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ORIGINAL RESEARCH SPINAL ANESTHESIA

Exploring the feasibility of cervicothoracic spinal anesthesia for head, neck, and upper extremity surgeries

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ABSTRACT

Background & objective: General anesthesia (GA) is the established method for upper dorsal region surgery, including head, neck, and upper extremity surgery. Cervicothoracic spinal anesthesia (CSA) is an infrequently performed alternative to GA. This prospective study evaluated the feasibility of CSA for head, neck, and upper extremity surgery.

Methodology: We consecutively enrolled 25 patients scheduled for head, neck, upper extremity, and upper dorsal surgeries between August 2023 and September 2024, at a general hospital in Indonesia. We performed CSA using a paramedian approach in the C7-T1 intervertebral space. We mixed a single injection of hyperbaric bupivacaine with five different cocktail drugs using the barbotage method for use in spinal anesthesia. We evaluated patient characteristics, neuraxial techniques of CSA, and outcomes of the CSA.

Results: Of the 25 patients, 8% required a second attempt at spinal needle insertion into the subarachnoid space. No epidural injection or additional analgesia was administered, and no transition to GA was reported in any case. This study identified complications associated with CSA, including apnea, bradycardia, and hypotension. However, apnea was observed exclusively in the cocktail D group, which received 0.75% hyperbaric bupivacaine (up to 10 mg). CSA exhibited an efficacious block-level with an onset time of just 5.7 ± 1.4 min.

Conclusion: Cervicothoracic spinal anesthesia was successfully and safely performed for head, neck, upper extremity, and upper dorsal surgery. It can serve as an alternative anesthesia for patients at high risk of requiring general anesthesia.

Abbreviations: CSA: Cervicothoracic spinal anesthesia, GA: General anesthesia

Keywords: Cervicothoracic Spinal Anesthesia; Head and Neck Surgery; Upper Extremity Surgery; Upper Dorsal Surgery; Regional Anesthesia; Feasibility Study

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1. INTRODUCTION

Currently, general anesthesia (GA) is the established method employed for upper dorsal surgery, including head, neck, and upper extremity surgeries. Nevertheless, it presents several disadvantages, such as inadequate pain management caused by insufficient residual analgesia, heightened stress response, increased risk of nausea and vomiting, and prolonged hospital stays.[1] For most patients requiring upper dorsal surgery, the side effects and complications associated with GA

preclude them from undergoing ambulatory surgery. Regional anesthesia may enhance the healing response to surgical stress and provide improved pain relief, leading to reduced postoperative opioid use.[2,3]

In this report, we describe the utilization of cervicothoracic spinal anesthesia (CSA) for head, neck, and upper extremity surgery, which is an infrequently performed and exceptional procedure.[4-8] The CSA technique was initially reported by Jonessco (1908); however, it was considered dangerous.[4]

We present this case to support and substantiate Jonnesco's first publication in the British Medical Journal, published in 1911. We have also demonstrated other procedures in which cervicothoracic anesthesia was performed during upper-extremity surgery, yielding successful results. In a letter to the editor titled "JONNESCO: A Century of Thoracic Spinal Anesthesia History," Professor Armando Fortuna drew the author's attention to the need to demonstrate that Jonnesco's methods can be substantiated and that spinal cervicothoracic anesthesia provides favorable outcomes in head and neck surgery.[4-6]

2. METHODOLOGY

This prospective observational feasibility study assessed the safety, efficacy, and practicality of CSA for surgeries involving the head, neck, upper extremities, and thoracic regions. This study was conducted at a general hospital in Indonesia from August 2023 to September 2024 following a standardized protocol to ensure consistent and reliable outcomes. Twenty-five patients were consecutively enrolled, including six who underwent head surgery, eight cervical surgeries, seven upper extremity surgeries, and four anterior or posterior thoracic surgeries. The first patient was enrolled on August 31, 2023. All participants were informed of the study objectives in a comprehensible local language, and written consent was obtained prior to their inclusion.

Participants aged 18–65 years with American Society of Anesthesiologists (ASA) class II or III, undergoing elective surgeries in designated regions, and with a body mass index (BMI) of less than 35 kg/m² were included. The exclusion criteria were pregnancy, bleeding disorders, infections at the block site, allergies to local anesthetics, and more than two failed attempts at regional anesthesia. Any alterations in the surgical plan warranted exclusion.

CSA was administered using a paramedian approach at the C7-T1 intervertebral space with the patient in the seated position (Figure 1). A 25-gauge Quincke-Babcock spinal needle was inserted into the subarachnoid space following stringent aseptic protocols. Successful entry was confirmed via smooth barbotage, even in the absence of cerebrospinal fluid (CSF). A single injection of hyperbaric bupivacaine combined with one of five predetermined drug cocktails was administered within 30 s. The drug combinations included: Drug A (Bupivacaine 5 mg, dexamethasone 5 mg, fentanyl 25 mcg); Drug B (Bupivacaine 7.5 mg, dexamethasone 5 mg, fentanyl 25 mcg); Drug C (Bupivacaine 7.5 mg, dexamethasone 5 mg, fentanyl 25 mcg, morphine 0.1 mg); Drug D (Bupivacaine 10 mg, dexamethasone 2.5 mg, fentanyl 25 mcg); Drug E (Bupivacaine 7.5 mg, dexamethasone 2.5 mg, fentanyl 50 mcg, morphine 0.1 mg). The patients were positioned supine after the procedure, and the block level was adjusted to the surgical site. Baseline vital parameters, including pulse oximetry, ECG, and noninvasive blood pressure (NIBP), were continuously monitored. The key evaluations included the number of needle insertion attempts, sensory and motor block characteristics, surgical duration, intraoperative analgesic requirements, and the occurrence of complications. Conversion to GA, if necessary, was also noted. This methodology aimed to provide a comprehensive evaluation of CSA's feasibility and potential application of CSA as a viable alternative to GA in specified surgical contexts.

3. RESULTS

Twenty-five patients who underwent head surgery (six patients), cervical surgery (eight patients), upper extremity surgery (seven patients), and anterior and posterior thoracic surgery (four patients) were recruited. Table 1 presents the demographic characteristics of the patients, including age, weight, height, and BMI.

This study classified the majority of patients as PS ASA 3 (72%), with one comorbidity accounting for 76% and two comorbidities accounting for 16% of the patients. Cardiovascular (54.3%) and pulmonary (17.1%) diseases were the most prevalent comorbidities in this cohort. One patient declined GA, necessitating CSA (Table 1).

This investigation demonstrated that Cervicothoracic anesthesia was administered for head surgery in six patients (24%), neck surgery in eight patients (32%), upper extremity surgery in seven patients (28%), and anterior and posterior thoracic surgery in four patients (16%) (Table 1). A paramedian approach was used to perform all blocks at the C7-T1 intervertebral level. CSA was successfully administered to all patients without the need for epidural injection. Table 2 demonstrates that 23 of the 25 executed blocks were completed with a single needle insertion attempt, whereas two patients (8%) required a second attempt to insert the spinal needle into the subarachnoid space. No epidural injection or additional analgesia was administered, and no shift in the anesthetic technique to GA was reported.

Table 1: Patient Characteristics

Patients Characteristics	Result
Age (years)	51 ± 18.5
Weight (kg)	59.0 ± 7.4
Height (cm)	154 ± 22.3
Number of Comorbidities	
1	19 (76)
2	4 (16)
3	1 (4)
4	1 (4)
Comorbidities or diseases	
Cardiovascular diseases	19 (54.3)
Pulmonary diseases	6 (17.1)
Allergy drugs	1 (2.8)
Renal diseases	7 (20)
Cerebrovascular diseases	2 (5.7)
Patient refusal of GA	1 (4)
PS ASA	
II	7 (28)
III	18 (72)
Surgical site	
Head	6 (24)
Neck	8 (32)
Upper extremity	7 (28)
Thoracal anterior and posterior	4 (16)
Types of surgery	
Parotidectomy	1 (4)
Wide resection of soft tissue tumors	14 (56)
Benign neoplasm of the tongue	1 (4)
Abscess incision and drainage	6 (24)
Debridement of diabetic ulcer	1 (4)
Open reduction and internal fixation (ORIF) of the humerus	1 (4)
Face reconstruction surgery	1(4)

Dara presented as eam SD ot n (%); ORIF = Open Reduction and Internal Fixation

The patient cohort comprised 25 individuals with a mean age of 51±18.5 years. The majority were classified as ASA PS 3 (72%), indicating a high-risk population with significant comorbidities, primarily cardiovascular (54.3%) and pulmonary (17.1%) disease. The detailed demographic characteristics, including weight, height, and BMI, are presented in Table 1.

Table 2: Neuraxial technique of cervicothoracic spinal anesthesia

Parameter	N (%)
Number of needle insertion attempts	
1	23 (92)
2	2 (8)
Complications	
Apnea	2 (8)
Bradycardia	6 (24)
Hypotension	22 (88)
Temporary vocal cord paralysis	2 (8)
Rescue doses of ephedrine	
5 mg intravenously	18 (72)
20 mg intravenously	4 (16)
No rescue	3 (12)

Data presented as n (%); Apnea: Temporary cessation of breathing; Bradycardia: Slow heart rate.

This study identified complications of cervicothoracic anesthesia, including apnea, bradycardia, hypotension, and hematoma. However, apnea was observed only in the cocktail D group, which received 0.75% hyperbaric bupivacaine (up to 10 mg). Apnea occurred for 5-7 minutes in all patients who received cocktail D, but all patients remained conscious. A noteworthy finding was observed in patients who received cocktail E; the addition of adjuvant fentanyl 50 µg did not induce hypotension, thus eliminating the need for a rescue dose of ephedrine. No complications, such as cardiac arrest, permanent extremity paralysis, or cranial nerve paralysis, were observed during or after the CSA (Table 2).

This report demonstrates that during CSA, CSF was not discharged and was not visible at the needle hub. This can explain why the CSF pressure decreases in the cervical region or closer to the brainstem. The absence of CSF pressure at C7-T1 may also suggest that the volume dimension at C7-T1 is greater than that below the vertebral level. CSA exhibited an efficacious block-level onset within a mean time of 5.7 min. Cocktail group D exhibited the longest onset of block rate, as this cocktail was administered to a cohort of patients undergoing head surgery, resulting in a sensory block in the cranial nerve branches (trigeminal and facial nerves) (Table 3).

4. DISCUSSION

This study was conducted over the course of a year and included 25 surgical cases involving the head, neck, upper extremities, and upper dorsal regions. All

Table 3: Outcome of cervicothoracic spinal anesthesia

Parameter	Mean ± SD or n (%)
The needle hub does not display any visible CSF (%)	25 (100)
Sensory block	
Adequate block level achieved (min)	5.7 ± 1.4
Time to achieve adequate block level according to the site of surgery, (min)	
C1 (Neck surgery)	5.3 ± 0.6
Trigeminal Nerve (Face surgery)	6.7 ± 2.1
C4 (Upper extremity surgery)	5.6 ± 1.5
C4 (Thoracal anterior + posterior)	5.6 ± 1.5
Motor block	
Time to achieve adequate motor block level according to drug cocktails, (min)	
Drugs A	5.4 ± 0.2
Drugs B	5.8 ± 1.6
Drugs C	5.0 ± 0.1
Drugs D	7.0 ± 0.1
Drugs E	5.0 ± 0.1
Duration of block according to drug cocktails (min)	
Drugs A	46.5 ± 1.5
Drugs B	57.6 ± 7.5
Drugs C	72.5 ± 3.5
Drugs D	112.8 ± 53.4
Drugs E	45.0 ± 0.1
Time to achieve adequate block level (min)	
C4-C5	26.0 ± 9.3
L2	28.2 ± 6.6
Time to recovery (min)	
Drugs A	14.3 ± 4.0
Drugs B	24.7 ± 3.0
Drugs C	40.5 ± 6.3
Drugs D	46.5 ± 2.1
Drugs E	24.0 ± 1.4
Duration of surgery (min)	60.8 ± 21.1
Patient satisfaction, (%)	
Satisfied	25 (100)
Surgeon satisfaction, (%)	
Satisfied	25 (100)
Not satisfied	0 (0)

CSF: Cerebrospinal Fluid, CN: Cranial Nerve.

procedures were successfully performed under CSA using five different anesthetic cocktails. The results demonstrated significant hemodynamic stability throughout the procedure, accompanied by high levels of satisfaction among patients and surgeons. This study focused on four primary concerns: (1) the potential risk of spinal cord injury, (2) the possibility of local anesthetic spreading to induce a high or total block, (3) hemodynamic or respiratory complications resulting from the blockade of cardioaccelerator fibers or intercostal nerves, and (4) the overall safety of the CSA technique.[10,11]

First, there is a risk of spinal cord injury; however, none of the patients exhibited clinical signs of spinal cord injury or iatrogenic trauma in this study. Postprocedural monitoring over a week revealed no evidence of limb paralysis or neurological deficits. However, spinal anesthesia is not entirely risky. Previous studies by Pozza et al. (2023) have highlighted the potential for transient or permanent neurological symptoms, epidural hemorrhage, or adhesive arachnoiditis associated with spinal cord injury due to anesthesia. The common symptoms of these complications include back pain, paresthesia, hypoesthesia, persistent anesthesia, and motor impairment.[12-14] In this study, the absence of cerebrospinal fluid (CSF) at the spinal needle hub was noted in all patients, which could indicate either low CSF pressure or the absence of detectable flow at the C7-T1 level. MRI studies have suggested that the C7 vertebra exhibits a larger subarachnoid volume than the lower thoracic or lumbar vertebrae, which may contribute to this observation.[15-17] Furthermore, the diminished CSF flow observed during barbotage at the C7-T1 level indicates a larger subarachnoid volume, potentially reducing the risk of complications associated with CSA. Although these findings suggest a favorable safety profile, more extensive studies with advanced methodologies are required to confirm these preliminary results.

In the cohort designated as cocktail D, which received 0.75% hyperbaric bupivacaine (up to 10 mg), apnea was observed in 8% of patients for a duration of 5–7 min, although all patients remained conscious. This complication may be attributed to the cephalad distribution of hyperbaric bupivacaine within the subarachnoid space, potentially affecting the brainstem respiratory centers or the cervical nerve roots (C3–C5) responsible for diaphragm innervation. The administration of a higher dose of bupivacaine in this group, primarily for cranial surgeries necessitating sensory blockade of the cranial nerve branches, likely contributed to this effect. Previous studies have documented similar transient apneas associated with high spinal anesthesia due to the spread of local anesthetic.[8-11] The absence of cerebrospinal fluid (CSF)

discharge at the C7-T1 level, as observed in this study, may also suggest lower CSF pressure or increased subarachnoid volume at this level, potentially facilitating the rostral spread of the anesthetic.

Second, the potential for high or total block, while high or total blocks are recognized complications of spinal anesthesia, this study reported no such instances, deviating from the established theoretical risks.[18,19] Most block levels in this study were above T4, with some extending to the cranial nerve level. However, no patient experienced loss of consciousness, cardiac arrest, or other symptoms associated with a total block. Two patients experienced transient apnea lasting 5–7 min, which resolved without complications. These findings suggest that CSA can be performed safely with careful monitoring, and the associated risks are manageable.

Third, regarding hemodynamic and respiratory safety, the study found no significant hemodynamic or respiratory instability attributable to the blockade of the cardioaccelerator fibers or intercostal nerves.[20,21] The transient apnea observed in two cases was not associated with adverse outcomes and resolved spontaneously. These results demonstrate the feasibility and safety of CSA as an alternative to traditional anesthesia. This feasibility study underscores the safety and practicality of CSA for upper-body surgery.

5. LIMITATIONS

The absence of significant complications, coupled with high patient and surgeon satisfaction, highlights its potential as a viable anesthetic option. However, further studies with larger sample sizes and advanced imaging techniques are required to validate these findings and provide additional insights into the safety and efficacy of CSA.

6. CONCLUSION

This study demonstrates that CSA is a feasible and safe alternative to GA for head, neck, upper extremity, and thoracic surgeries, particularly in high-risk patients with ASA PS 3 and significant comorbidities. The technique's efficacy, with a mean block onset of 5.7 minutes and no requirement for GA, makes it a valuable option in settings where GA is contraindicated or unavailable, such as resource-limited environments or during emergency surgeries. Future studies should explore its broader application and cost-effectiveness to facilitate its wider adoption in clinical practice.

7. Ethical considerations

This was an anonymous study. Although written informed consent was obtained from the patient for publication of this case report, the National Center of Research and Education Institute (NCREI), as the ethics committee in our hospital, waived the need for ethics committee approval (101/KEP/NCREI/2024).

8. Availability of data

Data are available upon request from the authors. Video and other recorded evidence were provided to substantiate the implementation of the actions in this study.

9. Consent for publication

Written informed consent was obtained from the patient for the publication of this study and any accompanying images. We obtained informed consent from the patients regarding the two particularly serious risks. A copy of the written consent is available for review by the editor-in-chief of this journal.

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12. Authors' contributions

AP: Contributed to all aspects of this manuscript, including writing the draft and reading the reference, supervision procedure, analysis, and drafting of the article.
NS, DT: Contributed to writing draft and reading reference

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