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Modified Supraclavicular and Pectoral Nerves Blocks for Implantation of Intravenous Port System in Cancer Patients

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Summary

Ultrasound-guided regional anesthesia can be an effective way to achieve analgesia during implantation of permanent intravenous port systems.

The aim of the study was to improve the quality of perioperative analgesia during placement of permanent intravenous port systems.

Material and methods. The prospective randomized study included 93 patients with malignant neoplasms. Patients were randomized into 3 groups, 31 people each, who were implanted with a permanent intravenous port system in 2019–2022. Group 1 patients were implanted under local infiltration anesthesia (LIA). Ultrasound-guided pectoral nerves block (PECS1) in group 2 was supplemented by LIA. In group 3 ultrasound-guided selective supraclavicular (SC) nerve block was supplemented with LIA. Pain intensity was assessed on a 100 mm visual analog scale (VAS) at rest and while moving at 8, 16, 32 and 72 hours after implantation. The inflammatory postoperative stress response was assessed by the dynamics of C-reactive protein (CRP), interleukin 1-β (IL 1-β), interleukin-6 (IL-6). We also analyzed the correlation of proinflammatory cytokines levels with VAS-measured pain intensity at the stages of the study taking into account a potential relationship between IL-6 and IL-1β fluctuations and the severity of inflammatory and neuropathic pain.

Results. In groups 2 (PECS1) and 3 (SC nerve block), pain intensity measured by VAS at rest and while conducting daily activities was significantly lower than in group 1 (LIA). CRP levels were also significantly lower in group 2 and 3 patients as compared to group 1. The lowest IL-6 and IL-1β concentrations after port implantation were revealed in a group 3 in 24 hours after the procedure, persisting through day 3. There was a correlation between proinflammatory cytokines levels and pain intensity.

Conclusion. Implantation of an intravenous port system under local infiltration anesthesia causes a significant inflammatory response in cancer patients, which can be balanced by regional techniques. Selective supraclavicular nerve block in combination with a local anesthesia for intravenous port implantation demonstrated the greatest analgesic potential and requires significantly reduced amounts of local anesthetic compared to pectoral nerves block in combination with LIA, or only local infiltration anesthesia.

Keywords: intravenous port system; oncology; pain; implantation; analgesia; PECS1; modified blockage; supraclavicular nerve; pectoralis nerves; ultrasound-guided; regional anesthesia

Conflict of interest. The authors declare no conflict of interest.

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Introduction

A recent large descriptive study of procedural pain in adult cancer patients reported that more than 50% of these patients experienced moderate to severe pain during procedures [1]. Implantation of an intravenous port system is a routine procedure in daily practice, usually performed by an anesthesiologist. Currently available literature, however, does not provide guidance on the perioperative anesthetic strategy for patients undergoing this procedure [2]. Local infiltration anesthesia (LIA) is a widely used technique for procedures such as drain placement, pacemaker or intravenous port system implantation [3, 4]. Cancer patients usually have previous experience with invasive procedures and often suffer from chronic pain syndrome directly related to the tumor and/or due to previous treatment. As a result, most of them experience anxiety and fear before the procedure [5].

The pain experienced by cancer patients during procedures can be excruciating for the patient, family, and caregivers. In addition, painful procedures can cause pain breakthrough or worsening in patients receiving analgesic therapy [6].

Nociceptive stimulation associated with any type of invasive procedure in cancer patients cannot be completely blocked by local anesthesia alone [7]. According to Renzini et al. and Sansone et al. [8–10], the LIA technique is insufficient when a subcutaneous «pocket» is created. Taxbro K. et al.

[11] believe that a quarter of patients experience severe pain and discomfort during implantation of an intravenous port system using only local anesthesia. Chang D. et al. point out that the combination of local anesthesia and sedation may also be insufficient for patients with high levels of anxiety and distress, and the level of distress is often underestimated by the operator [12].

Mehmet et al. [13] report that patients complain of pain after port system implantation within the next few days and most of them require additional analgesia [13]. However, according to Mehmet et al. [13], little attention has been paid to the importance of postoperative analgesia after portosystemic implantation. Byager et al. [14] reported that infiltration of the surgical wound with local anesthetic does not provide analgesia in the early postoperative period.

These facts warrant further research into the possibilities of improving the control of the pain associated with an invasive procedure in cancer patients.

Currently, there are several regional anesthesia techniques that provide more effective perioperative analgesia compared to LIA [15–18]. One of the disadvantages of LIA is the need for relatively large doses of local anesthetics (up to 30–40 ml [8]), which increases the risk of systemic toxicity.

In 2011, R. Blanco introduced a new type of fascial plane block, the neurofascial pectoralis nerve block, or PECS [19]. It is a block of the medial and lateral pectoral nerves, which, although considered motor, have both nociceptive and proprioceptive fibers [20, 21]. In addition, according to Munshey et al. and Sansone et al., this type of analgesia also blocks the intercostal nerves at the level of the Th3 to Th6 segments [9, 10]. It is worth mentioning that all thoracic motor nerves have postganglionic fibers from cervical and thoracic ganglia, which may be additional conductors of pain impulses and participate in the development of postoperative neuropathic pain [22]. The use of the PECS block provided a relatively simple and safe technique to achieve high quality postoperative anesthesia for breast surgery. Selective supraclavicular nerve (SSCN) block is another regional anesthesia technique that can be used for port system implantation. This ultrasound-guided technique was first described in 2011 by Maybin et al [23]. It was designed to avoid additional phrenic nerve block, which is particularly relevant in patients with comorbidities and in the outpatient setting. Traditionally, the supraclavicular nerve has been blocked by proximal spread of the solution during brachial plexus block via interscalene approach in shoulder and clavicle surgery [24, 25], but the technique of proximal compression failed to avoid the associated phrenic nerve block [26]. Selective block of the supraclavicular nerve and upper trunk of the brachial plexus (SCUT block) is known to allow clavicle surgery without additional anesthesia [27].

There are no studies comparing wound infiltration by a surgeon with any selective cutaneous nerve block. However, many comparative studies between standard mixed nerve block and wound infiltration show superiority of the former [28–31].

Given the extent of sensory anesthesia in selective supraclavicular nerve block, it can be effectively used for perioperative pain control during implantation of intravenous port systems (Fig. 1).

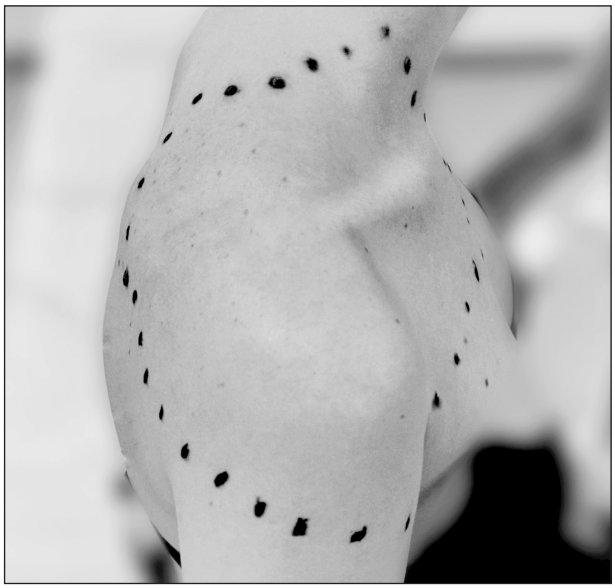

Fig. 1. Area of sensory anesthesia during supraclavicular nerve block.

Response to a noxious stimulus, such as surgery, involves changes in the hepatic production of acute-phase proteins, such as C-reactive protein (CRP), and various cytokines, which initiate and/or maintain an inflammatory response. High levels of proinflammatory cytokines (mainly IL-6) and lack of compensatory expression of anti-inflammatory cytokines can cause a systemic inflammatory response in cancer patients [32, 33].

Interleukin-1β and interleukin-6 are proinflammatory cytokines involved in autoimmune reactions, inflammation and pain processes, which also play an important role in evaluating the acute phase of postoperative stress response [34–38]. According to Ke Ren, Richard Torres and Zhou et al., interleukin-1β and interleukin-6 are critical in these processes [34, 35]. These cytokines also significantly influence the induction and maintenance of pain as chronic pain develops. Blocking the synthesis of these interleukins may have an analgesic effect [34–37]. Postoperative pain is associated with an inflammatory response, the reduction of which is an important determinant of both the

severity of acute pain and the persistence of pain after surgery [39].

Inflammatory pain is a multifaceted cellular response involving the development of abnormal hyperalgesia in response to tissue damage and inflammation (e.g., postoperative pain, trauma, ischemia, metabolic dysfunction, or infection) [40].

The choice of regional anesthesia for intravenous port system implantation can be challenging because each of the currently used blocks, including local infiltration anesthesia, «covers» only one part of the surgical field, leaving the other unaffected. Janc J. et al. used a modified block in their study, combining a thoracic nerve block with local anesthesia, and showed the superiority of such a combination [41].

We also used modified versions of the block combining local and regional anesthesia. The rationale behind the study was the assumption that regional anesthesia techniques ensure less response to surgical stress due to a more pronounced analgesic potential and reduce the need for postoperative analgesia.

The aim of the study was to improve the quality of perioperative analgesia during placement of permanent intravenous port systems.

Materials and Methods

The prospective, randomized, single-blind study included 93 patients aged 31 to 73 years (mean age, 59.5 years) assessed according to ASA III–IV [42]. The study flow chart is shown in Fig. 2. Patients were implanted with the intravenous Power Port™ isp M.R.I.™ Implantable Port System. The Mindray DC-N6 with L12-4 (3–13 MHz) linear transducer was used for ultrasound guidance.

The study was approved by the Ethics Committee of Northern State Medical University (Arkhangelsk) No. 04/10-19 dated October 30, 2019.

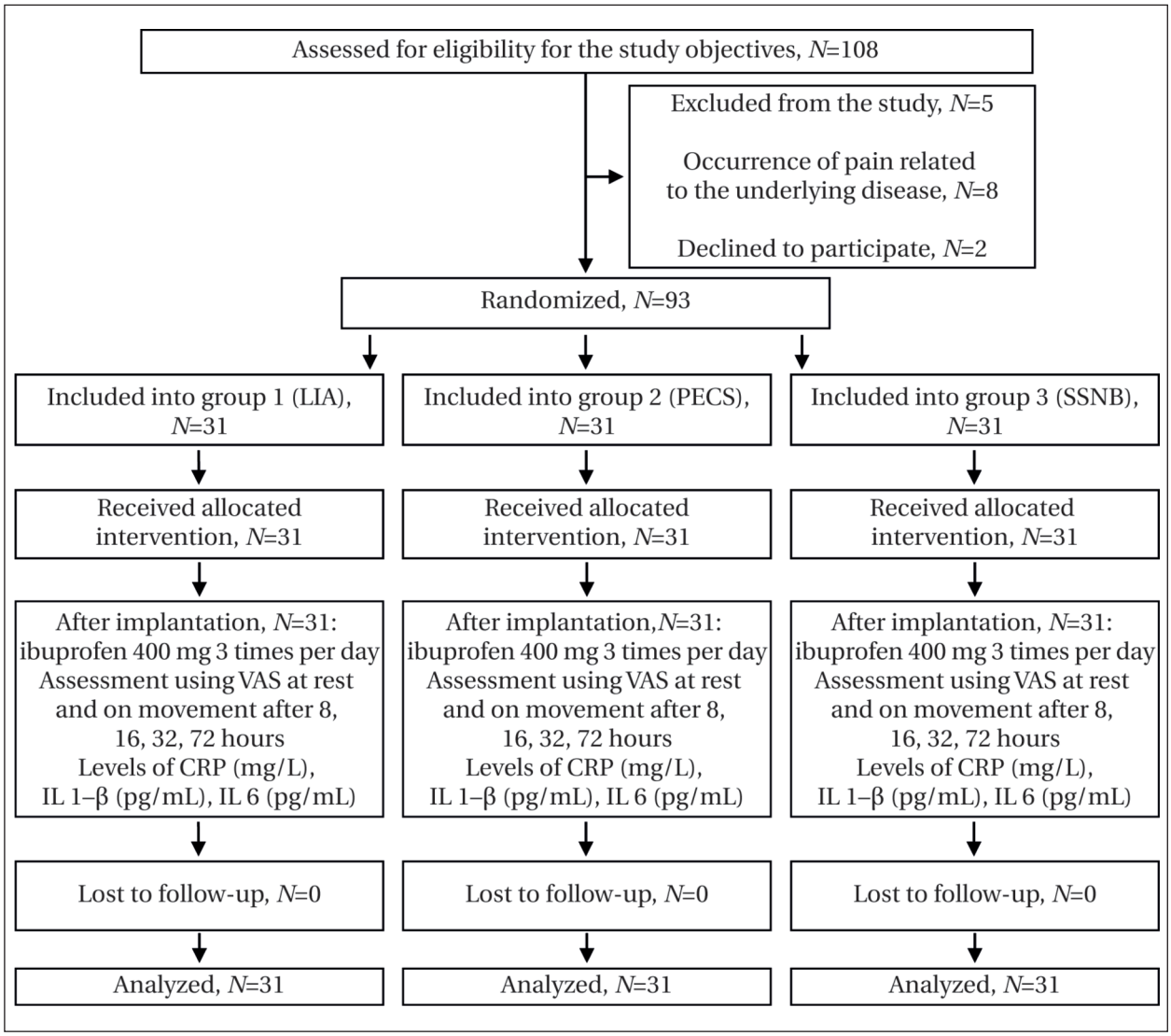

Fig. 2. The study flowchart.

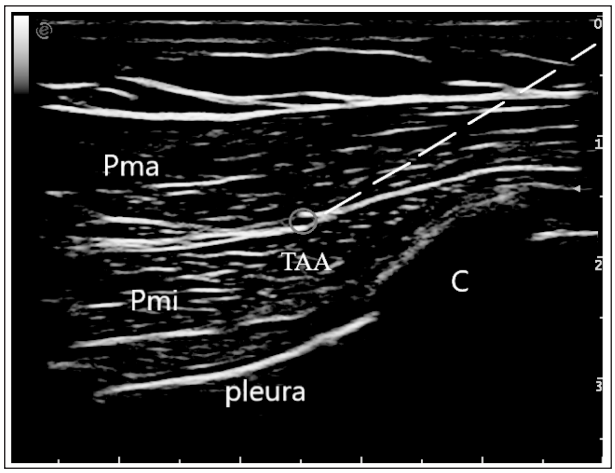

Fig. 3. Thoracic nerve block.
Note. Pma — pectoralis major muscle; TAA — thoracoacromial artery; Pmi — pectoralis minor muscle; C — costa (rib), dotted line indicates the direction of the needle movement.

Inclusion criteria for the study were:

1. Presence of indications for port system placement
2. Absence of pain
3. Absence of psychiatric disorders
4. Age older than 18 years
5. Absence of coagulopathy or systemic anticoagulant therapy
6. Absence of tissue changes at the site of port system implantation (complications after radiation therapy such as radiation dermatitis, infection foci, anatomical malformations, etc.)
7. Absence of allergy to local anesthetics.

Exclusion criteria were:

1. Refusal of the patient to participate in the study
2. Presence of pain related to the underlying disease or treatment immediately prior to port system implantation and during the study
3. Immunologic comorbidities requiring administration of systemic immunomodulatory drugs
4. Daily use of NSAIDs
5. Failure to meet the inclusion criteria.

Depending on the type of regional anesthesia, the participants were divided into three groups of 31 patients each. In group 1 patients, the port system was placed under local infiltration anesthesia (LIA) using the «creeping infiltration» technique with 35±5 mL of 0.5% ropivacaine. In group 2, local anesthesia was used in combination with pectoral block (PECS) under ultrasound guidance. The correct distribution of the local anesthetic between the fasciae was verified by visualizing the separation of the fascial layers between the pectoral muscles [19] (Fig. 3). The 0.5% ropivacaine 0.2 ml/kg and local anesthesia with 0.5% ropivacaine (20±5 ml) were used. In group 3, selective supraclavicular nerve block (SSNB) was performed under ultrasound guidance (2 mL of 0.5% ropivacaine) with additional local infiltration anesthesia along the dermatomes of the ventral branches of Th1–3 with 0.5% ropivacaine (10±5 mL) [23] (Fig. 4).

Postoperative analgesia in all groups was provided by ibuprofen 400 mg three times a day.

The port system was placed under the skin in the subclavian region at the level of 2–3 ribs. For successful implantation of the venous port system, percutaneous catheterization of the superior vena cava was done, using the subclavian vein for catheterization, which was performed under ultrasound guidance. After catheter insertion, a subcutaneous «pocket» was created and the catheter was connected to the port. The port was then inserted into the pocket with separate sutures, and the skin incision was sutured.

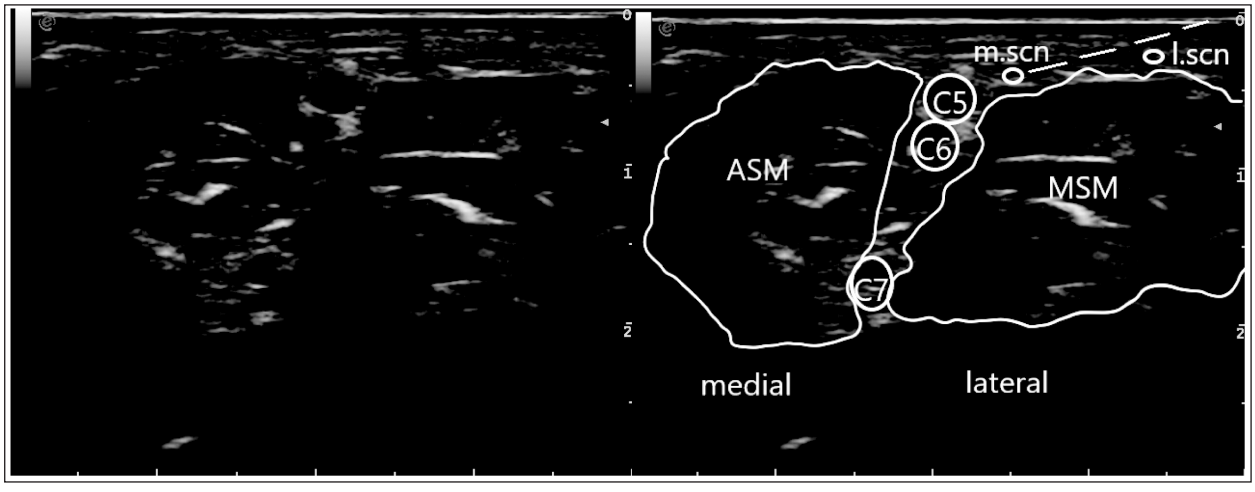

Fig. 4. Selective supraclavicular nerve block
Note. ASM — anterior scalenus muscle; MSM — middle scalenus muscle; m.scn — medial supraclavicular nerve; l.scn — lateral supraclavicular nerve; C5–C7 — cervical nerve roots.

Table 1. Patient characteristics **Me* [25; 75 percentile].

Parameter	Values in the groups			*P*-value
	1 (LIA), *N*=31	2 (PECS), *N*=31	3 (SSNB), *N*=31	
Age, years*	60 [53; 64]	63 [57; 68]	63 [54; 69]	0.267
ASA, points*	3 [3; 4]	4 [3; 4]	3 [3; 4]	0.216
Sex, number/%				
male	18/58	16/51.6	16/51.6	
female	13/42	15/48.4	15/48.4	

Table 2. Localization of the neoplasms.

Localization	Number/%
Gastrointestinal tract	40/43
Breast	16/17.2
Uterus	12/12.9
Lungs	11/11.8
ENT	4/4.3
Lymph nodes	3/3.2
Skin	3/3.2
Prostate	2/2.2
Kidneys	1/1.1
Liver	1/1.1

The intravenous port system was implanted in patients of both sexes, mean age 59.3 years, ASA III/IV, with different localization of neoplasms (Tables 1, 2). The main indication for implantation was chemotherapy.

In the postoperative period, pain was assessed using a visual analog scale (VAS) at rest and during movement at 8, 16, 32, and 72 hours after port placement. To assess the inflammatory response, the changes in the levels of CRP, interleukin-1β (IL-1β), interleukin-6 (IL-6) before the procedure and 24, 72 hours after surgery were measured. A semi-automated ELISA Rideret «Anthos 2020»(Sweden) and reagent kits from Vector-Best (Russia) were used.

The power of the study was assessed using G*Power 3.1.9.7 software, taking into account the number of patients (*N*=93) included in the study to compare the three groups. The effect size (ES) was 0.4, corresponding to a large effect according to Cohen's criteria, with α=0.05 and a sample size of 31 patients in each group. The a posteriori power (1-β) was 0.93.

Statistical analysis of the data was performed using the IBM SPSS Statistics software package (version 26.0). Normality of the distribution of quantitative variables was determined using the Shapiro–Wilk criterion. Quantitative data were described using median (*Me*) and interquartile range. For normal distribution, one-way analysis of variance (ANOVA) with Bonferroni correction was used to compare groups. For non-normal distributions, the non-parametric analog, Kruskal–Wallis test, and the Mann–Whitney test for pairwise a posteriori comparison were used. Parameters in groups 1 (LIA), 2 (PECS), and 3 (SSNB) were compared. When significance was reached, pairwise comparisons were made between groups 1 and 2, 1 and 3, and 2 and 3. The relationship between variables was quantitatively assessed using Spearman's rank correlation coefficient. The critical significance level for rejecting the null hypotheses was 0.05.

Results

The local anesthetic dose (0.5% ropivacaine hydrochloride) in group 1 (LIA) was 150 mg, additional LIA Me (25; 75 percentiles) was 25 (18.7; 31.2) mg, in group 2 (PECS) 75 mg with additional LIA Me of 95 (90.5;105.5) mg, in group 3 (SSNB) 10 mg with additional LIA Me of 20 (15; 39.8) mg.

In group 1 (LIA), the postoperative pain score on VAS at rest and during movement was significantly higher than in groups 2 (PECS) and 3 (SSNB) at all stages of the study, i. e. 8, 16, 36 and 72 hours after port system implantation ($P<0.001$). There were no significant differences in pain intensity at rest and during movement between groups 2 (PECS) and 3 (SSNB) at the same time points (Fig. 5).

According to the study design, all patients were prescribed ibuprofen 1200 mg/day after port system implantation, and the need for medication was then recorded in all groups. The ibuprofen requirement (*Me* [25; 75 percentiles]) was 1200 mg (1200; 1200) for three days in the LIA group, 800 mg (400; 800) in the PECS group, and 400 mg (0; 400) for one day in the SSNB group. A greater need for ibuprofen in the LIA group (P=0.001) was associated with persistent pain greater than 30 VAS points 48 hours after port system implantation.

Baseline CRP levels did not differ between groups.

In the LIA group, the increase in CRP 24 hours after port placement was significantly higher than in the PECS and SSNB groups ($P<0.001$) (Fig. 6a). On day 3, significant differences in CRP levels persisted between these groups (P=0.004). Notably, the CRP level in the LIA group was significantly higher than the reference values (8.05±2.97 mg/L) on day 1 after surgery, in contrast to the PECS and SSNB groups (5.45±2.16 and 4.97±2.59, respectively). The increase in CRP 24 hours after surgery was not significant in the PECS and SSNB groups. In 8 patients of the LIA group, the CRP concentration exceeded 10 mg/L, indicating clinically significant inflammation [43].

No significant differences in CRP levels were found in the PECS and SSNB groups ($P\geqslant0.05$), indicating a similar effect of these regional techniques on the inflammatory stress response (Table 4).

At baseline, there were no significant differences in interleukin-1β levels between groups.

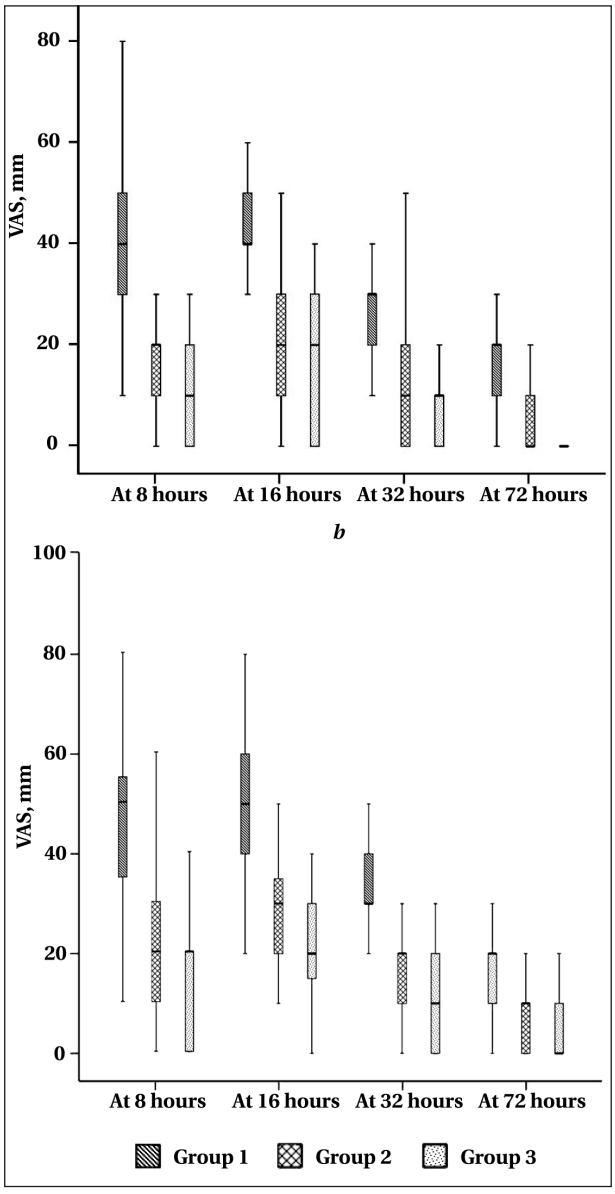

Fig. 5. Boxplot («whisker box») diagram of pain intensity according to VAS at rest (*a*) and during movement (*b*).
Note. Mann–Whitney test was used.

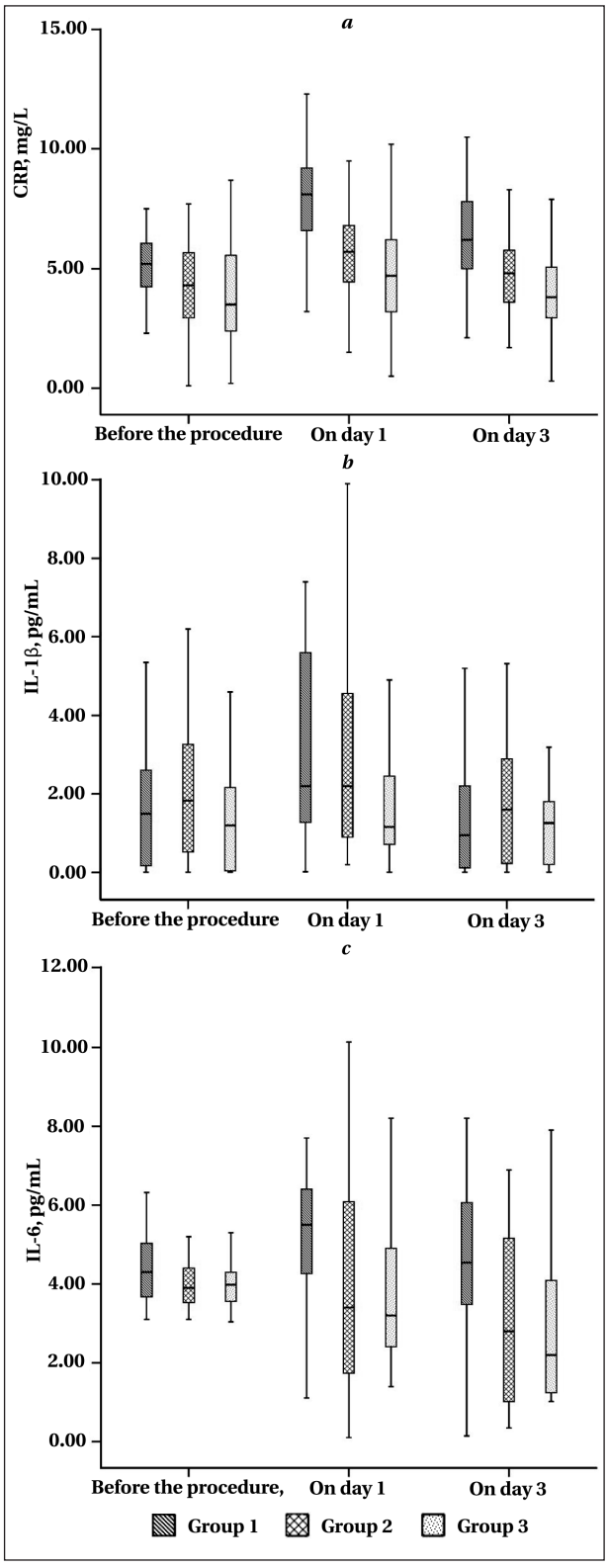

Fig. 6. Intergroup comparison of CRP (*a*) and interleukin (*b, c*) levels during the study phases.
Note. *a* — ANOVA test with Bonferroni correction; *b, c* — Kruskall–Wallis test.

On postoperative day 1, interleukin-1β levels were lower in groups 1 (LIA) and 2 (PECS) than in group 3 (SSNB), 2.1 (1.04; 5.8) and 1.9 (0.9; 4.02) vs. 1.14 (0.51; 2.64), respectively ($P<0.05$) (Table 5). There were no differences in this parameter between groups at day 3 (Fig. 6, *b*).

There were no significant differences in IL-1β between groups 1 (LIA) and 2 (PECS) at any time point ($P>0.05$).

Baseline IL-6 levels in the study groups did not differ and were above reference values due to the concurrent severe malignancy. Significant differences in IL-6 levels were found in groups 1 (LIA) and 2 (PECS) on day 1 after surgery, 5.5 (4.25;6.5) vs. 3.2 (2.32; 5.3) pg/mL, respectively, and on day 3, 4.54 (3.44; 6.1) vs. 2.2 (1.24; 4.1) pg/mL ($P<0.05$) (Fig. 6, *c*). The most significant differences in interleukin-6 concentrations on days 1 and 3 after surgery were found between the LIA and SSNB groups, 5.5 (4.25; 6.5) and 4.54 (3.44; 6.1) versus 3.2 (2.32; 5.3) and 2.2 (1.24; 4.1), respectively (Table 5).

Table 3. Paired comparison of CRP levels, difference of means (standard error).

Time point	Intergroup comparison of CRP levels (mg/l)			P_{1-2}	P_{1-3}	P_{2-3}
	1 (LIA) — 2 (PECS)	1 (LIA) — 3 (SSNB)	2 (PECS) — 3 (SSNB)			
Before the procedure	0.77 (0.47)	1.02 (0.47)	0.25 (0.47)	0.329	0.103	1.00
On day 1	2.6 (0.66)	3.08 (0.66)	0.48 (0.66)	0.0001	0.001	1.00
On day 3	1.16 (0.59)	2.03 (0.59)	0.87 (0.59)	0.152	0.003	0.43

Note. A posteriori comparisons with Bonferoni correction were used ($P<0.05$).

Table 4. Changes in IL-1β and IL-6 levels, *Me* [25th; 75th percentile].

Time point	Interleukin levels (pg/ml) in groups			P_{1-2}	P_{1-3}	P_{2-3}
	1 (LIA), *N*=31	2 (PECS), *N*=31	3 (SSNB), *N*=31			
		IL-1β				
Before the procedure	1.3 [0.15;2.62[	1,6 [0.36;3.09]	1.15 [0.04;2.32]	0.367	0.397	0.076
On day 1	2.1 [1.04;5.8]	1,9 [0.9;4.02]	1.14 [0.51;2.64]	0.573	0.011	0.03
On day 3	0.93 [0.09;2.33]	1,57 [0.18;2.5]	1.23 [0.12;1.88]	0.345	0.866	0.172
		IL-6				
Before the procedure	4.3 [3.65;5.1]	3.9 [3.5;4.45]	3.98 [3.5;4.3]	0.054	0.106	0.805
On day 1	5.5 [4.25;6.5]	3.4 [1.5;6.25]	3.2 [2.32;5.3]	0.019	0.002	0.751
On day 3	4.54 [3.44;6.1]	2.8 [1.0;5.21]	2.2 [1.24;4.1]	0.05	0.015	0.899

Note. Mann–Whitney test was used.

There were no significant differences in this parameter between the PECS and SSNB groups. Interestingly, in the supraclavicular nerve regional block group, IL-6 levels decreased 2-fold on day 3 after port system implantation compared to baseline (Table 5).

A significant correlation was found between the severity of pain according to VAS and the level of proinflammatory cytokines at all stages of the study. We found the most significant positive correlation between the difference in IL-6 concentrations in the first day after surgery and before surgery, as well as between IL-6 concentrations in the first day after surgery and pain severity according to VAS after 72 hours with *rho*=0.511 ($P<0.001$) and *rho*=0.542 ($P<0.001$), respectively (Fig. 7).

Discussion

When choosing the regional anesthesia technique for the implantation of intravenous port systems, we should consider the innervation of the anterior surface of the chest wall up to the third rib as the most common implantation site. This area is most often used for «pocketing» and direct insertion of the port receiving chamber [44].

The role of cutaneous nerve blocks in regional anesthesia is often underestimated. Such blocks are performed less frequently or in addition to conventional nerve blocks. Cutaneous nerves are involved in the development of acute postoperative pain, but they are also the most common cause of chronic postoperative neuropathic pain [45].

Taking into account the results of pain assessment by VAS in the study groups, SSNB was found to possess the greatest analgesic efficacy during intravenous port system implantation compared to LIA and PECS. The advantages of PECS block over local anesthesia for intravenous port system implantation have been

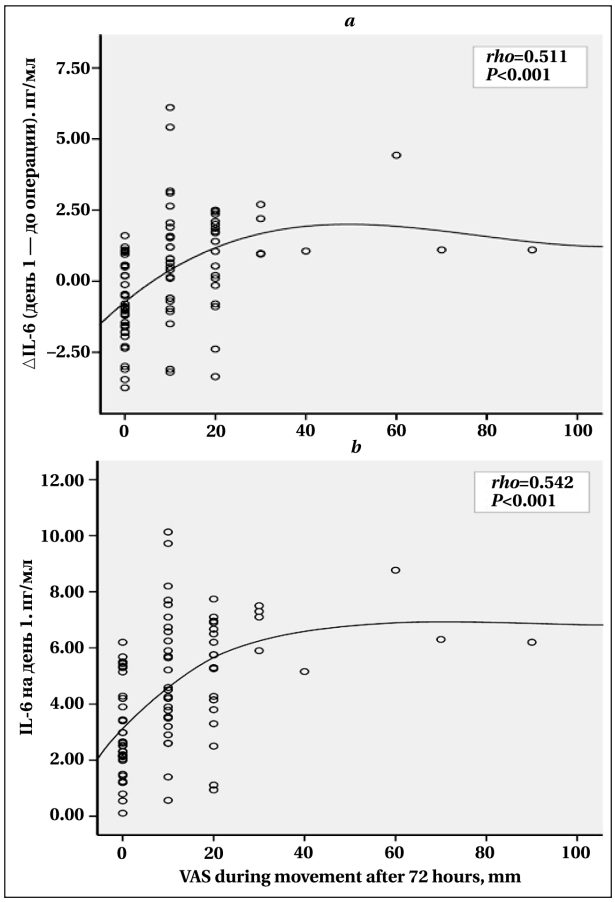

Fig. 7. Correlation of VAS pain severity with IL-6 levels during movement after 72 hours.
Note. Correlation: *a* — with the change in IL-6 level between day 1 after surgery and baseline; *b* — with the IL-6 level on day 1 after surgery.

demonstrated in several studies [13, 41]. In our study, PECS block also had a rather strong analgesic potential, comparable to that of selective supraclavicular nerve

block (SSNB). However, it was the SSNB that significantly reduced the local anesthetic dose and minimized the postoperative stress response.

According to Thomas Dahl Nielsen of Aarhus University Hospital (Denmark), «…whether or not cutaneous nerve blocks should be of relevance to the regional anaesthetist in regard to acute postoperative pain, depends on the objective of the postoperative pain treatment. If future improvements towards opioid-free, painless, fast track procedures are an ambition, then cutaneous nerves and knowledge of cutaneous nerve blocks seem like an unavoidably part that equation» [45]. This study confirms the above statement and also shows that the use of regional anesthesia techniques reduces the need for postoperative anesthesia. This is in agreement with the results of other authors [41].

The use of regional anesthesia is known to reduce the inflammatory response induced during surgery in cancer patients [46, 47]. When local anesthesia was used for intravenous port system implantation, a significant postoperative stress response was obtained on the first day after implantation. The levels of CRP and interleukin-6 significantly exceeded the reference values and did not decrease to the preoperative values even on the third day after surgery only in the local anesthesia group. The data obtained are consistent with the suggestion that CRP is an acute-phase protein induced primarily by the action of IL-6 on the gene responsible for CRP transcription in the acute phase of inflammation/infection [43].

CRP and IL-6 have been reported to have the strongest correlation with the severity of surgical injury, although CRP is probably the most clinically useful of them (Watt D. G. et al.) [48]. It can be concluded that even minimally invasive procedures in cancer patients can induce a significant inflammatory response when only local anesthesia is used.

One day after surgery under local anesthesia, an increase in interleukin-1β was observed compared to the group using selective supraclavicular nerve block combined with local anesthesia. Interleukin-1β, a 17.5 kDa polypeptide, is thought to play an important role in modulating neuronal excitability in the peripheral and central nervous systems. In addition to its immunoregulatory effects, IL-1β has a specific relevance to the development of persistent pain, including peripheral tissue injury (inflammatory pain) and nerve injury (neuropathic pain) [49].

In the acute immune response, tumor necrosis factor-alpha (TNF-α) and interleukin (IL)-1β are released first. They induce a secondary immune response in which IL-6 is produced [50]. Given the association of IL-1β and IL-6 with inflammatory and neuropathic pain, the findings reflect both the superior analgesic effect of cutaneous nerve block and the greatest nociceptive stimulation with local anesthesia alone.

A correlation between pain intensity and the expression of proinflammatory cytokines and CRP has been demonstrated. The study by Amano K et al. also reported a direct correlation between CRP and pain scores on a digital rating scale. In addition, serum levels of CRP have been identified as a «surrogate» for systemic inflammation in relation to survival, activities of daily living, and physical and psychological signs and symptoms [51].

The use of regional anesthesia was found to reduce the inflammatory response; in the cutaneous nerve block group, IL-6 levels were reduced 2-fold on day 3 compared to baseline. Pérez-González O. et al. reported that regional anesthesia in breast cancer surgery was associated with lower levels of inflammation and better immune response compared with general anesthesia and opioid analgesia [52].

In a recent review of perioperative anesthesia strategies in oncology, the authors conclude that regional anesthesia can be considered as a technique to potentially decrease the response to surgical stress, improve pain control, and reduce postoperative complications, providing significant benefit for cancer patients [53].

There is a growing interest in how perioperative strategies can alter cancer outcomes. Literature in recent years has suggested that regional anesthesia can increase recurrence-free survival in cancer patients, leading to the birth of a new specialty, oncoanesthesiology [54]. Mary Thomas, professor of anesthesiology at the Regional Cancer Center of India, argues that «anesthetic strategy could have significant oncological sequel is a quantum leap forward» [54]. Our study also underscores the importance of this point.

Conclusion

Implantation of an intravenous port system under local anesthesia induces a significant inflammatory stress response due to surgical trauma (CRP 8.05 mg/L, IL-6 5.5 pg/mL, IL-1β 2.1 pg/mL at 24 hours), while local anesthesia cannot provide sufficient analgesia after implantation in cancer patients.

The use of regional anesthesia techniques under ultrasound guidance helps to achieve a significant reduction in postoperative pain, the need for additional postoperative analgesia, and to counteract the inflammatory stress response after implantation of the intravenous port system.

Selective supraclavicular nerve block during implantation of the intravenous port system has the greatest analgesic potential and requires significantly less local anesthetic (additional 10 mg LIA median of 20 [5; 39.8] mg) compared to local infiltration anesthesia (additional 150 mg LIA median of 25 [18.7; 31.2] mg) and PECS block (additional 75 mg LIA median of 95 [90.5; 105.5] mg).

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