Comparison of Intermediate and Superficial Cervical Plexus Blocks for Central Venous Catheterisation

Murat Sevim[1], Mahmut Sami Tutar[2] and Betul Kozanhan[2]

[1]*Department of Anaesthesiology and Reanimation, Konya Beyhekim Training and Research Hospital, Konya, Turkiye*
[2]*Department of Anaesthesiology and Reanimation, University of Health Sciences, Konya City Hospital, Konya, Turkiye*

ABSTRACT

Objective: To compare the effectiveness of the superficial cervical plexus (SCP) and ultrasonography (USG)-guided intermediate cervical plexus (ICP) blocks for patient and operator satisfaction during central venous catheterisation (CVC).

Study Design: Experimental study.

Place and Duration of the Study: Department of Anaesthesiology and Reanimation, Konya City Hospital, Konya, Turkiye, between May and July 2022.

Methodology: Eighty patients were randomly assigned to the ICP and SCP block groups before CVC. Patients received 10ml of a local anaesthesia. Pain levels were assessed during needle insertion, dilation, catheter insertion, and suturing, and 5 minutes after the procedure using a 10-point numeric rating scale (NRS). Thirty minutes post-procedure, patient and operator satisfaction were evaluated using a 5-point Likert-type scale.

Results: The ICP block group had lower mean pain scores than the SCP block group during needle entry, dilation, and 5 minutes after CVC ($p = 0.022$, $p < 0.001$, and $p = 0.005$, respectively). However, no significant differences were found in pain scores after the block application, during catheter insertion, and suturing ($p = 0.279$, $p = 0.052$, and $p = 0.072$, respectively). Patient and operator satisfaction scores did not significantly differ between the two groups ($p = 0.189$ and $p = 0.329$, respectively).

Conclusion: The study demonstrated that the ICP and SCP blocks resulted in comparable patient and operator satisfaction levels during CVC. Given that the ICP block resulted in lower pain scores at various stages of the procedure, it is a recommended method to enhance overall patient comfort and minimise the pain during CVC.

Key Words: *Central venous catheterisation, Intermediate cervical plexus block, Superficial cervical plexus block, Patient satisfaction.*

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INTRODUCTION

Central venous catheterisation (CVC) is a standard medical procedure often warranted in critically ill patients for various clinical purposes, including intravenous drug administration, haemodynamic monitoring, and blood sampling. Over five million CVC procedures are conducted annually in the United States.[1] CVC procedures are generally conducted in awake patients, employing cutaneous local anaesthesia for the puncture site.[2] However, despite the administration of adequate local anaesthesia, a number of patients experience moderate-to-severe pain during the procedure.[3] This may arise from the inability of local infiltration anaesthesia to anesthetise deeper tissues effectively.[4] While systemic analgesics are effective in managing pain, they carry the risk of side effects such as respiratory depression; therefore, regional anaesthesia is recommended as a safer alternative.[5]

Correspondence to: Dr. Mahmut Sami Tutar, Department of Anaesthesiology and Reanimation, University of Health Sciences, Konya City Hospital, Konya, Turkiye
E-mail: masatu42@gmail.com

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The cervical plexus blocks are a commonly used regional anaesthesia technique for surgical procedures involving the distribution of C2 to C4.[6] Superficial cervical plexus (SCP) and intermediate cervical plexus (ICP) block methods have gained attention as potential approaches to enhance patient comfort during several procedures.[7,8] Nevertheless, despite the growing interest in these regional anaesthesia techniques, more comprehensive research comparing the effects of SCP and ICP blocks on patients' experiences and operator comfort during internal jugular venous catheterisation is required. This study aimed to fill this gap in current knowledge by comparing the SCP and ICP block methods when applied under ultrasonography (USG) guidance during CVC. Specifically, the authors sought to investigate the impact of these two block methods on patient and operator satisfaction. The hypothesis was a significant difference in patient satisfaction between the SCP and ICP block methods when applied under USG guidance during the internal jugular venous catheterisation procedure.

METHODOLOGY

This prospective, randomised, controlled experimental study received approval from the Ethics Committee of Necmettin Erbakan University, Meram Medical Faculty (Approval no: 2022/788, Dated: 9 March 2022). The study was registered in

the Clinical Trial database under the registration number NCT05362162 and was conducted at the Department of Anaesthesiology and Reanimation at the Health Sciences University, Konya City Hospital from 1st May to 31st July 2022, after obtaining written informed consent from all participants.

Participants eligible for inclusion in this study were voluntary individuals aged ≥18 years and presenting clinical indications for CVC. Participants were excluded if they had a diagnosis of psychiatric disease or compromised general condition requiring urgent medical intervention, were unable to respond to the survey questions, allergic to the local anaesthetics used in the study, had a contraindication to the cervical plexus block procedure, or had a ≥7 Hospital Anxiety and Depression Scale (HADS) score.[9]

Before the procedures, the participants' anxiety and depression levels were assessed using the 14-item HADS. Patients meeting the study criteria were randomly assigned to one of the two groups using a closed-envelope randomised method. Group S received the SCP block, and Group I received the ICP block. Following peripheral venous access, patients underwent standard monitoring, involving a pulse oximeter, electrocardiography, and non-invasive blood pressure measurements. Midazolam was administered at 0.03-0.1 mg/kg before the procedure to achieve anxiolysis and attain a Ramsay 2 level of sedation.

SCP and ICP blocks were conducted with USG guidance, as described by Pandit *et al*.[10] Patient's head was turned to the opposite side of the block site and the skin was cleaned with an antiseptic solution. An ultrasound probe was positioned on the skin overlying the targeted neck area. The probe was oriented to obtain longitudinal or transverse views for the SCP block, allowing visualisation of the SCP. When the plexus appeared as a cluster of small hypoechoic structure within the sternocleidomastoid muscle, 22 Gauge 80 mm peripheral nerve block needle was inserted through the skin at the identified entry point. The needle was advanced under continuous ultrasound visualisation towards the SCP. Once the needle tip was positioned accurately near the SCP, 10 ml of prilocaine (2% conversion solution vial) was slowly and carefully injected. The anaesthetic spread was monitored in real-time under the ultrasound guidance to ensure comprehensive coverage of the plexus. For the ICP block, after identifying the C7 vertebra sonographically, the transducer was repositioned cranially to the C4 vertebra. Subsequently a needle was inserted behind the sternocleidomastoid muscle at the fourth transverse process and advanced laterally between the superficial and prevertebral layers of the cervical fascia using an in-plane technique. Subsequently, 10 ml of prilocaine was injected into the interfascial compartment, ensuring consistent local anaesthetic distribution between the sternocleidomastoid muscle's posterior border and carotid sheath. After 15 minutes, the effectiveness of the SCP and ICP blocks was assessed using the pinprick test. Following the block procedures, CVC was performed on the jugular vein by a skilled anaesthesiologist, who was unaware of the patient's randomisation. CVC was conducted under the USG guidance by inserting a catheter (Multicath 7.5Fr) into the internal jugular vein using the Seldinger technique. The accuracy of catheter placement was confirmed by ultrasound imaging. Subsequently, all assessments conducted during and after CVC were performed by the researcher (MST), who remained blinded to the patients' group assignments.

Haemodynamic parameters including heart rate, blood pressure, and oxygen saturation were documented at four distinct time intervals: Before the block procedure (T1), immediately after the block procedure (T2), during CVC (T3), and 5 minutes following CVC (T4). Pain levels were evaluated using the numeric rating scale (NRS), a well-established subjective pain measurement method. The NRS assigns pain levels on a scale ranging from 0 (no pain) to 10 (severe pain).[11] Pain assessments were conducted in six specific instances: 5 minutes after the block procedure; during needle insertion, dilation, catheter insertion, and suturing stages; and 5 minutes after CVC. A 5-point Likert-type scale was employed 30 minutes following the CVC to gauge patient satisfaction with pain management.[12] The scale offered response options: 1, not at all satisfied; 2, unsatisfied; 3, undecided; 4, satisfied; and 5, very satisfied.

The anaesthesiologist, who performed the CVC procedure, rated the comfort level during the procedure 30 minutes after completion using a 5-point Likert-type scale.

Additionally, the block and CVC durations, the number of attempts made during catheterisation, and any complications stemming from either the block application or CVC were documented.

The primary outcome of this study was to assess patient satisfaction during CVC and compare the effectiveness of the SCP and ICP block methods. The sample size was determined based on post-procedure patient satisfaction, with a significant 30% score difference considered significant between the study groups.[13] Utilising a Cohen's D effect size of 0.675 in the t-test model, derived from pilot study data for independent groups, it was established that each group required 36 patients, in total 72 patients to attain a statistical power of 80% with a maximum type 1 error of 5%. The final sample size was set at 80 patients to account for a potential dropout rate of 10%.

The Statistical Package for the Social Sciences (IBM-SPSS Inc., Chicago, IL, USA) was used to analyse the obtained data. The conformity of the data to the normal distribution was examined with the Kolmogorov-Smirnov test. According to their distribution status, continuous variables were expressed as mean and standard deviation and categorical variables were expressed as numbers and percentages. In analysing continuous variables, the Independent-sample Student's t-test was used, and the Pearson's Chi-squared test was conducted to compare categorical variables. The analysis of variance test was conducted for repeated measures between the groups at different times. The statistical significance level was accepted as $p < 0.05$.

RESULTS

Initially, 95 cases met the inclusion criteria. After excluding 10 patients who declined to participate and 5 who exceeded the HADS cut-off limit, the final analysis included 80 cases. Patient demographics and HADS scores exhibited no significant differences between the two groups ($p > 0.05$, Table I).

The duration of the block and CVC procedures did not significantly differ between the groups ($p = 0.717$ and $p = 0.472$, respectively). Following the application of the block, hoarseness was observed in 5% of the patients in Group S and 10% in Group I, with a p-value of 0.671.

Heart rate, systolic arterial blood pressure (SBP) (mmHg), mean arterial blood pressure (MAP) (mmHg), diastolic arterial blood pressure (DBP) (mmHg), and oxygen saturation (SpO_2) (mmHg) were evaluated at four different time points (T1, T2, T3, and T4). A significant difference was observed between the two groups regarding the changes in heart rate values over time (time-group interaction) ($p = 0.017$). However, no significant differences were detected in SBP, MAP, DBP, and SpO_2 parameters ($p = 0.504$, $p = 0.501$, $p = 0.279$, and $p = 0.355$, respectively). Group I had lower mean NRS scores than Group S at all evaluation points. Significant differences in NRS scores were noted during the needle entry, dilation stages, and 5 minutes after CVC ($p = 0.022$, $p < 0.001$, and $p = 0.005$, respectively). However, no significant differences were found for evaluations conducted after the block application, during catheter insertion, and suturing ($p = 0.279$, $p = 0.052$, and $p = 0.072$, respectively, Table II).

Changes in the mean NRS scores over time (time-group interaction) significantly differed in both groups ($p = 0.001$, Figure 1). Patient satisfaction and operator comfort scores showed no significant differences between the two groups ($p = 0.189$ and $p = 0.329$, respectively).

Table I: Demographic data of the groups.

Characteristics	Group S (n: 40)	Group I (n: 40)	p-value
Age (years)	63.45 ± 11.86	60.60 ± 14.04	0.330
Weight (kg)	75.25 ± 13.69	74.38 ± 14.57	0.783
Height (cm)	166.22 ± 7.12	165.80 ± 8.07	0.803
BMI (kg/m^2)	27.28 ± 5.02	27.14 ± 5.63	0.909
Gender (male / female)	23/17 (57.5/42.5%)	26/14 (65/35%)	0.491
ASA II/III	16/24	17/23	0.820
HADS depression score	4.72 ± 2.05	4.03 ± 2.13	0.138
HADS anxiety score	4.60 ± 2.37	4.12 ± 2.05	0.341

Statistical test applied: Independent sample Student's t-test and Chi-square test. Data presented as mean ± standard deviation or n (%). ASA, American Society of Anaesthesiologists; BMI, Body mass index, HADS, Hospital Anxiety and Depression Scale.

Table II: Mean pain scores of the groups.

Time	Group S (n: 40)	Group I (n: 40)	p-value
After block application	1.85 ± 0.62	1.70 ± 0.61	0.279
Needle entry	2.03 ± 0.73	1.65 ± 0.70	0.022
Dilation	3.03 ± 0.86	2.18 ± 0.93	<0.001
Catheter insertion	0.70 ± 0.69	0.40 ± 0.67	0.052
Suturing	2.13 ± 0.85	1.78 ± 0.86	0.072
Fifth minute after catheterisation	1.90 ± 0.74	1.45 ± 0.64	0.005

Statistical test applied: Independent sample Student's t-test. Data presented as mean ± standard deviation or n (%). NRS, Numeric Rating Scale.

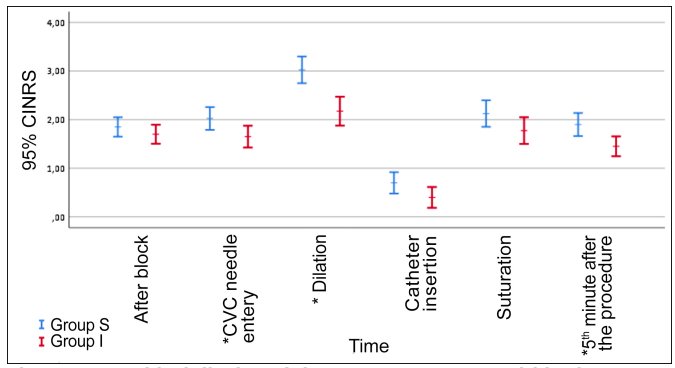

Figure 1: Graphical display of the mean NRS scores within the groups according to time, *p<0.05.

DISCUSSION

CVC is crucial in critical care settings; however, it often poses challenges related to patient discomfort and procedural complications. This study compared two regional anaesthesia techniques, the SCP and the ICP blocks, guided by USG, and assessed their effectiveness in enhancing patient comfort and operator satisfaction during CVC. The ICP block consistently led to lower pain scores at specific stages of the procedure, particularly during needle entry, dilation, and 5 minutes post-procedure, indicating that the ICP block may offer superior pain management compared to the SCP block. Despite the differences in pain scores, both groups exhibited comparable patient and operator satisfaction levels.

Morrison *et al.* described CVC as moderately painful and highly uncomfortable, rating it on a 5-point numeric scale.[14] Similarly, Samantaray *et al*. reported that the patient's median (IQR) pain score during CVC was 6 (4 - 6.7).[4] Hence, improved pain management in central line placements is critical in patient care protocols. Recent studies demonstrated that the SCP block provided adequate analgesia for patients undergoing CVC.[15-17] In a prospective randomised study, Kovvuri *et al*. compared SCP block and local infiltration for pain relief during internal jugular vein (IJV) cannulation in awake patients.[15] They reported that the SCP block offers superior pain control compared to local infiltration anaesthesia during the painful stages of central line insertion: Subcutaneous tunnelling and suture placement. Moreover, Tikle *et al.*'s randomised control trial assessed the efficacy of SCP block *versus* local infiltration anaesthesia in pain control during IJV cannulation in patients undergoing cardiac surgery.[16] The findings revealed that the SCP block was associated with lower pain scores as compared to local infiltration. Akelma *et al.* compared anaesthetic techniques for port catheter placement in oncology patients and concluded that the SCP block provided better pain control and enhanced procedural efficiency in oncology settings.[17] The present study is the first study to compare the SCP block with the ICP block regarding pain management during IJV catheterisation. The research findings revealed that pain scores were significantly lower in the ICP block group than in the SCP block group, supporting the hypothesis by Pandit *et al.,* indicating that injections beneath the investing fascia in the neck reach the deep cervical plexus,

effectively blocking the nerve roots and potentially providing more profound and consistent analgesia.[18]

The link between effective pain management and patient satisfaction is well-documented and has become critical in hospital quality assessments and influencing reimbursement models.[19] Reducing procedural pain facilitates patient anxiety and fear, making the procedure smoother and enhancing patient satisfaction. Studies have demonstrated that patients experience less pain than anticipated, and their satisfaction with the surgery and anaesthesia improves.[20] Ramachandran *et al.* evaluated the efficacy of SCP and ICP blocks in carotid endarterectomy and found that both methods were equally effective in managing pain and achieving high levels of surgeon-patient satisfaction.[21] Moreover, Hosamani *et al.* compared USG-guided ICB to local infiltration techniques during IJV cannulation, focusing on patient satisfaction and reported that ICP block is better than local infiltration regarding patient satisfaction at all time-points in various procedural steps of IJV cannulation.[22] The present study found that the ICP and SCP blocks resulted in comparable patient and operator satisfaction levels during CVC. The ICP block targets a deeper plane and potentially provides more comprehensive neck anaesthesia and may be more effective in managing pain associated with needle insertion and catheter placement than local infiltration. However, the comparison between SCP and ICP blocks may lead to similar outcomes due to their adequate analgesia successfully attained during the procedure of IJV.

Pain or discomfort during IJV cannulation can stimulate haemodynamic responses, including increased heart rate and blood pressure. Arya Mohan *et al.* compared USG-guided ICP block and local infiltration during IJV cannulation, focusing on haemodynamic changes and reported that the heart rate and systolic, diastolic, and mean arterial pressure of the ICP block group remained significantly more stable, with variations within 20% of baseline values.[23] They experienced more consistent haemodynamics than the local infiltration group throughout each IJV cannulation phase. The current study evaluated the effects of USG-guided ICP block compared to those of SCP block on haemodynamic stability during IJV cannulation and revealed no significant differences in SBP, MAP, DBP, or SpO_2, indicating that both ICB and SCP block result in comparable haemodynamic stability and patient safety levels. This equivalence indicates that either approach can be effectively used without significantly affecting the patient's cardiovascular response to the procedure. Local infiltration, which may not always provide as deep or uniform analgesia as a nerve block, could result in elevated pain and more marked haemodynamic fluctuations.

Ultrasound-guided techniques have improved needle placement accuracy and local anaesthetic distribution in nerve block procedures, reducing side effects.[24] However, complications such as Horner's syndrome, transient hoarseness, and asymptomatic haemidiaphragmatic paresis remain possible with cervical plexus blocks. A comparative study revealed hoarseness in 12% of patients receiving an ICP block and 17% in those undergoing a combined (superficial + deep) cervical plexus block.[25] In the present study, hoarseness was observed in 5% of patients with an SCP block and 10% of those with an ICP block.

Importantly, no block-related severe complications, such as LA intravascular injection, LA toxicity or systemic adverse events, were noted in any patient.

This study had some limitations. First, its single-centred design and relatively small sample size possibly limited the generalisability of the findings. Second, using a single local anaesthetic agent may introduce bias, as different agents could yield varying results. Future research with larger sample sizes and multi centre designs could provide further insights into the comparative effectiveness of SCP and ICP blocks for CVC. Finally, anxiolytics were administered to all participants, which may have affected the motivational components and pain extent before the procedure; however, this does not represent a significant limitation because all the individuals included were given the same anxiolytic.

CONCLUSION

CVC is a widely performed invasive healthcare procedure requiring adequate analgesia. Moreover, ICP and SCP blocks provide patient satisfaction and facilitate the procedure for healthcare providers. Notably, the ICP block offers superior pain control during crucial CVC phases. Based on these findings, the authors recommend the use of ICP blocks for improving pain management during CVC. Future larger studies are warranted to confirm these findings.

ETHICAL APPROVAL:
This prospective, randomised, controlled experimental study received approval from the Ethics Committee of Necmettin Erbakan University, Meram Medical Faculty, Konya, Turkiye, (Approval no: 2022/788; Dated: March 9, 2022). The study was registered in the clinical trial database under the registration number NCT05362162.

PATIENTS' CONSENT:
Written informed consent was taken from all the patients.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
MS: Data collection, introduction and discussion write-up, literature search, and performed reference setting.
MST: Conception and study design, critical evaluation, and statistical analysis.
BK: Material and methods section, discussion section, and interpretation of the data.
All authors approved the final version of the manuscript to be published.

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