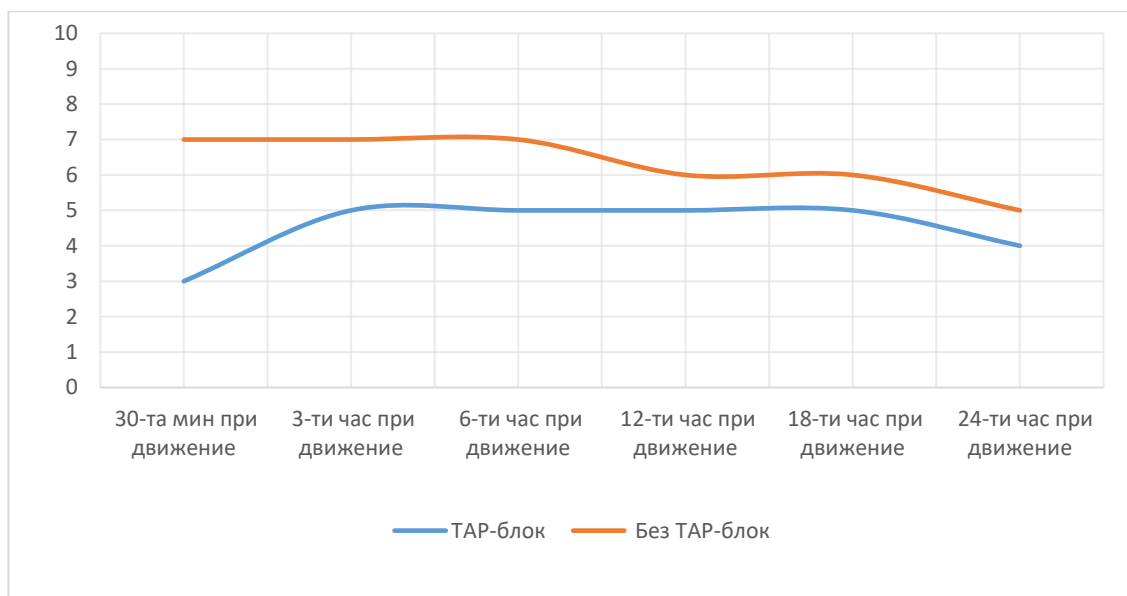

Figure 27. Comparison of the mean VAS value at turning in bed between the two main groups.

From Figure 26 and Figure 27 we can see the dynamics of the average VAS value during coughing and turning in bed. The significant difference in pain scores in the early postoperative period is clearly evident. There is a gradual tendency for it to decrease between the two groups, especially after the 18th hour. However, as we pointed out earlier in the text, it remained statistically significant until the end of the study period.

Pain resulting from disruption of muscle tissue and fascia is more severe and more difficult to manage than that of skin incision and visceral organs (50). Therefore, the severe dynamic pain provoked by movements necessary to get patients out of bed and mobilize bronchial secretions by coughing cannot be relieved by systemically administered potent opioids alone without causing some of their adverse effects to manifest (10). The data from our study show that TAP-block improves control not only of static pain but also of dynamic pain during the first 24 hours of the postoperative period. This determines not only a better sense of comfort in the supine position, but also the possibility of earlier mobilization of patients and the associated reduced postoperative morbidity.

4.3.2. Postoperative haemodynamics

In task 2, for the postoperative period, we monitored and compared hemodynamic parameters in different time ranges, in patients with TAR block and those without TAR block. The data are shown in Table 40, 41, 42 and Figure 28, 29.

From the results obtained, again, a difference in hemodynamic indices was observed in the two main groups.

Postoperative hemodynamic	TAP – block								
	N	*MEAN*	*SD*	*Me*	*Q1*	*Q3*	*Min*	*Max*	*Range*
SBP 30 min	82	131.49	11.07	131	123	138.75	113	166	53
DBP 30 min	82	78.94	10.82	78	71	88	63	100	37
MAP 30 min	82	95.46	9.1	95	86	105	80	117	37
HR 30 min	82	73.54	6.08	72	71	76	61	90	29
SBP 3th h	82	126.71	8.72	130	120	130	110	145	35
DBP 3th h	82	74.23	9.33	75	70	75	60	95	35
MAP 3th h	82	91.12	7.34	90	85	95	80	112	32
HR 3th h	82	71.71	6.08	71	69	73	59	88	29
SBP 6 th h	82	131.06	11.16	130	125	140	110	160	50
DBP 6 th h	82	75.87	10.63	75	68	85	60	100	40
MAP 6 th h	82	93.84	9.47	92	86	100	80	117	37
HR 6 th h	82	73.07	7.65	71	69	78	61	90	29
SBP 12 th h	82	120.46	15.16	120	109.8	131.25	91	152	61
DBP 12 th h	82	71.54	10.51	69	63	78	56	106	50
MAP 12 th h	82	87.72	10.89	86	79	95	71	119	48
HR 12 th h	82	76.77	7.43	74	71	82	66	97	31
SBP 18 th h	82	131.2	12.35	131	120.8	141	109	161	52
DBP 18 th h	82	77.5	9.58	76	70	82	62	98	36
MAP 18 th h	82	95.33	9.46	94	87.75	101.25	80	118	38
HR 18 th h	82	76.1	9.12	75	71	81	59	99	40
SBP 24 th h	82	133.27	11.65	135	121	145	115	155	40
DBP 24 th h	82	82.46	10.83	83	70.75	92	65	98	33
MAP 24 th h	82	99.39	9.82	100	92.25	107.25	82	117	35
HR 24 th h	82	73.17	10.12	71	69	78	59	99	40

Table 40. Descriptive statistics of the main hemodynamic parameters in patients with TAP-block in the first 24 postoperative hours.

Postoperative hemodynamic	No *TAP*-block								
	N	*MEAN*	*SD*	*Me*	*Q1*	*Q3*	*Min*	*Max*	*Range*
SBP 30 min	89	144.52	15.44	149	135	156	115	171	56
DBP 30 min	89	88.06	14.38	88	75	102.5	65	110	45
MAP 30 min	89	106.81	12.44	107	98.5	119	83	130	47
HR 30 min	89	78.91	9.1	79	73	87	56	91	35
SBP 3th h	89	147.7	9.77	145	140	155	130	170	40
DBP 3th h	89	85.29	12.45	85	75	95	60	105	45
MAP 3th h	89	106.07	9.55	107	100	113	85	127	42
HR 3th h	89	75.06	8.54	74	71	82	61	89	28
SBP 6 th h	89	143.81	13.23	145	140	150	115	170	55
DBP 6 th h	89	84.16	14.35	85	70	95	60	110	50
MAP 6 th h	89	104.02	11.81	105	94	113	83	127	44
HR 6 th h	89	76.8	8.51	77	71	85	61	89	28
SBP 12 th h	89	132.73	17.75	139	114.5	146	98	155	57
DBP 12 th h	89	79.91	14.36	77	69	90	61	111	50
MAP 12 th h	89	97.48	14.13	98	85	107	74	124	50
HR 12 th h	89	77.12	9.39	76	72	87	56	91	35
SBP 18 th h	89	131.34	15.22	125	118	143.5	109	161	52
DBP 18 th h	89	78.83	13.25	72	66	91	60	101	41
MAP 18 th h	89	96.34	11.38	95	86	105	79	119	40
HR 18 th h	89	72.46	8.61	71	66.5	79	56	91	35
SBP 24 th h	89	134.8	12.03	140	121	145	111	152	41
DBP 24 th h	89	80.18	11.7	80	69	90	65	100	35
MAP 24 th h	89	98.25	9.05	98	93	107	81	110	29
HR 24 th h	89	74.36	8.81	75	67.5	80	60	91	31

Table 41. Descriptive statistics of the main hemodynamic parameters in patients without TAP-block in the first 24 postoperative hours.

Postoperative hemodynamic	Diff	*Mann-Whitney U*	*P*
SBP 30 min	-18,00	5 445	<0,0001
DBP 30 min	-10,00	4 998	<0,0001
MAP 30 min	-12,00	5 527	<0,0001
HR 30 min	-7,00	5 153	<0,0001
SBP 3th h	-15,00	6 565	<0,0001
DBP 3th h	-10,00	5 447	<0,0001
MAP 3th h	-17,00	6 466	<0,0001
HR 3th h	-3,00	4 712	0,001
SBP 6 th h	-15,00	5 644	<0,0001
DBP 6 th h	-10,00	4 866	<0,0001
MAP 6 th h	-13,00	5 397	<0,0001
HR 6 th h	-6,00	4 661	0,002
SBP 12 th h	-19,00	5 127	<0,0001
DBP 12 th h	-8,00	4 917	<0,0001
MAP 12 th h	-12,00	5 118	<0,0001
HR 12 th h	-2,00	4 030	0,237
SBP 18 th h	6,00	3 577	0,825
DBP 18 th h	4,00	1 634	0,964
MAP 18 th h	-1,00	3 778	0,690
HR 18 th h	4,00	2 788	0,008
SBP 24 th h	-5,00	3 805	0,627
DBP 24 th h	3,00	3 207	0,170
MAP 24 th h	2,00	3 437	0,512
HR 24 th h	-4,00	4 090	0,171

Таблица 42. Сравнителе анализ между хемодинамичните показатели между пациентите с *TAP* – блок и тези без *TAP* – блок.
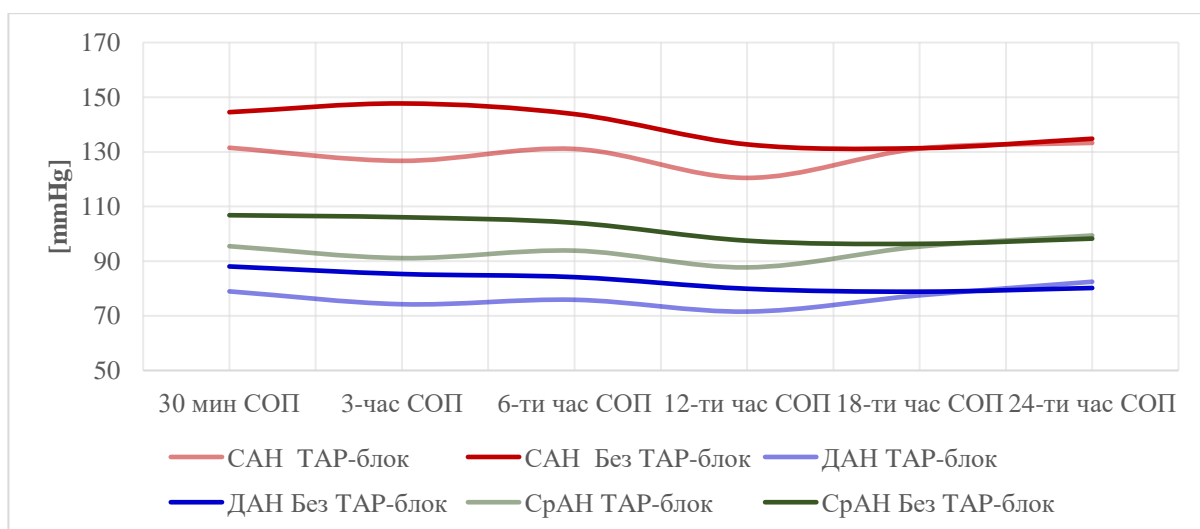
Figure 28. Postoperative distribution of median blood pressure indices SBP, DBP, MAP for patients with and without TAP-block.

In our study, the median SBP at the 30th postoperative minute in the experimental group was 133 mmHg (IQR=15) and that in the control group was 149 mmHg (IQR=21). The median SBP of the experimental and control groups was 78 mmHg (IQR=17) and 88 mmHg (IQR=27), respectively. The difference in blood pressure between patients in the two groups was statistically significant for the individual parameters (U = 5445, p < 0.001; U = 4998, p < 0.001, respectively).

The difference persisted until the 18th hour, after which the values overlapped. Median SBP in the experimental group was 131 mmHg (IQR=20.2) and in the control group 125 mmHg (IQR=25.5), median DBP in the experimental group was 76 mmHg (IQR=12) and in the control group 72 mmHg (IQR=25). These minimal differences in values were statistically insignificant (U=3577, p=0.83; U=1634, p=0.96). This result is consistent with the VAS pain scale data, which shows convergence of differences between the two groups at the respective time interval. This confirms the thesis that the intensity of TAP-block decreases after the 18th postoperative hour.
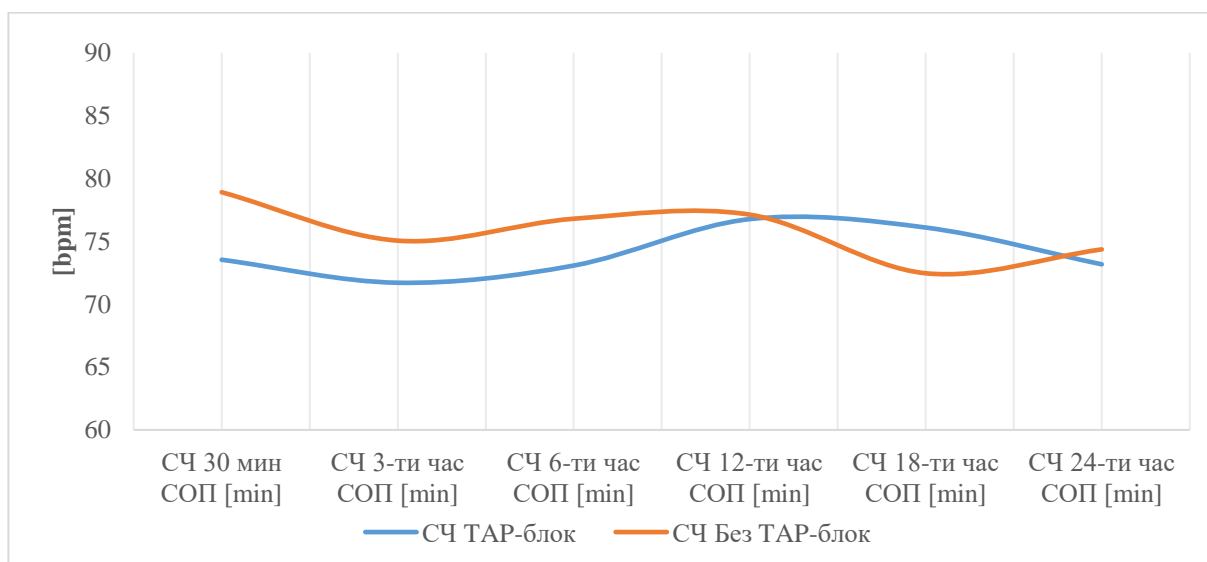

Figure 29. Postoperative distribution of median heart rate parameters for patients with and without TAP-block.

Regarding heart rate, the data showed a similar trend between the two groups, with a statistically significantly higher HR in the early postoperative period in the patients without TAP-block compared to the experimental group (U = 5153, p < 0.001). The median of HR in the experimental group at the 30th minute after the end of surgery was 72 y/min (IQR 5) and in the control group it was 79 y/min (with IQR = 5). A similar difference persisted until the 12th postoperative hour, where the values equalized. At the 18th hour, our team observed a statistically significant decrease in HR in the control group compared to the experimental group (U=2788, p=0.008). Median HR at the 18th hour of postoperative period (POP) in the experimental group was 75 y/min (IQR=5) and in the control group was 71 y/min (IQR=12.5). At the 24th hour, there was again a leveling of values and no statistical difference between them (U=4,090, p=0.171). These data are presented in Table 40.

From the results obtained it is evident that in the postoperative period the tendency of the patients from the control group to have higher blood pressure and heart rate values was

maintained. According to our team, this is due to the postoperative stress response of the body caused by the higher level of pain stimulus in patients without applied TAR-block compared to those with TAR-block. A similar claim was discussed in a study performed by Liu et al. which demonstrated elevated levels of stress hormones (*Epinephrine, Norepinephrine,Cortisol и glucose*) in the plasma of patients after abdominal surgery without an applied TAP-block compared to a group with one performed preoperatively (32).

4.3.3. Postoperative analgesia

In the postoperative period, we used an NSAID, Ketoprofen, and an opioid agonist, Pethidine (Lydol), to provide analgesia to patients in both main groups. In Task 3, we compared the results obtained between patients with TAP-block and those without TAP-block.

4.3.3.1 Pethidine (Lydol)

Total opiate use in the postoperative period is shown in Table 43 and Figure 30.

The data show that the mean amount of Pethidine used postoperatively in the experimental group was 45.43 mg (SD $\pm$ 22.6), while in the control group it was 84.8 mg (SD $\pm$ 19.4). The difference between the two groups is evident as the amount of opiate administered in the control group was significantly greater. This difference was of high statistical significance (U = 6613, p < 0.001). In our study there was a reduction of postoperative opiate dose by 46% in the TAR-block group. Other studies have also reported a reduction in postoperative opiate consumption during abdominal surgery in patients with TAR-block compared with those without-Catherine et al. by 33% (52), Liu et al. by 30% (32), McDonnell et al. by 73%(35), Elkassabany et al. by 51% (17).

Postoperative opiate consumption		Pacients	*TAP*-block	no *TAP*-block	Total
Total dose *Pethidine* [*mg*]	0,00	Number	11	0	11
		%	13,4%	0,0%	6,4%
	25,00	Number	6	0	6
		%	7,3%	0,0%	3,5%
	50,00	Number	55	10	65
		%	67,1%	11,2%	38,0%
	75,00	Number	7	40	47
		%	8,5%	44,9%	27,5%
	100,00	Number	3	33	36
		%	3,7%	37,1%	21,1%
	125,00	Number	0	6	6
		%	0,0%	6,7%	3,5%
Total		Number	82	89	171
		%	100,0%	100,0%	100,0%

Table 43. Distribution of patients according to the total amount of Pethidine used postoperatively in TAP-block and non-TAP-block groups.
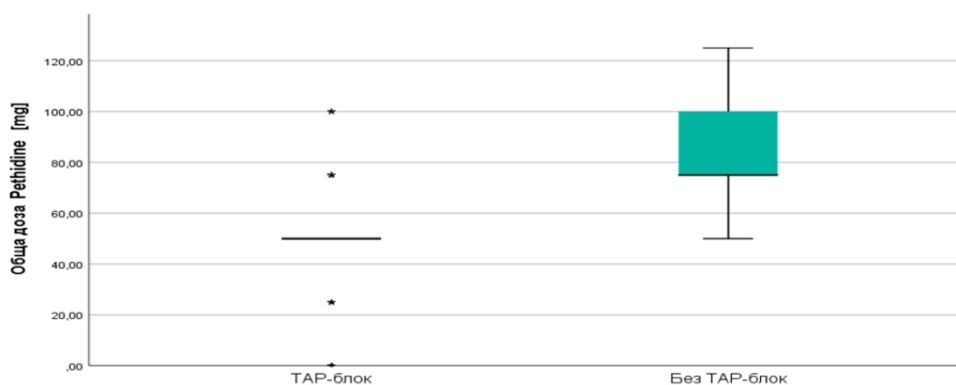
Figure 30. Distribution of total dose of Pethidine used postoperatively in patients with and without TAP-block.

To make our results comparable with those of other authors, we converted the administered doses of Pethidine into equianalgesic doses of Morphine. The mean administered doses in our study were 4.5 mg for the group with and 8.5 mg Morphine for the group without TAP-blocker in the first 24 hours of the postoperative period. We compared these values with data from other studies in lower abdominal surgery. The results showed significantly less opiate used in our sample compared with 46.6 mg and 66.8 mg in patients with TAP-block and without TAP-block, respectively, reported by Liu et al. (32); 39 mg with TAP-block and 52 mg without TAP-block in the publication by Walter et al. (52); 22.1 mg and 45.5 mg reported by Elkassabany et al. (17), respectively. The results closest to ours were obtained in the study of Bharti et al. (7), where 6.45 mg and 17.55 mg of Morphine were used in patients with and without TAR-block, respectively, for colorectal surgery.

The data confirm the clinical observations regarding the low level of postoperative pain relief in Bulgaria, which may lead to increased morbidity, prolonged hospital stay and chronic pain. This further increases the need for the routine introduction of postoperative analgesia techniques that do not require special care by medical staff. One such example is the application of TAP-block.

Table 44 and Figure 31 show the comparison data in Pethidine used for the two main groups according to mg/kg dose.

Pethidine [mg/kg]	N	Mean	SD	Me	Q1	Q3	IQR	Min	Max	Range	U-Тест	p
TAP-block	82	0,59	0,30	0,66	0,48	0,74	0,26	0,00	1,32	1,32	6 479	<0,001
no *TAP*-block	89	1,09	0,29	1,04	0,94	1,32	0,38	0,48	1,84	1,36		

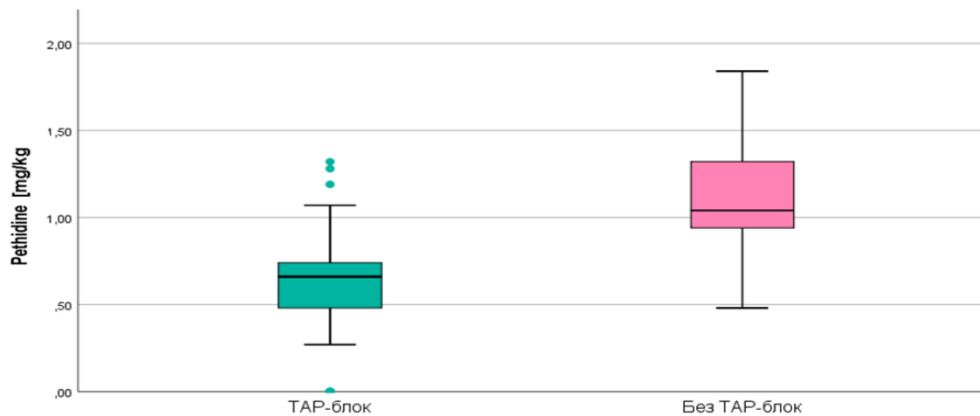Table 44. Postoperative Pethidine consumption [mg/kg].

Figure 31. Comparison in postoperative Pethidine consumption [mg/kg] in patients with TAP-block and those without TAP-block.

From these results, it is clear that there is a statistically significant difference not only in the absolute dose of opioids used, but also in the calculated dose relative to body weight.

From the results for postoperative administration of Pethidine shown in Table 43, it is noteworthy that in the experimental group in 11 of the patients (13.4%) no opioid agonist was administered at all for postoperative analgesia and in 6 (7.3%) only 25 mg of Pethidine was used. The most commonly used opiate dose was 50 mg, administered in 55 patients (67.1%). In 7 (8.5%) patients, 75 mg had to be used and in only three (3.7%) patients, 100 mg was used, respectively. In the control gup, all patients required the administration of Pethidine. In 10 (11.2%) 50 mg, in 40 (44.9%) 75 mg, in 33 (37.1%) 100 mg and in 6 (6.7%) 125 mg were administered.

Comparison of these data clearly demonstrated the statistically significant difference in postoperative opioid consumption in the two groups (Fisher's exact test - 110.99, $p < 0.001$). Similar results to ours have been obtained in other studies (111, 128, 211). However, studies by some authors did not show a reduction in postoperative opioid consumption in patients with and without administered TAP-block (190, 202).

The data from our study demonstrate the feasibility of achieving „opioid free" and „opioid sparing" analgesia in the early postoperative period during preoperative administration of bilateral lateral access TAP-block in lower abdominal surgery. This could limit the occurrence of side effects of postoperative opioid use such as PONV, excessive sedation, respiratory depression, prolonged postoperative ileus, delayed recovery, etc (18).

We also made a comparison between the amount of Pethidine administered at different intervals of the postoperative period, for the two main groups. The results are presented in Table 45 and Figure 32.

Of these, it is noteworthy that in the first time interval, up to the 30th minute, no opiate was required in the patients with TAR block, whereas 21 (23.6%) patients in the group without TAP-block were administered Pethidine. In the second time interval, up to the 3rd hour, only 4 (4.9%) patients in the experimental group had opiate administration, whereas 71 (79.8%) patients in the control group had opiate administration. In the following period, up to the 6th hour, opiate was administered in 23 (28.0%) and 13 (14.6%), respectively. In the time period up to the 12th hour, Pethidine was used in 28 (34.1%) of patients with TAP-block and 48 (53.9) without TAP-block. For the 18th postoperative hour, 32 (39.0%) patients from the experimental group and 18 (20.2%) from the control group were anesthetized with an opiate. At the 24th hour, only one patient in each group required Pethidine administration.

Postoperative opiate consumption		Pacients	TAP-block	no TAP-block	Total	χ^2	p
30 min	No *Pethidine*	Number	82	68	150	22,057	< 0,0001
		%	100,0%	76,4%	87,7%		
	Meperedine	Number	0	21	21		
		%	0,0%	23,6%	12,3%		
Total		Брой Number	Number 100,0%	89 100,0%	171		
		% %					
3 th h	No *Pethidine*	Number	78	18	96	97,229	<0,0001
		%	95,1%	20,2%	56,1%		
	Meperedine	Number	4	71	75		
		%	4,9%	79,8%	43,9%		
Total		Брой Number	Number 100,0%	89 100,0%	171		
		% %					
6 th h	No *Pethidine*	Number	59	76	135	4,639	0,031
		%	72,0%	85,4%	78,9%		
	Meperedine	Number	23	13	36		
		%	28,0%	14,6%	21,1%		
Total		Брой Number	Number 100,0%	89 100,0%	171		
		% %					
12 th h	No *Pethidine*	Number	54	41	95	6,766	0,009
		%	65,9%	46,1%	55,6%		
	Meperedine	Number	28	48	76		
		%	34,1%	53,9%	44,4%		
Total		Брой Number	Number 100,0%	89 100,0%	171		
		% %					
18 th h	No *Pethidine*	Number	50	71	121	6,766	0,009
		%	61,0%	79,8%	70,8%		
	Meperedine	Number	32	18	50		
		%	39,0%	20,2%	29,2%		
Total		Number	82	89	171		
		%	100,0%	100,0%	100,0%		
24 th h	No *Pethidine*	Number	81	88	169	0,003	0,953
		%	98,8%	98,9%	98,8%		
	Meperedine	Number	1	1	2		
		%	1,2%	1,1%	1,2%		
Total		Number	82	89	171		
		%	100,0%	100,0%	100,0%		

Table 45. Distribution of patients according to Pethidine administration in the different time ranges.
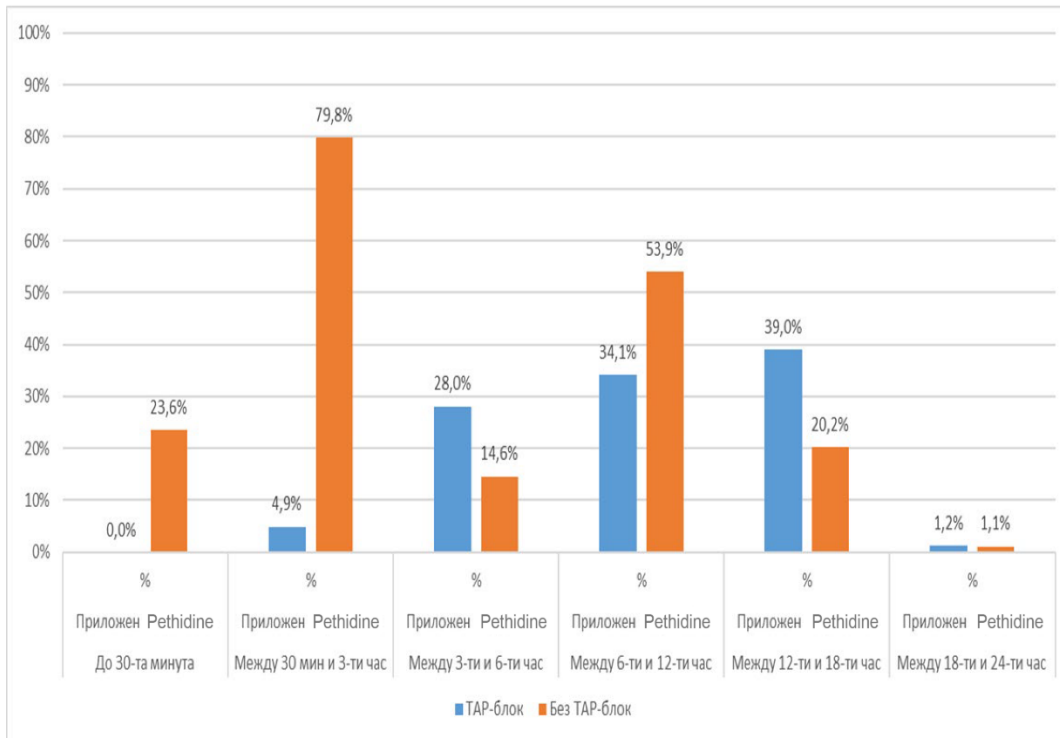
Figure 32. Percentage distribution of patients with Pethidine administered in the different time ranges.

It is evident from these data that a significantly higher percentage of patients require earlier inclusion of opiate analgesics in the treatment for post-operative pain control if no prior TAP-block is administered. They are also directly related to the higher pain sensation demonstrated by VAS readings in this period both at rest and when coughing and turning in bed. It is clearly seen that two peaks in postoperative opiate consumption are formed in the TAP - block and non-TAP - block groups in the different time ranges. For the control group, the first peak was as early as the 3rd hour, at which time Pethidine had to be used in over 79% of cases, whereas in the experimental group only 4.9% had used opiate by this point. The second peak in patients in the control group was at the 12th postoperative hour with 53.9% using an opiate. A significantly more even distribution in Pethidine administration is seen in the experimental group as here the main opiate consumption was delayed to the period between the 12th and 18th postoperative hour. Similar results for deferred opiate consumption in patients with TAP-block have been observed and described by other authors such as Alotaibi et al. and Walter et al. (17, 215).

4.3.3.2. Ketoprofen
The other medication used for postoperative analgesia in our study was Ketoprofen. The results of the data collected and analyzed are shown in Table 46 and Figure 33.

Total dose Ketoprofen [mg]	TAP-block		no TAP-block		χ^2	p
	Number	%	Number	%		
200,00	80	97,6	80	89,9	4,175	0,059
300,00	2	2,4	9	10,1		
Total	82	100,0	89	100,0		

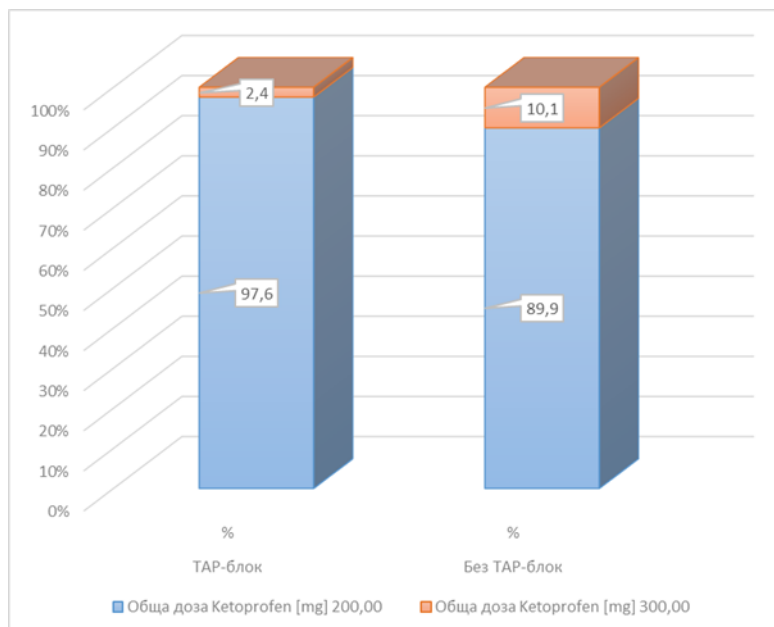Table 46. Comparison between total postoperative Ketoprofen consumption in groups with and without TAP-block.

Figure 33. Comparison of total postoperative Ketoprofen consumption in patients with and without TAP-block.

As can be clearly seen from the data, Ketoprofen was used in all patients for postoperative pain relief needs. In 80 (97.6%) patients in the experimental group as well as in 80 (89.9%) patients in the control group 200mg of the drug was used. Only two (2.4%) patients of those with TAP-block and 9 (10.1%) without TAP-block were administered 300mg of Ketoprofen as this difference did not show statistical significance (2 = 4.175, p = 0.059).

NSAIDs, despite some adverse effects, remain the "gold standard" in postoperative pain management as the inability to use them creates significant difficulties for adequate pain control (197, 201).

Ketoprofen		Pacients	TAP-block	no TAP-block	Total	χ²	p
3 th h	0 mg	Брой	67	22	89	55,53	< 0,001
		%	81,7%	24,7%	52,0%		
	100 mg	Брой	15	67	82		
		%	18,3%	75,3%	48,0%		
	Общо	Брой	82	89	171		
		%	100,0%	100,0%	100,0%		
6 th h	0 mg	Брой	32	67	99	23,01	< 0,001
		%	39,0%	75,3%	57,9%		
	100 mg	Брой	50	22	72		
		%	61,0%	24,7%	42,1%		
	Общо	Брой	82	89	171		
		%	100,0%	100,0%	100,0%		
12 th h	0 mg	Брой	54	26	80	23,01	< 0,001
		%	65,9%	29,2%	46,8%		
	100 mg	Брой	28	63	91		
		%	34,1%	70,8%	53,2%		
	Общо	Брой	82	89	171		
		%	100,0%	100,0%	100,0%		
18 th h	0 mg	Брой	32	63	95	17,44	< 0,001
		%	39,0%	70,8%	55,6%		
	100 mg	Брой	50	26	76		
		%	61,0%	29,2%	44,4%		
	Общо	Брой	82	89	171		
		%	100,0%	100,0%	100,0%		
24 th h	0 mg	Брой	60	80	140	8,04	0,004
		%	73,2%	89,9%	81,9%		
	100 mg	Брой	22	9	31		
		%	26,8%	10,1%	18,1%		
	Общо	Брой	82	89	171		
		%	100,0%	100,0%	100,0%		

Table 47. Distribution of patients according to Ketoprofen used in groups with TAP-block and without TAP-block in the different time ranges.

Regarding the distribution of Ketoprofen use across time intervals, the results are shown in Table 47 and Figure 34. Here it is clearly seen that two peaks in Ketoprofen use are formed in the TAR-block and non-TAR-block groups. For the experimental group, the first peak in NSAID administration was at the 6th postoperative hour, in 61.0% of patients. The second peak was at the 18th hour, again with 61% of patients. In the control group, the first peak was at the 3rd postoperative hour (75.3% of patients), and the second peak was at the 12th hour, with 70.8%.
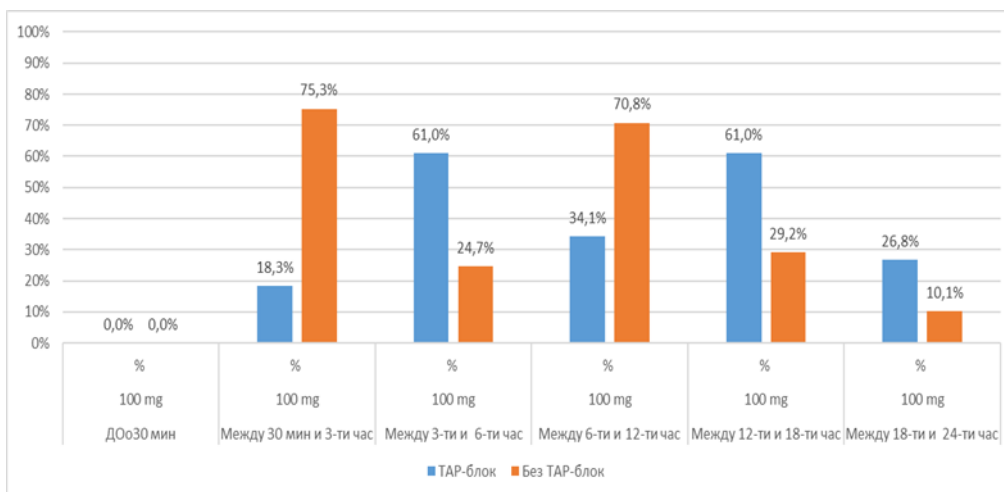
Figure 34. Distribution of patients according to Ketoprofen used in TAP and non-TAP-block groups in different time ranges.

These results are consistent with the data we obtained for postoperative VAS and opiate consumption, whose peaks were also in the early postoperative period. This clearly indicates the need for earlier additional postoperative analgesia in patients without compared to those with a TAP-block in place.

4.3.4. Complications related to the analgesic drugs used and the technique of administration of TAR-block

In task 5, we observed some adverse events associated with the use of opioid analgesics perioperatively such as postoperative nausea and vomiting and postoperative sedation. In the performance of task 6, we followed up the complications arising from the administration of TAP-block.

4.3.4.1. Postoperative nausea and vomiting - PONV

In our study, we monitored the occurrence and severity of one of the most common complications after general anaesthesia, namely postoperative nausea and vomiting (PONV). Although not life-threatening, this condition can cause significant patient discomfort in the early postoperative period. We compared the results between the groups with TAR block and those without TAP-block at different time points after patients were discharged from the operating room. The data are presented in Table 48 and Figure 35.

From the results obtained, it is evident that up to the 30th minute postoperatively, 57 (69.5%) patients in the experimental group did not show clinical evidence of PONV, and 55 (61.7%) patients in the control group. The remaining 25 (30.5%) patients with TAR block and 33 (38.3%) without showed some of the symptoms characteristic of PONV. Despite the larger number of patients with evidence of PONV in the control group, the difference remained statistically insignificant ($2 = 4.66$, p = 0.069).

In our study, we also followed the severity of PONV symptoms. In the experimental group, 19 (23.9%) patients experienced mild nausea and discomfort, and 6 (7.3%) experienced severe and distressing nausea. In the control group 24 (27.1%) patients complained of mild nausea and discomfort, 8(9%) of severe and distressing nausea and two (2.2%) of vomiting.

PONV		Patients	TAP - block	no TAP- block	Total
30 min	No any complaint	Брой	57	55	112
		%	69,5%	61,7%	60,2%
	Mild degree nausea	Брой	19	24	43
		%	23,2%	27,1%	30,4%
	Moderate degree nausea and vomit	Брой	6	8	14
		%	7,3%	9,0%	8,2%
	Frquently vomit	Брой	0	2	2
		%	0,0%	2,2%	1,2%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
3 th h	No any complaint	Брой	70	54	124
		%	85,4%	60,7%	72,5%
	Mild degree nausea	Брой	10	25	35
		%	12,2%	28,1%	20,5%
	Moderate degree nausea and vomit	Брой	2	10	12
		%	2,4%	11,2%	7,0%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
6 th h	No any complaint	Брой	78	82	160
		%	95,1%	92,1%	93,6%
	Mild degree nausea	Брой	4	7	11
		%	4,9%	7,9%	6,4%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
12 th h	No any complaint	Брой	79	89	168
		%	96,3%	100,0%	98,2%
	Mild degree nausea	Брой	3	0	3
		%	3,7%	0,0%	1,8%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
18 th h	No any complaint	Брой	82	89	171
		%	100,0%	100,0%	100,0%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
24 th h	No any complaint	Брой	82	89	171
		%	100,0%	100,0%	100,0%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%

Table 48. Distribution of patients according to the degree of PONV in groups with TAP-block and without TAP-block in the different time ranges.
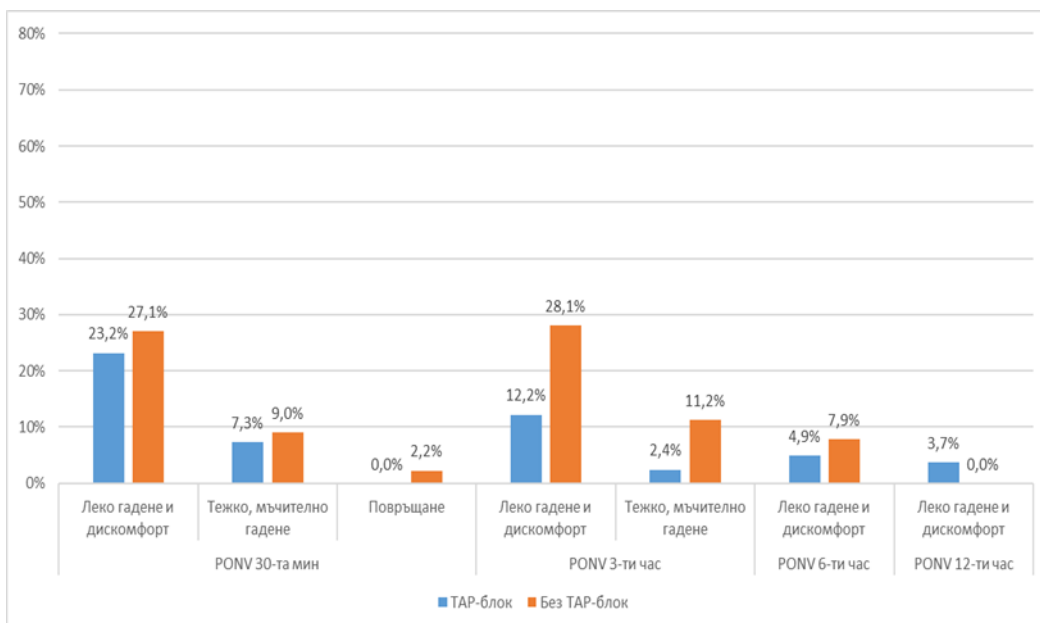
Figure 35. Distribution of patients according to the degree of PONV at different time intervals in the postoperative period.

Intra- and postoperative opioid use is one of the major risk factors for PONV. Many other reasons related to the type of surgical intervention and patient specificity may also contribute to its development (21, 111). The lack of statistically significant difference in PONV manifestation by the 30th minute postoperatively despite reduced doses of intraoperative Fentanyl and postoperative Pethidine may be explained by the fact that the amount of intraoperative opioid used in the TAP-block group was sufficient to induce PONV manifestations.

In the interval from the 30th minute to the 3rd postoperative hour, the data showed that 12 (14.6%) patients in the experimental group showed symptoms of PONV, whereas 35 (39.3%) patients in the control group did. These results demonstrate a statistically significant increase in cases in patients without TAP-block (2 = 5.66, p < 0.001).

Here, the association with increased opiate consumption in the indicated time period in the control group is clearly evident. For this purpose, we used Spearman's correlation test, which revealed a moderate but statistically significant correlation between Pethidine used and the presence of PONV (rho = 0.239, p = 0.024). This confirms the role of opiates in the manifestation of PONV symptoms.

In terms of severity of manifestations, 10 (12.2%) patients in the experimental group had mild nausea and two (2.4%) had severe and distressing nausea. In the control group, 25 (28.1%) patients had mild nausea and 10 (11.2%) had severe and distressing nausea, respectively.

At the 6th hour, only 4 (4.9%) patients in the experimental group and 7 (7.9%) patients in the control group had PONV symptoms and these were associated with a feeling of mild nausea and discomfort. These minimal differences did not show a statistically significant result (2 = 0.63, p = 0.53).

At the 12th postoperative hour, mild nausea and malaise was mentioned by only 3 patients and only by those with TAR block, but the differences were statistically insignificant between the two groups (2 = 3.31, p = 0.1).

In the remaining time ranges, our team did not note symptoms of postoperative nausea and vomiting, in any of the study participants. We believe this is due to the relatively low opiate use in the postoperative period.

As previously mentioned, a multitude of different factors can lead to PONV manifestations. Therefore, both our results and those in the global literature are mixed. Some authors indicate a significant reduction in the incidence and severity of PONV (87, 136, 190), but others demonstrate no such difference (17, 28,29, 111), and still others show even more frequent manifestations of PONV in the group of patients with TAR block compared with those without TAR block (52). Some of the different findings in the trials are due to the design of the trials and the use of antiemetic prophylaxis in some of them.

4.3.4.2 Postoperative sedation

We monitored the level of postoperative sedation by scoring on a standardized and simplified Filos scale. The results of the study are shown in Table 49 and Figure 36.

The data from the earliest period, at the 30th mannula postoperatively, showed that 21 (25.6%) patients in the experimental group and 35 (39.3%) patients in the control group had mild sedation (sleepy but responsive to verbal stimuli). Only one patient (1.1%) in the control group exhibited a deeper degree of sedation and a need for physical stimulus to make contact.

The difference in postoperative sedation between the two groups at the 30th postoperative minute showed a statistically significant result ($2 = 4.23$, $p = 0.039$). This could be explained by the larger amount of opiate used intraoperatively. Fentanyl rapidly crosses the blood-brain barrier and produces its effects in only 1 to 2 minutes after its intravenous administration. Serum levels decrease rapidly from peak concentrations because of extensive tissue uptake. Its duration of action is 30 to 40 minutes, although at high doses a second peak of activity may be observed several hours later because of the release of bound drug from tissue depots (26). In our team's opinion, this together with the synergistic action of administered Pethidine in the early postoperative period in patients in the control group are the reasons for the presence of more pronounced sedation.

At the 3rd postoperative hour, there was also a difference in the clinical manifestation of sedation between patients in the two groups. With regard to the experimental group, this was observed in only 1 patient (1.8%), whereas in the control group - in 16 patients (18%). These differences showed statistical significance ($2 = 13.38$, $p = 0.002$). The data demonstrated similarity to the peak of Pethidine use postoperatively, which was also in the hour range up to the 3rd hour.

Postoperative time	Sedation level	Пациентии /Брой/%	TAP-блок	Без TAP-блок	Общо
30 min	Awake and alert	Брой	61	53	114
		%	74,4%	59,6%	66,7%
	Drowsy, responds to verbal stimuli	Брой	21	35	56
		%	25,6%	39,3%	32,7%
	Drowsy, responds to physical stimuli	Брой	0	1	1
		%	0,0%	1,1%	0,6%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
3 th h	Awake and alert	Брой	81	73	154
		%	98,8%	82,0%	90,1%
	Drowsy, responds to verbal stimuli	Брой	1	16	17
		%	1,2%	18,0%	9,9%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
6 th h	Awake and alert	Брой	82	89	171
		%	100,0%	100,0%	100,0%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
12 th h	Awake and alert	Брой	82	89	171
		%	100,0%	100,0%	100,0%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
18 th h	Awake and alert	Брой	82	89	171
		%	100,0%	100,0%	100,0%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%
24 th h	Awake and alert	Брой	82	89	171
		%	100,0%	100,0%	100,0%
	Total	Брой	82	89	171
		%	100,0%	100,0%	100,0%

Table 49. Distribution of patients according to the degree of sedation in the postoperative period in groups with TAP-block and those without TAP-block.

At subsequent time intervals, our team found no evidence of postoperative sedation in any of the patients in the study sample. This, in our opinion, was due to the relatively low opiate use in the postoperative period.

We compared the results with those reported by other authors. Bharti et al, Liu et al and McDonell et al (7,32,35) reported a decrease in the degree of sedation in the postoperative period in patients with TAP-block. However, others have demonstrated no difference in sedation between patients with and without TAP-block (22)
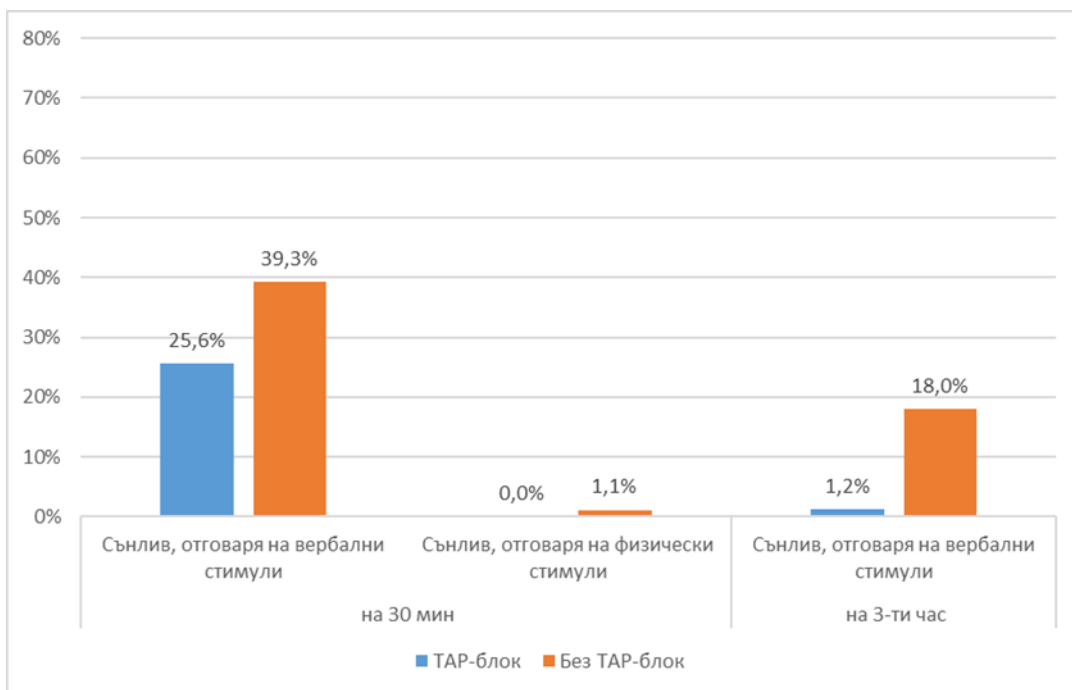
Figure 36. Percentage distribution of patients in terms of degree of sedation in the early postoperative period in patients with TAP-block and those without TAP-block.

The lack of wake-up rooms and Post-Anesthesia Care Units (PACU), as well as the limited staff and bedding in intensive care units in most Bulgarian hospitals, place the responsibility directly on the anesthesiologist to deliver the patient to the surgical ward with fully restored consciousness and reflexes. This is especially true for elderly patients and major surgical interventions, as was the contingent in our study.

Reduced sedation, better hemodynamic stability and less postoperative opiate requirements demonstrate the benefits of TAR-block administration and the necessity of its standard introduction for intra- and postoperative analgesia.

4.3.4.3. Other complications

In our study, we placed a TAR block in 82 patients.

In one case, on the occasion of an operation for sigmoid carcinoma, the needle tip was found to be in a blood vessel. On routine aspiration specimen before application of the solution on the right side, the presence of blood on the mandible was noted. This necessitated a change in needle position and infiltration several centimeters caudally. The patient had a normal coagulation status and no subsequent manifestations of LAST were noted.

In another patient for open prostatectomy, 5 minutes after insertion of a bilateral TAR-block and before making a surgical incision, extreme bradycardia up to 35 y/min and hypotension up to 81/46 mm/Hg were recorded, which were quickly managed with 10 mg Ephedrine intravenously, bolus. In our team's opinion, this was not due to loco-regional technea due to the fact that peak plasma LA concentrations in TAR-block are mostly reached between the 10th and 35th minute (49). Furthermore, as mentioned earlier, the period between induction of anesthesia and surgical incision is associated with the greatest risk of hemodynamic decline (33).

5.   SUMMARY

A total of 171 patients were included in the present study. From them 31 were females and 140 were males. From the practical, clinical and scientific point of view, the participants were divided into two main groups: group I with TAP- block (experimental group) - 82 patients and group II without TAP-block (control group) - 89 patients.

The participants were mainly male. This was due to the nature of the surgical interventions included in the study (prostatectomy, rectum/sigma resection and cystectomy).

The mean age of the patients was relatively high (66.78 ± 8.19 years for the experimental group and 68.64 ± 5.76 years for the control group). This was also determined by the nature of the surgical interventions involved. However, in the recent years, there has been a decline in the age of patients requiring radical organ resections. The youngest patient in our study was 47 years old and 22 patients (12.9%) were under 60 years of age.

Based on the data collected and analyzed presented in this thesis, we came to several conclusions.

After induction of anesthesia, a decrease in hemodynamic indices was observed in both groups. The decrease in values was due to the vasodilating and direct cardiodepressive effect of intravenous and inhalational anesthetics. Hypotension in noncardiac surgery is most frequently recorded in the period between induction and the start of surgery, namely between the 5th and 10th minute of induction (131).

Another distinct result is the rise in the blood pressure and heart rate values after skin incision and the start of the surgical intervention. The changes were attributed to surgical stress - pain and sympathetic activation resulting from inadequate analgesia. The degree of increase was different in patients of the two groups. After skin incision, hemodynamic indices in the control group exceeded baseline levels, whereas those in the experimental group did not reach them. The results show a statistically significant difference, which we believe is due to the synergistic analgesic effect of the preoperatively performed TAP-block and the administered intravenous opioid (Fentanyl).

The development of modern anesthesiology is making the intraoperative period safer for the patients. However, patients with cardiovascular disorders remain at high risk for perioperative cardiovascular complications, especially in major abdominal surgery (73). Patients with TAP-block exhibit better hemodynamic stability intraoperatively. Furthermore, the use of this regional technique is accompanied by reduced opioid consumption, which we believe is again due to the synergistic analgesic effect of TAP-block and Fentanyl.

Adequate intraoperative analgesia in lower abdominal surgery can be achieved by several different techniques. One possibility to accomplish this is the administration of epidural anesthesia. The increasing use of anticoagulants and antiaggregants, particularly in patients with cardiovascular diseases in whom the maintenance of adequate haemodynamics is of great importance, may significantly reduce the indications for its use. In addition, episodes of hypotension or cardiac rhythm disturbances may frequently be observed during epidural anaesthesia.

Another method of intraoperative analgesia is through the use of opioid analgesics. In order to achieve good analgesia and maintain stable haemodynamics, especially in major surgical procedures, the use of relatively high doses of opioids is often necessary. This in turn can lead to delayed recovery from anaesthesia and subsequent complications from opioid medication.

For these reasons, the administration of a TAP-block as part of multimodal anaesthesia has advantages over both of these methods.

In the period immediately after extubation, a statistically significant difference in haemodynamic parameters was again detected, with higher values in patients without prior TAP-block. This determines the more pronounced hemodynamic instability, especially for the HR index, in the early postoperative period.

Regarding intraoperative opioid consumption, we found that in the experimental group the mean total Fentanyl dose used was 302.13 μg (SD ± 61.26), and in the control group the mean amount of Fentanyl used was 327.53 μg (SD ± 50.99). This data showed that the total dose of Fentanyl used was 7.93% less in the experimental group and the result has high statistical significance (t = 2.95, p = 0.003). Apart from the absolute value, the use of Fentanyl was also statistically significantly less in the experimental group when calculating by kilogram for each individual patient.

Regarding pain in the early postoperative period, we found that in the experimental group 52 patients (63.4%) reported no postoperative pain and 29 (35.4%) reported mild pain. Only one patient of those with TAP-block reported moderate pain and none reported severe pain. On the other hand, in the control group, only 7 patients (7.9%) reported no pain, 41 (46.1%) reported mild, 33 (37.1%) - moderate and 8 (9%) patients reported severe pain. The difference in the level of pain between the two groups had very high statistical significance (Fisher's exact tes = 84.39, p < 0.001). We believe that these results are due to the analgesic effect of the TAP-block on the parietal abdominal surface, which soreness is strongest in the early postoperative period.

Assessment of the intensity and control of the acute postoperative pain at rest are important to ensure patient comfort in the supine position. In addition, adequate relief of dynamic pain during mobilization, deep breathing and coughing is important to reduce the risks of cardiopulmonary and thromboembolic complications after surgery. Effective relief of dynamic pain facilitates mobilization and may therefore improve long-term postoperative prognosis (10). In our study, we monitored and compared the postoperative VAS in different time ranges up to the 24th hour at rest, coughing, and turning in bed. From the results obtained, the distinct difference and higher pain sensation rate in patients without a prior TAP-block compared to those who had a prior TAP-block was striking. At the 18th postoperative hour, the indices were significantly similar, however the differences remained statistically significant. Although statistically significant, this difference was clinically insignificant because patients subjectively described their pain as mild and moderate in severity. The situation was similar at the 24th hour. This leads us to conclude that the effectiveness of the TAP-block is reduced after the 18th hour. Pain originating from the disruption of muscle tissue and fascia is stronger and more difficult to manage than the one from the skin incision and visceral organs (50). Our study also demonstrated that TAP - block improves not only static but also dynamic pain during the first 24 hours of the postoperative period. This determines a better sense of comfort in the supine position and also the possibility of earlier mobilization of patients and the associated reduced postoperative morbidity.

In the postoperative period persisted the tendency that patients in the control group have higher blood pressure and heart rate values. According to our team, this is due to the postoperative stress response of the body caused by the higher level of pain stimulus in patients without applied TAP-block compared to those with TAP-block.

Concerning postoperative opioid use, we found that according to our results the consumption was 46% lower in patients with TAP-block. In addition we found that both the

absolute value of Pethidine and the calculated individual dose per kilogram were statistically significantly lower in the experimental group. However, our results showed a significantly lower absolute amount of opioid used in our study compared to the reported in other studies in similar type of operations. Our data confirms clinical observations regarding the low level of postoperative pain relief in Bulgaria, which may lead to increased morbidity, prolonged hospital stay and pain chronification. This further increases the need for routine introduction of postoperative analgesia techniques that do not require special care by medical staff. Such an alternative is the application of TAP-block.

From the results for postoperative administration of Pethidine it is also noteworthy that in the experimental group in 11 of the patients (13.4%) no opioid agonist was administered at all for postoperative analgesia, and in 6 of them (7.3%) only 25 mg was used. This demonstrates the possibility of achieving „opioid free" and „opioid sparing" analgesia in the early postoperative period by preoperative administration of bilateral TAP - block with lateral access in lower abdominal surgical procedures. This also suggests a lower incidence of side effects from postoperative opioid use.

From the data in our study, is evident the high percentage of patients (79%) who required early inclusion of opioid analgesics in the treatment to manage postoperative pain in the group without TAP-block. In contrast, in the TAP-block group, opioid consumption was distributed significantly more evenly. The same trend was seen in the postoperative use of NSAIDs.

In regard to postoperative nausea and vomiting, we found no statistical difference between the two groups in the early postoperative period, whereas a higher degree of sedation was observed in patients without TAP-block.

In our study, we observed no serious side effects from the technique of TAP-block administration as well as the drug combination used for application.

6. CONCLUSIONS

Based on the obtained results, we formed the following conclusions regarding the application of bilateral TAP-block with lateral access in surgical interventions with inferior midline laparotomy.

1. The use of ultrasound in the application of TAP-block allows precise visualization of the structures, constant control in the passage of the needle, verification of the infiltration with local anaesthetic and high success rate of the technique.

2. TAP - block applied preoperatively reduces intraoperative opioid consumption.

3. Administration of TAP - block improves hemodynamic stability perioperatively.

4. Administration of TAP - block significantly reduces postoperative opioid requirements.

5. Administration of TAP - block does not affect the dose of NSAIDs used for postoperative analgesia.

6. Administration of TAP - block reduces the intensity of postoperative static and dynamic pain.

7. TAP - block is an effective choice as part of the multimodal intraoperative analgesia strategy.

8. Application of TAP - block does not reduce the incidence of PONV, but reduces the degree of sedation in the earliest postoperative period.

7.   CONTRIBUTIONS

<u>Scientific and practical contributions</u>

1.   Literature and practical data are presented on the usefulness and safety of ultrasound guidance in the application of TAP - block for analgesia of surgical interventions with inferior midline laparotomy.

2.   The practical and technical features of the application of bilateral lateral TAP - block under ultrasound control are outlined.

3.   An analysis of the efficacy and safety of the TAP - block is made.

4.   The advantages of infiltration of local anaesthetic in the transverse abdominal plane over the standard postoperative analgesia are presented.

<u>Scientific and theoretical contributions</u>

1.   The advantages of the ultrasound application of the TAP - block over the conventional intra- and postoperative analgesia are presented.

2.   Contraindications and limitations of the method are specified.

3.   The results obtained in our study are compared with data from the world and bulgarian literature.

8.   LIST OF PUBLICATIONS RELATED TO THE THESIS

1. Transversus abdominis plane block, TAP block - part of the multimodal approach to analgesia in abdominal surgery (Review).
Zanev A., Mladenov N., Varna Medical Forum vol.11, 2022 № 1.
DOI: http://dx.doi.org/10.14748/vmf.v11i2.8526
https://journals.mu-varna.bg/index.php/vmf/article/view/8526/7532

2. Current trends in the treatment of postoperative pain in abdominal surgery
(Review) Zanev A., Naidenova B., Varna Medical Forum vol.11, 2022 № 1
 DOI: http://dx.doi.org/10.14748/vmf.v11i2.8527

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