Superficial Cervical Plexus Block During Internal Jugular Vein Cannulation for Pain Relief in Awake Patient

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Citation

Shrestha M, Shrestha A, Vaidya S, Dwa M, Ranjit S. Superficial Cervical Plexus Block During Internal Jugular Vein Cannulation for Pain Relief in Awake Patient. *Kathmandu Univ Med J.* 2025; **Online First.**

ABSTRACT

Background

Internal jugular venous cannulation is required in many aspects for patients in intensive care, major surgeries, hemodialysis etc. Superficial cervical plexus block allows field of anesthesia to operate and secure the cannula in awake patient.

Objective

To study pain relief caused by superficial cervical plexus block of local anesthesia during the procedure of cannulation of internal jugular vein in patients requiring central venous cannulation.

Method

This prospective observational study was conducted from December 2023 to August 2024 at Dhulikhel Hospital, Kathmandu University Hospital. Sixty four awake patients with American Society of Anesthesia (ASA) I-III requiring central venous cannulation received ultrasound-guided Superficial cervical plexus block with 10 ml of 0.25% ropivacaine prior to internal jugular venous cannulation. Pain score (Verbal Pain Rating Scale) and hemodynamic changes (Heart rate, Mean Arterial Pressure, Spo2) were assessed at key procedural steps: during block, needle puncture, subcutaneous tunneling, catheter insertion, securing and suturing and five minutes post-procedure with any adverse effect and complication. Data were analysed using SPSS 22, student's unpaired t-test was applied to the continue statistical data and chi square test to the categorical test considering significance p value <0.05.

Result

All cannulations were successful on the first attempt. Only 1 patient (1.56)% required additional analgesia due to moderate pain during tunneling. Mean pain scores were minimal at all other stages (≤ 1). Hemodynamic parameters remained stable throughout the procedure, with no significant complications observed.

Conclusion

Ultrasound guided superficial cervical plexus block provides effective analgesia at various stages of procedure avoiding the complications. This study recommends Superficial block as one of the analgesic technique during awake internal jugular venous cannulation to improve patient comfort and procedural safety.

KEY WORDS

Awake, Internal jugular venous cannulation, Superficial cervical plexus block

INTRODUCTION

Central venous catheter (CVC) is a routine procedure in anesthesiology for patient undergoing major surgeries and intensive care medicine.[1] These patients may require a prior CVC placement for numerous reasons such as volume replacement, administration of vasopressors, highly concentrated and irritant medications, inability to cannulate peripheral veins following chemoradiation and nutritional support after surgery, emergency venous access, central venous pressure (CVP) measurement, transvenous pacing and pulmonary catheter wedge pressure (PCWP) measurement.[2]

Cannulation of the CVC carries potential for serious complications from unintentional arterial puncture or cannulation, hematoma, hemothorax, or pneumothorax.[3,4] Ultrasound guided cannulation can improve the success rate of surgery, reduce the number of required needlesticks, and mitigate complications.[5]

The internal jugular vein (IJV) is a commonly used route for access to the central circulation. The incidence of pain is increased when multiple attempts are required to cannulate the vein in awake patient.[6] Adverse effects caused by pain during cannulation can stimulate sympathetic systems, hypothalamic stimulation, catecholamine and catabolic hormone secretion and decrease secretion of anabolic hormones insulin and testosterone.[1]

The superficial cervical plexus (SCP) originates from the anterior rami of the C1-C4 spinal nerves and gives rise to 4 terminal branches providing sensory innervation to the skin and superficial structures of the anterolateral neck and sections of the ear and shoulder.[7] SCP block produces a field of anesthesia, anesthetizing muscle in the subcutaneous plane. Therefore, the whole procedure including tunneling, dilating and suturing is pain-free. This study evaluated whether SCP block provided pain relief for patients undergoing IJV cannulation.

METHODS

This prospective observational study was carried out at the Department of Anesthesiology and critical care at tertiary center of Kavre District from December 2023 to August 2024. The study protocol was approved by the Institutional Review Committee (IRC), with reference number 234/23.

Data was taken according to Census Sampling Method, using the formula $n= 4pq/d^2$.

Using the formula,

$n = 4pq/d^2$

where, n= required sample size

p = rate of major surgical cases (20%).[8]

According to this study performed in Dhulikhel Hospital, rate of major surgical cases was taken as 20% which required IJV access.

q= 100-p

d= permissible error in estimate of p.[9]

Applying the formula,

$$n = 4*20\ (100-20)/=10^2$$

$$= 64$$

So, in each group 64 patients were enrolled in this study.

In this study, inclusion criteria included age more or equal than 18 years; ASA I-III ; elective surgeries in which central venous cannulation were planned and non-intubated patients admitted to ICU and requiring CVP. Patient refusal, patients with coagulopathy, thrombocytopenia, infection at site of insertion, neck masses, patients with psychiatric illness, focal neurological deficits were excluded from this study.

After standard monitoring and recording of baseline vitals, patients were sedated with midazolam and 1 mcg/kg fentanyl and oxygen flow was given at the rate of 2 L/minute via nasal cannula. Patients were prepared following sterile technique and patients were administered superficial cervical plexus block with 10 ml of 0.25% of Ropivacaine.[10] Negative aspiration was done every 2 ml to confirm inadvertent puncture of blood vessels for the block under ultrasound guidance. With the help of ultrasonography (USG) and the Seldinger technique, internal jugular vein was cannulated with confirmation of aspiration of venous blood flow from all 3 ports and secured with suturing.[11] Pain scores and hemodynamic changes was assessed at the following time points during the procedure:

- During procedure
- During needle puncture
- Subcutaneous tunneling
- Catheter insertion
- Securing and suturing
- Five minutes after completion of procedure.

Patient's heart rate, NIBP, ECG, SpO_2 was monitored and a simple verbal pain rating scale was used to assess pain during the IJV cannulation procedure. Verbal contact was maintained with the patient throughout the procedure in order to assess the pain experienced by the patient.

Verbal Pain Rating Scale[12]

0 - No pain

1 - Mild pain

2- Moderate pain

3- Severe pain

4- Very severe pain

5- Worst possible pain

If the Verbal Pain Rating Scale was ≥ 2 then the patient was given IV Fentanyl 25 mcg bolus and VPR scale was re-assessed. Verbal Pain Rating Scale ≥ 3 was noted and discarded from the study. Possible complications like accidental puncture of carotid artery, hematoma, intravascular injection of local anesthetic drug and local anesthetic toxicity was assessed.[13] Patients were advised for chest X-ray after the procedure within 80 minutes or completion of surgeries to assess malposition of cannulation.[14]

Data were analysed using SPSS 22, student's unpaired t-test was applied to the continue statistical data and chi square test to the categorical test considering significance p value < 0.05.

RESULTS

Demographic profile of enrolled patients is shown in table 1. The age of the patient ranges from 40 to 85 years. The mean age was 58.00 ± 12.794 years. There was a greater number of male pa-tient than female patient (M: F= 49:15) with male being 49 and female being 15 in total 64 number of the patients in the study. Upon evaluating the weight, it was found that the minimum weight was 47 kg and the maximum weight was 90 kg. The average patient weight was 64.50 ± 8.736 kg. Patient height ranged from 152 to 174 cm, and the mean height was 162.50 ± 6.990 cm. The mean duration for the procedure was 10.00 ± 3.377 minutes.

Table 1. Demographic variables (n=64)

Variables	Mean ± SD
Age (years)	58.00 ± 12.794
Height (cm)	162.50 ± 6.990
Weight (kg)	64.50 ± 8.736
Duration (minute)	10.00 ± 3.377

Hemodynamic values for procedure as heart rate, mean arterial pressure and oxygen saturation was evaluated and was compared with its baseline values at different steps of central vein cannulation.

The heart rate during different steps of central vein cannulation is shown in table 2. The baseline heart rate was 89.25 ± 14.811 bpm. Following administration of superficial cervical plexus block, the mean heart rate increased 102.91 ± 111.888 bpm, which was not statistically significant. Throughout the procedure of central vein cannulation, mean heart rate did not change. There were no statistically significant changes in values when compared with its baseline which is shown in table 3.

The mean arterial pressure during different steps of central vein cannulation is shown is Table 4. The baseline mean arterial pressure was 80.92 ± 15.269 mmHg. There were statistically insignificant changes during tunnelling with p value 0.044 when compared with the baseline value which is shown in table 5.

Table 2. Heart Rate at Various Stages of Cannulation (n=64)

Stage	Mean HR ± SD (bpm)
Baseline	89.25 ± 14.811
During Block	102.91± 111.888
Needle Puncture	88.88 ± 14.790
Tunnelling	89.16 ± 15.060
Catheter	90.25 ± 14.200
Suture Secure	90.09 ± 14.341
After 5 minutes	89.09 ± 15.860

Table 3. Comparison of Heart Rate with Baseline (n=64)

Comparison	Mean difference (mmHg)	SD	p-value
HR Baseline – HR during SCP Block	-13.656	109.975	0.324
HR Baseline - HR during Needle Puncture	+0.375	5.278	0.572
HR Baseline - HR during Tun-nelling	+0.094	5.784	0.897
HR Baseline - HR during Can-nulation	-1.000	5.907	0.180
HR Baseline - HR during su-ture securing	-0.844	5.334	0.210
HR Baseline- HR after 5 minutes of procedure	+0.156	5.769	0.829

Table 4. Mean Arterial Pressure (MAP) at Various Stages of Cannulation (n=64)

Stage	Mean Map ± SD (mmHg)
Baseline	80.92 ± 15.269
During Block	81.23 ± 16.058
Needle Puncture	81.31 ± 15.731
Tunnelling	81.98 ± 15.581
Catheter	81.47 ± 15.743
Suture Secure	81.38 ± 15.664
After 5 minutes	81.19 ± 15.181

Table 5. Comparison of Mean Arterial Pressure (MAP) with baseline (n=64)

Comparison	Mean Difference (mmhg)	SD	p-value
MAP Baseline – MAP during SCP Block	-0.312	3.728	0.505
MAP Baseline - MAP during Needle Puncture	-0.391	3.517	0.378
MAP Baseline - MAP during Tunnel-ling	-1.062	4.132	0.044
MAP Baseline - MAP during Cannula-tion	-0.547	3.049	0.156
MAP Baseline - MAP during suture securing	-0.453	3.236	0.267
MAP Baseline- MAP after 5 minutes of procedure	-0.266	3.945	0.592

The oxygen saturation change during central vein cannulation is shown in table 6. However, there was no statistically significant changes of oxygen saturation during any stage of catheterization of central line which is shown in table 7.

Table 6. Oxygen saturation at Various Stages of Cannulation (n=64)

Stage	Mean SpO_2 ± SD (%)
Baseline	96.66 ± 2.248
During Block	96.73 ± 2.177
Needle Puncture	96.50 ± 1.791
Tunnelling	96.69 ± 1.798
Catheter	96.55 ± 1.885
Suture Secure	96.63 ± 1.890
After 5 minutes	96.78 ± 2.066

Table 7. Comparison of SpO_2 with Baseline (n=64)

Comparison	Mean Difference (%)	SD	p-value
SpO_2 Baseline – SpO_2 during SCP Block	-0.047	0.278	0.182
SpO_2 Baseline - SpO_2 during Needle Puncture	+0.156	1.144	0.279
SpO_2 Baseline - SpO_2 during Tunnel-ling	-0.031	0.959	0.795
SpO_2 Baseline - SpO_2 during cannu-lation	+0.109	0.911	0.340
SpO_2 Baseline - SpO_2 during suture securing	+0.031	0.835	0.766
SpO_2 Baseline- SpO_2 after 5 minutes of procedure	-0.125	0.577	0.088

Table 8. Verbal pain rating scale during different stages

Stage	Mean Pain Score ±SD
Baseline	0.00 ± 0.000
During Block	0.52 ± 0.642
Needle Puncture	0.55 ± 0.532
Tunnelling	0.55 ± 0.532
Catheter	0.27 ± 0.445
Suture Secure	1.00 ± 0.000
After 5 minutes	0.00 ± 0.000

The procedure of central cannulation was done in single attempt. Average patient pain assess-ment scores during superficial cervical plexus block, needle puncture, tunnelling, cannulation, se-curing the catheter with stitches and 5 minutes after the procedure were 0.52 ± 0.642, 0.55 ± 0.532, 0.55 ± 0.532, 0.27 ± 0.445, 1.00 ± 0.000 and 0.00 ± 0.000, respectively (Table 8). As-sessing the pain score, after superficial cervical plexus block, only 1 patient had moderate pain during needle puncturing and tunnelling who required intravenous Fentanyl 25 mcg and none had VPRS ≥ 3. On physical examination and chest radiographs revealed no any complications or malposition of the catheter.

DISCUSSIONS

The aim of our study is to evaluate patient's pain relief from superficial cervical plexus block during internal jugular vein cannulation, hemodynamic parameters and comparing the baseline parameters with the changes of parameters during the block and cannulation.

In this study, ultrasound guided internal jugular vein cannulation was successful with single attempt in all the sixty four patients. This align with conclusion from studies by Christopher et al., where ultrasound guidance cannulation of internal jugular vein facilitates locating internal jugular vein and permitting safe entry with fewer attempts in less time.[13] We observed the change in mean arterial pressure during tunneling with p value = 0.44 which could be due to sympathetic stimulation during creating a tract and dilatation for catheter insertion. This was similar to the studies of Harshwardan et al., where they stated all the parameters were comparable between two groups of superficial cervical plexus block vs local anesthesia except the change in heart rate during the dilation and subcutaneous tunneling.[1] In addition, studies conducted by Herring et al., showed hemodynamic variables which were significantly diminished and had better patient satisfaction in all the point of procedure in superficial cervical plexus block.[15] We did not observe any electrocardiographic abnormalities, oxygen desaturation or other complication during the entire study period in any of the patients. Ruesch et al., study showed only 2% of patient who had complication undergoing ultrasound guidance central vein cannulation and concluded the superiority of ultrasound guidance use, during the cannulation.[16] Ultrasound guidance central vein cannulation reduces the risk of complication, such as arterial puncture from vascular injury, secondary hematoma, and most importantly, it reduces the possibility of pneumothorax or hemothorax compared with landmark technique.[17] Adding similar study from Turker et al., demonstrated the superiority of ultrasound - assisted cannulation stating lower access time and lower rate of immediate complication which are consistent with our study with single attempt of successful cannulation and no complication were addressed.[18]

The verbal pain score is highly reliable instrument for measurement of acute pain.[19] We used verbal pain score in our study for assessing the effectiveness of superficial cervical plexus block during the internal jugular cannulation. In this present study, 37 patients (52.9%) complained of mild pain with visual pain scale score ≤ 1 during tunneling and dilatation but they did not require addition analgesia. However, our study showed only 1 patient (1.4%) who complained of moderate pain of visual pain rating scale of 3, received additional analgesia during tunneling and dilatation which can be due to applied force to create a track and dilate for catheter insertion. Various studies reported cannulation of catheter has low pain score at different time of the procedure and did not require additional

sedoanalgesia in any patient.[20] The study done by Ben Ho et al reported significant analgesia following superficial cervical plexus block was also obtained in cervical fracture, paracervical muscle spasm, acromioclavicular joint injuries, and rotator cuff disorder.[21]

The choice of drug for the block was ropivacaine in our study. Ropivacaine are associated with low rates of complications when used properly. Ropivacaine reduces lipid solubility, limits its penetration into cardiac and central nervous tissues, which contributes to its better safety profile.[22] A meta- analysis by Li et al., supports the use of Ropivacaine for peripheral nerve blocks due to its lower potency but better differential blockade, which often results in faster motor recovery.[23] This supporting the study done by Anupreet et al. also concluded the onset of action of sensory, motor block was early in ropivacaine group with faster recovery of motor functions with no adverse noted.[24] Messner et al., researched superficial cervical plexus block with ropivacaine on postoperative pain therapy where they found significant reduction in morphine consumption and lower pain score when compared with placebo undergoing unilateral carotid endarterectomy.[25]

This study corrolates with using superficial cervical plexus block with ropivacaine for internal jugular vein cannulation with low pain score. However, this perspective, observational study was a single centered study and had few limited samples. There wasn't any analysis done with respect to other drug comparing the efficacy, quality and better choices for the block. The intensity of pain can vary between individual and their perception of pain.

CONCLUSION

Central venous catheterization is widely performed invasive healthcare procedure. Superficial cervical plexus block provide sufficient analgesia at various stages of procedure. It also provide stable hemodynamics especially important in patient who cannot tolerate changes in hemodynamics during induction of anesthesia or sick patient in ICU. It is a very simple procedure with no complications. We therefore strongly recommend that superficial cervical plexus block should be used as frequently during internal jugular cannulation as 52.9% complained of mild pain with visual pain scale score ≤ 1 and only 1.4% complained of moderate pain of visual pain rating scale of 3.

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