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Evaluation of our patient-controlled analgesia protocols applied in orthopedic surgery

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Abstract

The patient-controlled analgesia (PCA) method is a crucial part of daily anesthesia practice, with different application methods to provide analgesia after orthopedic surgeries. This study aims to assess the effectiveness of intravenous (IV), interscalene, and subacromial PCA in managing postoperative pain in shoulder arthroscopy operations performed at our clinic. Follow-up forms of patients aged between 25 and 85 who were operated on and underwent PCA in the Istanbul Medical Faculty Orthopedics operating room were scanned. The patients who underwent shoulder arthroscopy were divided into three main groups (intravenous, interscalene, and subacromial) according to the PCA application method. Visual Analog Scale (VAS) values at rest and during movement, the presence of nausea and vomiting, and the need for additional analgesia were recorded. Of the 142 patients in whom PCA was used after shoulder arthroscopy, 40 had intravenous, 41 had interscalene, and 61 had subacromial PCA. The demographic characteristics (age, gender, and body mass index) of all three groups were statistically similar. When we look at the percentage of cases with a resting VAS value >3 in patients who underwent intravenous, interscalene, and subacromial PCA, it was found to be 25%, 0.0%, and 32.8%, respectively (p=0.005). The percentage of cases with a movement VAS value >3 was 80%, 12.2%, and 73.8% for the groups, respectively (p<0.001). Additional analgesia was required in 80% of intravenous PCA patients, 52.5% of subacromial PCA patients, and 7.3% of interscalene PCA patients (p<0.001). Vomiting complaints occurred in 50%, 2.4%, and 1.6% of intravenous, interscalene, and subacromial PCA, respectively (p<0.001). Using interscalene PCA instead of intravenous PCA significantly reduced the likelihood of a VAS score at movement of more than 3 and the need for additional analgesic administration (p<0.001). Postoperative pain control after arthroscopic shoulder surgery is important for the patient's comfort and recovery. Patient-controlled analgesia can be applied intravenously, subacromial, or interscalene to control postoperative pain in this patient group. However, interscalene PCA application is a more effective method than intravenous application in terms of both pain control and side effects.

Keywords: Postoperative pain, arthroscopy, shoulder, patient-controlled analgesia

Introduction

Shoulder arthroscopy is one of the most common orthopedic surgeries, and early rehabilitation and rapid discharge are targeted after the operation. Effective postoperative pain control is necessary to achieve these goals.

As well as the difference in surgical technique, the patient's gender, age, and psychological state can determine the level of pain and the need for analgesia [1,2]. In general, it may be possible to provide postoperative analgesia with intravenous or oral analgesic drugs. Particularly the widespread use of peripheral block techniques and ultrasound-guided catheterization methods, which allow avoiding systemic effects, come to the fore.

Regardless of the pain control method used, it is crucial to evaluate and regulate the severity of pain experienced by the

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patient in order to assess and optimize the efficacy of analgesia. Although it is not a complex assessment, the Visual Analogue Scale (VAS), one of the unidimensional scales, is the most widely used scaling method for simple questioning of the pain of patients from different sociocultural segments in daily practice [3,4]. Postoperative pain can be evaluated during movement and at rest with the VAS scale.

No matter which analgesia technique we use, it may not be possible to dynamically control the patient's pain. In this case, an interactive technique, in other words, where the patient contributes to the treatment timing and needs, may be more comfortable. In this respect, patient-controlled analgesia offers a good alternative.

The patient-controlled anagesia (PCA) is a microprocessor-controlled infusion pump that allows adjustment of several variables, including medication dosage, initial loading dose, bolus or demand dose, lockout interval, continuous infusion rate, and one- and four-hour limits. In this way, patients are allowed to self-administer analgesic drugs in controlled bolus doses within a set safe range via an administration button [5,6]. PCA application in shoulder arthroscopy surgeries is possible with intravenous, subacromial, or interscalene catheters [7,8].

In this study, different PCA application methods used for pain control after shoulder arthroscopy were evaluated retrospectively in terms of VAS movement, VAS rest, need for additional analgesia, and nausea and vomiting.

Material and Methods

The study was conducted at the Orthopedics and Traumatology Department, İstanbul University İstanbul Faculty of Medicine. This study was approved by the ethics committee of İstanbul Medical Faculty, İstanbul University (2008/1621). The need for informed consent was waived because of the retrospective study design. The files of patients who used PCA for postoperative pain control were examined, and patients who underwent shoulder arthroscopy were included in the study.

In retrospectively, the patients' PCA follow-up forms were examined, and based on the PCA application techniques—intravenous, interscalene, and subacromial—the patients were divided into three groups. All operations were performed by the same surgical team. Likewise, interscalene catheterizations were placed by the same senior anesthesiologist. A pain catheter was inserted into the subacromial space by the same orthopedic surgeon under general anesthesia. The same standard anesthesia protocol was applied to all patients accompanied by standard monitorization. The study excluded patients who underwent shoulder arthroscopy without patient-controlled analgesia (PCA), patients under 18 years old or over 80 years old, patients with a physical condition of ASA>III, patients with mental retardation, patients with coagulopathy, and patients who received PCA for less than 24 hours.

In total, 63 out of 197 people were excluded. The remaining 134 people were divided into 3 according to the PCA method applied in the postoperative period (Figure 1). The PCA technique to be applied after shoulder arthroscopy was selected by the individual evaluation of anesthesiologists. Study data were collected from the PCA forms used for follow-up purposes in our clinic.

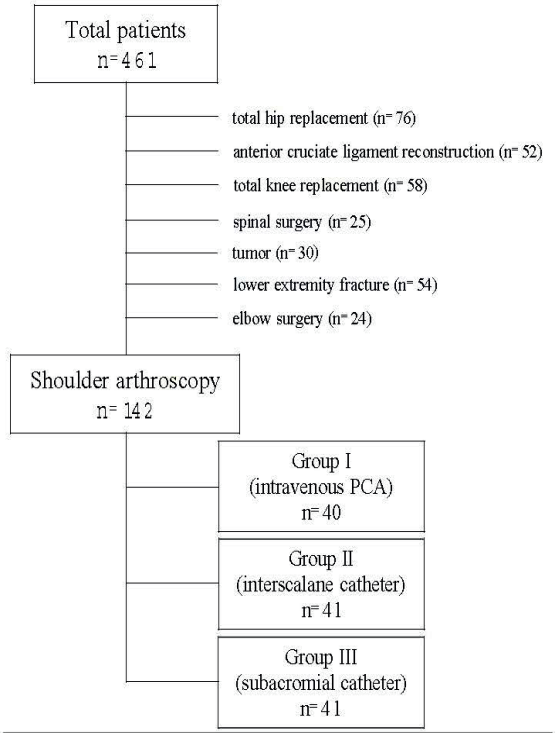

Figure 1. Study flowchart

In the preoperative period, 20 cc of 0.5% bupivacaine was administered as standard for patients with interscalene catheters.

General anesthesia induction was provided to all patients with 1–2 µg/kg fentanyl, 2–2.5 mg/kg propofol, and 0.5 mg/kg atracurium IV, as in our clinic's practice. Anesthesia was maintained with a mixture of nitrous oxide (60%) and sevoflurane 1–3% in oxygen.

All types of PCA were started immediately after the operation. Patients in intravenous PCA administration were administered 0.3 mg/h morphine, a bolus dose of 1mg, and a 20-minute lockdown time.

In patients who underwent postoperative PCA through subacromial and interscalene catheters, 0.125% bupivacaine was administered with 5-10 ml/h infusion, 5 ml bolus, and a lockout period of 20 minutes. All PCAs were terminated after 24 hours of treatment. During this period, a PCA follow-up form was filled out every 4 hours.

According to the information obtained from these forms, the age, gender, height-weight, The American Society of Anesthesiologists (ASA) classification of the patients, which PCA method was used, whether the VAS values of intelligence and movement were >3 at 4-hour intervals, duration of PCA,

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medication used, undesirable effects throughout the application, termination criteria, the need for additional analgesics were recorded.

Statistical Analysis

Data were given as mean (standard deviation), median (quartiles) and percentages. Kolmogoro-Simirnov test was used to detect normality. Student-t, Mann-Whithney U and chi-square tests were used for comparisons of each two groups, whereas ANOVA, Kruskal Wallis and chi-square test were used for comparisons of three groups by using Bonferroni correction. For VAS>3, the usage of the additional analgesic and vomiting, relative risks were detected by using the Z test. The estimated power was calculated as 0.99 by using the number of groups and the difference between the percentages of the number of patients with VAS Movement >3 of the groups (GI: 40 and 80%, GII: 41 and 12.2% and GIII: 61 and 73.8%; independent proportions difference and Fischer's exact test SPSS version 29 was used for statistical analysis. p-value was accepted as <0.05 for statistically significant.

Results

Of the 142 patients in whom PCA was used after shoulder arthroscopy, 40 had intravenous, 41 had interscalene, and 61 had subacromial PCA. The demographic characteristics (age, gender, and BMI) of all three groups were statistically similar (Table 1). When we look at the percentage of cases with a resting VAS value >3 in patients who underwent intravenous, interscalene, and subacromial PCA, it was found to be 25%, 0.0%, and 32.8%, respectively (p=0.005). The percentage of cases with a movement VAS value >3 was 80%, 12.2%, and 73.8% for the groups, respectively (p<0.001). Additional analgesia was required in 80% of intravenous PCA patients, 52.5% of subacromial PCA patients, and 7.3% of interscalene PCA patients (p<0.001) (Table 2). Nausea complaints occurred in 50%, 2.4%, and 1.6% of intravenous, interscalene, and subacromial PCA, respectively (p<0.001). Using interscalene PCA instead of intravenous PCA significantly reduced the likelihood of a VAS score at movement of more than 3 and the need for additional analgesic administration (p<0.001) (Table 3).

Table 1. Patients' characteristics

	GI (Intravenous PCA) (n=40)	GII (Interscalane catheter) (n=41)	GIII (subaracromial catheter) (n=61)	p
Age, year	45 (38-81)	47 (36-77)	42 (32-73)	0.545
Female, n (%)	27 (67.7)	25 (61.3)	40 (65.5)	0.342
BMI, kg/m²	28.7 (25.3-29.9)	29.3 (24.9-31.3)	27.8 (25.8-31.1)	0.671
ASA	2 (2-2)	2 (1-3)	2 (2-3)	0.188
Duration of surgery, min	188 (154-228)	195 (160-242)	190 (158-217)	0.456

ASA: American Society of Anesthesiology, BMI: body mass index, PCA: patient-controlled analgesia

Table 2. Comparisons of VAS, the usage of the additional analgesic, and vomiting of groups

	GI (Intravenous PCA) (n=40)	GII (Interscalane catheter) (n=41)	GIII (Subacromial catheter) (n=61)	p
VAS (R) >3, n (%)	10 (25.0)	0 (0.0)**	20 (32.8)ß,###	**0.005**
VAS (M) >3, n (%)	32 (80.0)	5 (12.2)***	45 (73.8)###	**<0.001**
The usage of the additional analgesic, n (%)	32 (80.0)	3 (7.3)***	32 (52.5)ß,###	**<0.001**
Vomiting, n (%)	20 (50.0)	1 (2.4)***	1 (1.6)ßßß	**<0.001**

M: movement, PCA: patient-controlled analgesia, R: rest, VAS: visual pain scale, *: GI-GII comparison, ß: GI-GIII comparison, #: GII-GIII comparison: *: p=0.05-0.01, **: p=0.01-0.001, ***: p<0.001, ß: p=0.05-0.01, ßß: p=0.01-0.001, ßßß: p<0.001, #: p=0.05-0.01, ##: p=0.01-0.001, ###: p<0.001

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Table 3. Relative risks for VAS, the usage of the additional analgesic, and vomiting

	Relative risk (95% CI)	p
VAS (M) >3		
Intravenous PCA	**Reference**	
Subacromial catheter	0.9 (0.7-1.1)	**0.461**
Interscalane catheter	0.2 (0.1-0.4)	**<0.001**
The usage of the additional analgesic		
Intravenous PCA	**Reference**	
Subacromial catheter	0.7 (0.5-0.9)	**0.004**
Interscalane catheter	0.2 (0.1-0.3)	**<0.001**
Vomiting		
Intravenous PCA	**Reference**	
Subacromial catheter	0.2 (0.1-0.3)	**<0.001**
Interscalane catheter	0.2 (0.1-0.4)	**0.003**

CI: confidence interval, M: movement, PCA: patient-controlled analgesia, VAS: visual pain scale

Discussion

In this study, we found that interscalene PCA application in shoulder arthroscopy is more successful than intravenous and subacromial PCA in terms of pain control and patient compliance. The nausea and vomiting rate, which is extremely important in terms of patient compliance with analgesia, was found to be significantly lower in the interscalene group compared to the intravenous PCA group, as in the subacromial group.

If acute pain cannot be controlled, this pain can turn into chronic pain with sensitization of the nervous system [9]. There are many publications concerning that providing effective postoperative pain control during shoulder arthroscopies is important in terms of postoperative rehabilitation and surgical success [1,10]. When choosing anaesthesia and analgesia for shoulder arthroscopy, it is important to remember that surgical technique and functional recovery goals should be evaluated along with characteristics such as age, body mass index, comorbidities, and shoulder pathology [11].

Which method is used for postoperative pain control in shoulder arthroscopy depends on several factors, including patient preference, surgical technique, and institutional protocols.

In addition to peripheral nerve block methods and local anesthesia infusion techniques with catheterization, local anesthesia infiltration applied by the surgical team through arthroscopy portals is widely used. As shown by Scoggin et al., local anesthetics applied immediately before portal removal contributed to pain control in the postoperative period [12]. On the other hand, a comparison of intra-articular local anesthetic application with interscalene block and portals by Debnath et al. showed poor analgesia control compared to interscalene block [13].

For this reason, in the literature, intra-articular local anesthesia infiltrates are recommended in combination with other modalities rather than alone. Especially in shoulder arthroscopy where early physical therapy and rehabilitation is planned, it is important to continue analgesia for the desired length of time as well as early onset analgesia.

Volume and concentration play an important role in the effect of local anesthetics. Pippa et al. found the application of local anesthesia with low concentration and high volume in interscalen block to be effective and safer in terms of side effects compared to high concentration and low volume. For this reason, single application of relatively low volumes, such as through portals, provides both short and insufficient analgesia in high concentration applications [14].

Applying the analgesia method to be applied with PCA is considered a safe method to minimize drug use and side effects [15]. The use of patient-controlled analgesia requires prior information to the patient, which naturally causes the patient to have knowledge and expectations about postoperative pain. This expectation is important in terms of controlling anxiety and contributing to the patient's analgesic method. For this reason,

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the PCA technique should be explained to the patient, that is, the practitioner, by the anesthesia team, and compliance should be questioned periodically.

In shoulder arthroscopy, various techniques are implemented to manage pain postoperatively and prevent complications. However, peripheral block applications and catheterization are particularly remarkable [10,16]

Especially in peripheral block and catheterization procedures, preoperative local anesthesia application increases the power of postoperative analgesia with preemptive pain control [17]. We think that this effect is one of the reasons why pain control with PCA application with a catheter, such as interscalene, is more effective than intravenous use.

While interscalene catheters offer superior pain relief and fewer opioid requirements, they require special skills for insertion, time and carry a risk of complications18. Acute and non-acute complications of interscalene block and catheterization have been emphasized in the literature. Some of the expected problems, such as catheter displacement, migration and nerve damage, are related to the catheter itself, and some are related to the negative effects of local anesthetics [19,20].

In the literature, subacromial block is reported to have a lower complication rate than interscalene block [21]. However, in one study, local anesthetic drug infusion through a subacromial catheter did not show a clinically significant benefit compared with placebo in shoulder arthroscopy cases and was not cost effective despite low complication rates [22].

In our patients who underwent PCA with an interscalene catheter, no serious complication requiring discontinuation of treatment after successful catheterization was encountered and effective analgesia was provided when both resting and movement VAS values were considered.

In the cases with subacromial catheters, PCA was initiated at the end of the operation, i.e. after the surgical stress occurred, while local anesthetic application through interscalene catheters was applied immediately after catheterisation before the surgery started, and PCA was activated postoperatively. This difference may have resulted in better pain control with the activation of preemptive analgesia in patients undergoing PCA via interscalene catheter.

The most commonly used opioid in intravenous PCA application is morphine, and serious adverse effects such as respiratory depression, sedation, confusion, and urinary retention can be observed, but the most frequently observed adverse effect is nausea and vomiting, which, although seemingly innocent, seriously affects the sustainability of the treatment [15]. Due to these undesirable systemic effects and patient compliance problems, alternatives are coming to the fore in daily practice. Our intravenous PCA patients experienced postoperative nausea and vomiting at a rate similar to that in the literature, and this rate was significantly higher than in the interscalene and intraarticular groups [23,24].

Similar to the Cohrane study of Ullah et al., in our results, the need for additional analgesia and the frequency of nausea and vomiting were less in the group using Interscalene PCA compared to intravenous PCA, and pain control was better according to VAS score [25].

Whether local anesthetic or opioid is administered to patients receiving PCA, it is important to monitor the patient for both allergic reactions and respiratory failure. In addition to diaphragmatic paralysis and respiratory failure that may develop in patients receiving interscalene block, respiratory depression due to opioids may also increase morbidity and mortality [26,27]. Close follow-up of patients is necessary to detect the problem early and terminate PCA treatment.

This study has some limitations, the study was conducted in a single center, the number of patients was small, and only 24-hour follow-up data of the patients were included in the study. Rehabilitation and hospital discharge performances in the postoperative period were not included.

Conclusion

As a result, managing pain is crucial to the recovery process following a shoulder arthroscopy. PCA administration with interscalene catheters is a safe way to minimize systemic side effects and is an excellent way to reduce pain both at rest and during the movement phase.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the ethics committee of İstanbul Medical Faculty, İstanbul University (2008/1621).

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