Effect of dexmedetomidine on Sensory Evoked Potential monitoring during cervical spine surgery with total intravenous anesthesia: a randomized controlled trial

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Abstract

Background: The effect of α2 adrenergic receptor agonist-dexmedetomidine on evoked potentials in cervical spinal cord remains unclear at the current stage. Therefore, this research investigates the effect of dexmedetomidine on sensory evoked potential during cervical spine surgery under total intravenous anesthesia, so as to provide reference for clinical practice.

Methods: A total of 45 patients undergoing cervical spine surgery at the teaching hospital were randomly divided into group D (Dexmedetomidine group, n=23) and group C (Control group, n=22). Both groups were anesthetized with propofol and remifentanil. Group D was infused with dexmedetomidine starting at 1μg/kg for 10 minutes before induction, and then maintained at 0.4μg/kg/h during the operation. Group C was injected with the same dose of saline. Evoked responses were evaluated under seven conditions: awaking (T0), at the end of the loading dose infusion (T1), after induction of anesthesia (T2), after intubation (T3), positioning (T4), spinal canal decompression (T5), and interbody fusion cage insertion (T6). The amplitude (N13-P15, N45-P37) and latency (N13, P15, N45, P37) of SEP, heart rate (HR), mean arterial pressure (MAP), body temperature (T), and bispectral index (BIS) were recorded at these seven time points. The pre- and post-operative red blood cell specific volume (HCT) counts, as well as the intraoperative dosage of propofol and remifentanil were recorded in both groups.

Results: A total of 40 patients completed the study. 1. Compared with T0, the N13-P15 amplitude decreased at T1 and T6 in group D P<0.05, and significantly decreased at T6 in group C P<0.01. The amplitude of N45-P37 decreased at T1, T5, and T6 in group D (P<0.05), and significantly decreased at T5 and T6 in group C P<0.01. Compared with group D, the N45-P37 amplitude significantly decreased at T4 in group C P<0.05. 2. Compared with T0, the N13, P15, N45, and P37 latency were not statistically significant in both groups (P>0.05). 3. There was no statistical difference in MAP, HR, T, and BIS between the two groups (P>0.05).

Conclusion: Dexmedetomidine has no effect on the amplitude and latency of SEP in patients undergoing cervical spine surgery. More importantly, dexmedetomidine may have a protective effect on nerves during the positioning process.

Trial registration: The study registered on the Chinese Clinical Trial Registry (www.chictr.org.cn), Clinical Trials identifier ChiCTR2300072621(19/06/2023).

BACKGROUND

Somatosensory evoked potential (SEP) refers to action potentials generated by stimulating sensory nerve fibers of the skin or peripheral nerves. The action potential is transmitted along the nerve endings, nerve plexus, sensory nerve roots, and pseudounipolar cell bodies in the dorsal root ganglion and spinal cord, and recorded on the sensory conduction pathway or the corresponding scalp in the sensory projection area of the cerebral cortex, reflecting the functional status of the ascending sensory
conduction pathway of the spinal cord. The action potential mainly monitors sensory nerve conduction pathways in the posterior spinal cord, especially the dorsal column-medial thalamus pathway[1]. The assessment of the integrity of sensory pathways by monitoring and observing the amplitude and latency of SEP will improve intraoperative decision-making accuracy and reduce surgical disability during spinal surgery[2].

Many complications may occur during the cervical spine surgery due to the complex anatomical structure of the neck and the wide range of involved areas, such as soft tissue injury, loss of fixator, degeneration of adjacent segments, dysphagia, pharyngeal perforation, throat polyps, etc, and even intraoperative spinal cord displacement, expansion, nerve spinal cord injury and others, making it unfavourable to the postoperative recovery of spinal nerve function[3]. In addition, processes such as tracheal intubation, posture, spinal decompression can also lead to secondary cervical injury, thus causing iatrogenic injury. SEP monitor during cervical spine surgery can provide timely feedback on changes in spinal nerve function to surgeons, anesthesiologists and evoked potential monitoring technicians, thereby guiding appropriate intervention measures, avoiding iatrogenic spinal nerve injury and reducing perioperative complications. However, the effect of dexmedetomidine, α2 adrenergic receptor agonist on evoked potentials in cervical spinal cord remains unclear at the current stage[4]. Therefore, this research aims to investigate the effect of dexmedetomidine on sensory evoked potential during cervical spine surgery under total intravenous anesthesia, so as to provide reference for clinical practice.

METHODS

Ethics approval and consent to participate

The implementation plan of this study was approved by the Ethics Committee of the General Hospital of Ningxia Medical University. All methods were carried out in accordance with relevant guidelines and regulations and with CONSORT recommendations, and all subjects knew and signed the informed consent form (Ethics number:2019-472). The research had completed registration with China Clinical Trials Registry (Registration number:ChiCTR2300072621 date:19/06/2023).

Study design

A total of 45 patients undergoing elective anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF), or ACDF + ACCF in spine surgery from March 2019 to December 2020 were enrolled in the study. Inclusion criteria: ASA grade I ~ III; Age 18 to 65, no gender limit; Body mass index 18.5 ~ 23.9 kg / m². Exclusion criteria: Patients with craniocerebral trauma and/or diabetes; Atrioventricular block and/or sinus bradycardia indicated by preoperative electrocardiogram; Patients with preoperative anemia; Patients allergic to dexmedetomidine; Massive intraoperative blood loss and frequent use of blood circulation drugs; Intraoperative body temperature not in the normal range; Various reasons lead to intraoperative SEP monitoring failure; Intraoperative surgical position changes; Operation time exceeding 3 hours.
Randomization, blinding, and general anesthesia process

Patients were randomly assigned 1:1 to two equally sized groups using a computer-generated random number table, with this list being maintained in a locked cabinet to which only study implementer without any direct involvement in patient care or the study as a whole had access. These study implementer prepared study medications in a closes room without observation based on patient group assignments.

Basic vital signs, including heart rate (HR) and mean arterial pressure (MAP), the pulse oxygen saturation (SpO₂), and electrocardiogram (ECG), etc. were monitored after admission. Dorsal vein access was established and axillary disposable temperature probe was placed to monitor temperature. BIS was used to monitor the depth of anesthesia. Muscle relaxation monitor was connected. The evoked potential monitoring electrode was placed, and electrical stimulation was performed after completion. The SEP amplitude and latency of the patient at that time were recorded as the basic values. Subsequently, group D was administrated with a loading dose of 1µg/kg of dexmedetomidine hydrochloride injection by pump for 10min. Group C was administrated with the same volume of saline infusion for 10 min. Anesthesia induction was performed after infusion. 1. Induction of anesthesia: Patients in both groups were induced by intravenous injection of midazolam sufentanil, rocuronium bromide and etomidate emulsion. After the muscle relaxant completely had taken effect on the epiglottis root and surface anesthesia was performed, the enhanced tracheal tube was inserted in the neutral position under the visual laryngoscope. After successful intubation, the anesthesia machine was connected, and the tidal volume and respiratory rate were adjusted according to P\textsubscript{ET}CO\textsubscript{2}. The standardized anterior cervical spine improved position was used to guide the position process. 2. Anesthesia maintenance: propofol 4-6mg/kg/h, remifentanil 12-30ug/kg/h were continuously infused into the two groups to maintain anesthesia. Group D was continuously administrated with dexmedetomidine 0.4 ug/kg/h, and group C was continuously administrated with the same volume of saline. BIS was maintained between 40-60, and the operating room temperature was maintained between 22-24°C. Water blankets, warming liquid and other methods were used to maintain the patient’s body temperature within the normal range. The amount of anesthetic drugs was adjusted according to HR, BP, and BIS values. Reasons should be analyzed and corresponding measures should be taken under the condition that the intraoperative blood pressure is lower than or higher than 20% of the basic value, or the heart rate is less than 50 beats/min or greater than 100 beats/min. 3. Wake up: removing the tracheal tube when the patient opens the eyes, with the tidal volume of > 5ml/kg, the BIS value of > 90, and the TOF value of >90%.

Intraoperative monitoring of evoked potentials

After the patient was prepared, the monitoring technician explained the purpose and precautions of monitoring evoked potentials to the patients, informed them that electrical stimulation may cause slight discomfort while awake, and told them to relax.

Evoked potential monitoring was performed using a Neuroelectrophysiological monitor (Endeavor CR). The needle electrode acted as the recording electrode and the surface-mount electrode acted as the
stimulus electrode. Electrodes placement: SEP: stimulation electrodes: upper extremity stimulation electrodes were pasted at the median nerve of the patient's wrist, and lower extremity stimulation electrodes were pasted at the posterior tibial nerve of the medial malleolus. Recording electrode: the recording electrode was placed under the scalp near the central posterior gyrus according to the international EEG 10/20 system. The reference electrode was Fz. Stimulation parameters: stimulation intensity range of 16~20mA, stimulation frequency of 4.7Hz, stimulation interval of 0.3ms, observation of (N13-P15, N45-P37) amplitude, (N13, P15, N45, P37) latency. Electrical stimulation was performed before the loading dose of dexmedetomidine, and the SEP amplitude and latency were recorded as the baseline values.

**SEP alarm standard**

SEP alarm criteria: > 50% reduction in SEP amplitude and/or >10% increase in latency compared with the baseline [1].

**Primary outcomes**

Recording the N13-P15, N45-P37 amplitudes and N13, P15, N45, P37 latency of SEP, and HR, MAP, T, BIS values in the two groups at seven time points: awaking (T₀), at the end of the loading dose infusion (T₁), after induction of anesthesia (T₂), after intubation (T₃), positioning (T₄), spinal canal decompression (T₅), and interbody fusion cage insertion (T₆).

**Secondary outcomes**

Recording the number of cases of bradycardia, tachycardia, intraoperative hypotension and intraoperative hypertension in the two groups.

**Other outcomes**

(1) Recording the characteristics of patients, including age, BMI, ASA grade, fluid input, urine output, blood loss, operation time, operation segment, and surgical procedure.

(2) Recording the preoperative and postoperative HCT counts, as well as intraoperative amount of propofol and remifentanil in both groups.

**Statistical Analysis**

The data following the normal distribution was expressed as the mean standard deviation (X ± s). The comparison of measurement data groups was conducted using t-test, and the comparison of the two groups and different time points was conducted using repeated analysis of variance. The counting data was expressed in %, and the comparison was conducted using chi-square test or Fisher exact probability method. Software SPSS 25.0 was used for statistical testing. The results were considered significant when P < 0.05.
Results

This study was a randomized controlled trial. The amplitude of SEP was the primary outcome. According to the literature review and the pilot trial, the mean amplitude of the control group was 1.70, the standard deviation was 0.19, and the amplitude was expected to decrease by 0.18 after the administration of dexmedetomidine. Assuming bilateral $\alpha = 0.05$, with an efficacy of 0.8, the required sample size for each subject in group D and C to be studied is 17 cases according to the PASS application. The dropout rate was considered to be 15%, and the number of cases per group was set at 20.

1. The comparison of characteristics between the two groups was not significant.

A total of 58 patients were included in this study, of which 18 were excluded, and ultimately 40 patients completed the research and underwent statistical analysis (Figure 1). There was no significant difference in characteristics such as age, BMI, ASA grade, fluid volume, urine output, blood loss, operation time, surgical segment, and surgical type between the two groups ($P>0.05$) (Table 1)

Table 1. Characteristics of the Patients Who Underwent Randomization.
2. There was no significant difference in preoperative and postoperative HCT counts, as well as intraoperative propofol and remifentanil usage between the two groups (P>0.05) (Table 2).

Table 2. The comparison of HCT count, intraoperative propofol and remifentanil usage between the two groups

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>D group</th>
<th>C group</th>
<th>t/(\chi^2)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>53.60 ± 13.07</td>
<td>57.05 ± 12.35</td>
<td>-0.858</td>
<td>0.384</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.58 ± 3.66</td>
<td>23.33 ± 3.77</td>
<td>1.065</td>
<td>0.612</td>
</tr>
<tr>
<td>ASA (II/III)</td>
<td>11/9</td>
<td>10/10</td>
<td>0.100</td>
<td>0.752</td>
</tr>
<tr>
<td>Liquid volume (ml)</td>
<td>1940.0 ± 492.5</td>
<td>1582.5 ± 641.4</td>
<td>0.318</td>
<td>0.139</td>
</tr>
<tr>
<td>Urine output (ml)</td>
<td>757.5 ± 393.1</td>
<td>795.0 ± 611.5</td>
<td>-0.231</td>
<td>0.149</td>
</tr>
<tr>
<td>Blood loss (ml)</td>
<td>152.0 ± 143.0</td>
<td>159.5 ± 219.0</td>
<td>-0.128</td>
<td>0.388</td>
</tr>
<tr>
<td>Operation Time (Time)</td>
<td>132.1 ± 43.4</td>
<td>148.3 ± 75.2</td>
<td>-0.834</td>
<td>0.412</td>
</tr>
<tr>
<td>segments (1/2/3/4)</td>
<td>9/6/4/2</td>
<td>9/4/4/4</td>
<td>1.067</td>
<td>0.795</td>
</tr>
<tr>
<td>surgical type (Number)</td>
<td>ACDF/ACCF</td>
<td>11/8/1</td>
<td>0.592</td>
<td>0.744</td>
</tr>
<tr>
<td>ACDF+ACCF</td>
<td>9/9/2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. The research found that compared with T\textsubscript{0}, the N13-P15 amplitude decreased at T\textsubscript{1} and T\textsubscript{6} in group D (P<0.05), while significantly decreased at T\textsubscript{6} in group C (P<0.01). Compared with T\textsubscript{0}, the amplitude of N45-P37 decreased at T\textsubscript{1}, T\textsubscript{5} and T\textsubscript{6} in group D (P<0.05), while significantly decreased at T\textsubscript{5} and T\textsubscript{6} in group C (P<0.01). However, there was no statistically significant comparison at other time points (P>0.05). More importantly, there was no significant comparison of N13-P15 amplitude between the two groups. Intriguingly, the N45-P37 amplitude in group C significantly decreased at T\textsubscript{4} (P<0.05) (Figure 2, Figure 3).

4. There was no significant difference in the latency of N13, P15, N45 and P37 between the two groups (P>0.05) (Table 3).

Table 3. Comparison of N13, P15, N45, P37 latency in the two groups

<table>
<thead>
<tr>
<th>Latency</th>
<th>Groups</th>
<th>T\textsubscript{0}</th>
<th>T\textsubscript{1}</th>
<th>T\textsubscript{2}</th>
<th>T\textsubscript{3}</th>
<th>T\textsubscript{4}</th>
<th>T\textsubscript{5}</th>
<th>T\textsubscript{6}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>20.44 ± 1.34</td>
<td>20.44 ± 1.34</td>
<td>20.59 ± 1.82</td>
<td>21.03 ± 2.05</td>
<td>20.54 ± 1.45</td>
<td>20.85 ± 1.80</td>
<td>20.79 ± 1.87</td>
</tr>
<tr>
<td>P15</td>
<td>D</td>
<td>16.12 ± 2.12</td>
<td>15.99 ± 2.40</td>
<td>16.79 ± 2.59</td>
<td>16.25 ± 2.00</td>
<td>15.85 ± 3.16</td>
<td>15.74 ± 2.97</td>
<td>15.48 ± 3.07</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>15.24 ± 3.01</td>
<td>15.23 ± 3.02</td>
<td>15.79 ± 2.63</td>
<td>16.00 ± 1.78</td>
<td>16.15 ± 1.86</td>
<td>16.26 ± 2.00</td>
<td>16.06 ± 2.47</td>
</tr>
<tr>
<td>N45</td>
<td>D</td>
<td>51.74 ± 7.84</td>
<td>51.11 ± 7.62</td>
<td>51.58 ± 8.31</td>
<td>51.67 ± 5.31</td>
<td>51.95 ± 5.79</td>
<td>52.30 ± 5.78</td>
<td>51.83 ± 9.93</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>50.56 ± 4.79</td>
<td>50.66 ± 4.79</td>
<td>51.00 ± 6.67</td>
<td>51.57 ± 4.32</td>
<td>51.52 ± 6.32</td>
<td>51.54 ± 4.45</td>
<td>52.17 ± 4.96</td>
</tr>
<tr>
<td>P37</td>
<td>D</td>
<td>44.09 ± 5.32</td>
<td>43.00 ± 5.00</td>
<td>43.31 ± 5.21</td>
<td>43.59 ± 5.09</td>
<td>43.60 ± 5.13</td>
<td>44.27 ± 5.91</td>
<td>43.04 ± 5.25</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>42.00 ± 4.27</td>
<td>42.00 ± 4.27</td>
<td>42.51 ± 4.35</td>
<td>43.37 ± 4.31</td>
<td>43.21 ± 3.92</td>
<td>43.00 ± 4.22</td>
<td>43.94 ± 3.54</td>
</tr>
</tbody>
</table>
5. Compared with T_0, MAP decreased at T_4-T_6 (P<0.05) in both groups. In group D, HR decreased at T_1-T_6 (P<0.05). However, in group C, HR increased at T_3 (P<0.05), then decreased at T_4-T_6 (P<0.05). Body temperature showed no significance (P>0.05). BIS decreased at T_1-T_6 (P<0.05) in group C, while decreased at T_2-T_6 in group D (P<0.05) (Table 4).

Table 4. Comparison of vital signs between the two groups

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Groups</th>
<th>T_0</th>
<th>T_1</th>
<th>T_2</th>
<th>T_3</th>
<th>T_4</th>
<th>T_5</th>
<th>T_6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
<td>99±10</td>
<td>94±9</td>
<td>94±11</td>
<td>93±11</td>
<td>84±10*</td>
<td>84±10*</td>
<td>83±11*</td>
</tr>
<tr>
<td>(mmHg)</td>
<td>C</td>
<td>95±11</td>
<td>95±12</td>
<td>90±12</td>
<td>94±12</td>
<td>83±14*</td>
<td>77±14*</td>
<td>80±14*</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>D</td>
<td>78±3</td>
<td>70±3*</td>
<td>73±3*</td>
<td>73±3*</td>
<td>68±3*</td>
<td>61±2*</td>
<td>62±2*</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>71±3</td>
<td>71±3</td>
<td>71±3</td>
<td>81±3*</td>
<td>61±3*</td>
<td>63±3*</td>
<td>64±3*</td>
</tr>
<tr>
<td>Body temperature (°C)</td>
<td>D</td>
<td>36.2±0.4</td>
<td>35.8±0.7</td>
<td>36.0±0.8</td>
<td>36.1±0.6</td>
<td>36.0±0.8</td>
<td>36.3±0.3</td>
<td>36.2±0.4</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>36.2±0.5</td>
<td>35.8±0.7</td>
<td>36.0±0.3</td>
<td>36.1±0.3</td>
<td>36.3±0.2</td>
<td>36.2±0.5</td>
<td>36.0±0.6</td>
</tr>
<tr>
<td>BIS</td>
<td>D</td>
<td>99±1</td>
<td>93±1*</td>
<td>41±2u*</td>
<td>43±2*</td>
<td>42±1*</td>
<td>44±1*</td>
<td>47±1*</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>98±1</td>
<td>98±1</td>
<td>44±1*</td>
<td>44±1*</td>
<td>42±1*</td>
<td>42±2*</td>
<td>46±1*</td>
</tr>
</tbody>
</table>

*Compered to T_0, *P<0.05

5. There was no significant difference in bradycardia, tachycardia, intraoperative hypotension, intraoperative hypertension between the two groups (P>0.05) (Table 5).

Table 5. Comparison of adverse reactions in the two groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Bradycardia</th>
<th>Tachycardia</th>
<th>Hypotension</th>
<th>Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>3 (15)</td>
<td>0 (0)</td>
<td>6 (30)</td>
<td>1 (5)</td>
</tr>
<tr>
<td>C</td>
<td>3 (15)</td>
<td>0 (0)</td>
<td>6 (30)</td>
<td>1 (5)</td>
</tr>
<tr>
<td>*P</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Discussion

SEP is an electrical signal converted from an action potential recorded at a certain point in the sensory conduction pathway.

Recent studies have shown that anesthesia can block dendritic action potentials, thereby blocking the transmission of potentials to distant dendrites [7]. Therefore, when monitoring SEP under intraoperative anesthesia, the action potential generated by the given stimulus may be affected by the action potential blocked by anesthetic drugs. Dexmedetomidine acts on adrenal receptors in the brain and spinal cord [8], and rightly, it is widely used in clinical practice. As we all know, propofol can be reduced when the dexmedetomidine plays an adjunct role in general anesthesia for cervical spine surgery. However, before using dexmedetomidine as an adjuvant for total intravenous anesthesia, it is necessary to consider the possible dose-response or neurodepressive effects of dexmedetomidine on SEP.

The neuroprotective effects of on the brain and spinal cord have been demonstrated in animal experiments and clinical studies [9-11]. It has been confirmed that dexmedetomidine can exerts its spinal neuroprotective role at the transcriptional level [12], and keep ketamine-induced neural cells away from injury and reverse sevoflurane-induced neurotoxicity in animal experiments [13]. Interestingly, dexmedetomidine plays a neurospinal protective role on the one hand, and may block the conduction of action potentials on the other. Studies [14] have shown that maintenance of a plasma concentration of dexmedetomidine of 0.6 ug/L (continuous infusion dose of about 0.3 ug/kg/h) during spinal surgery has no significant inhibitory effect on SEP. Rozet et al. [15] found that under the condition that the experimental group pumped the loading dose of dexmedetomidine 0.6ug/kg followed by 0.6ug/kg/h maintenance dose, in 40 patients undergoing spinal surgery, there was no significant difference on SEP between the two groups. The results revealed that this dose had no effect on SEP as an adjunct for total intravenous anesthesia. Wei Meng et al. [16] found that dexmedetomidine at doses of 1ug/kg and 1ug/kg/h was able to significantly prolong the latency of SEP in neurosurgery. The amplitude usually reflects the electrical activity of gray matter neurons. As shown in this study, the N13-P15 and N45-P37 amplitude of SEP in group D were both lower than the baseline at T1, but there was no change in group C, indicating that the N13-P15 amplitude of SEP would be slightly reduced after pumping 1 ug/kg loading dose of Dexmedetomidine, but did not change the results of SEP. Compared with the baseline value, there was no difference in the N13-P15 amplitude between the two groups at T2-T5, and there was also no difference in the N45-P37 amplitude at T2-T4. Nevertheless, the N13-P15 amplitude of the two groups of SEP at T6 were lower than the baseline value when the N45-P37 amplitude of the two groups of SEP at T5 and T6 was lower than the baseline value. At the same time, the MAP and BIS of both groups were lower than the basic values at T5 and T6, which may be related to a decrease in amplitude. In addition, the decrease in amplitudes of N13-P15 and N45-P37 was more pronounced in group C, suggesting that dexmedetomidine may reduce the reduction in evoked potential amplitude. Notably, there was no difference in the N13-P15 amplitude between the two groups at T1-T6, and the same is true for the N45-P37 amplitudes at T1, T2, T3, T5 and T6. However, at T4 which positioned the patients, the amplitude of
N45-P37 in group C decreased significantly, while there was no obvious change in group D. We found that the decrease in amplitude was due to the decrease in the number of nerve fibers reported by participants. Our study confirmed that dexmedetomidine can reduce the number of nerve fibers and exert a protective role. However, whether the specific protective mechanism of dexmedetomidine is to protect nerve fibers and reduce secondary injury during the positioning process in cervical spine patients still needs support from multiple centers and large samples. Additionally, among 75 patients undergoing cervical spine surgery, 5 patients were reported to have evoked potential alarms during positioning, and 2 had lost their SEP waveform\(^\text{[17]}\). In this study, SEP showed a downward trend after the induction of anesthesia and the postural positioning, but did not meet the alarm standard. Considering that although the anterior cervical spine specification was used in positioning to avoid the impact on SEP, the neck would be slightly overflexed or hyperextended during movement to fully expose the surgical field, which would interfere with the N45-P37 amplitude of SEP. Therefore, it is beneficial to use dexmedetomidine in cervical spine surgery when positioning during evoked potentials monitoring. In addition, N13 represents the posterior angle protrusion potential of the cervical medulla, P15 represents the medial thalamus/dorsal thalamic posterior propagation potential, P37 represents the upper central posterior gyrus of the cerebral cortex, and N45 represents the cortical potential\(^\text{[1]}\). During the positioning process, there was no statistically significant difference in the N13-P15 amplitude between the two groups, but the N45-P37 amplitude was different, which possibly because the process of positioning only affected the shallow N45-P37 amplitude, but not the deep N13-P15 amplitude. It can be seen that dexmedetomidine has no significant effect on evoked potential within a certain dose, but attention should be paid to the incidence of bradycardia\(^\text{[11]}\). Dexmedetomidine can cause a dose-dependent decrease in heart rate, which is associated with a decrease in serum catecholamine concentration\(^\text{[18]}\). In this study, a loading dose of 1 ug/kg dexmedetomidine significantly reduced the increase in heart rate induced by tracheal intubation, and the heart rate remained within the normal clinical range throughout the procedure.

Currently, the mechanism by which dexmedetomidine affects SEP remains unknown. Firstly, the effect of dexmedetomidine on SEP may be slightly related to the site of action, which mainly acts on the blue plairous nucleus of the brainstem, while SEP is produced in the sensory area of the cerebral cortex. Because the two different locations, which may be the reason why dexmedetomidine has less effect on SEP during cervical spine surgery\(^\text{[19]}\). Secondly, it may also be related to the reduction of propofol dosage after dexmedetomidine as an adjunct, thereby reducing the effect of propofol on SEP\(^\text{[20]}\). In this study, the dosage of propofol in group D was reduced compared with that in group C, but there was no difference between the two groups, which may be related to small sample sizes or other factors. Thirdly, the sedative and hypnotic effects caused by dexmedetomidine are produced by \(\alpha_2\) adrenal receptors that affect different circuits. High-dose dexmedetomidine induces hypnosis by inhibiting the blue-spotal nuclear neurons, thereby releasing the motor neuron inhibition of interneurons, while low-dose dexmedetomidine sedative effect independent of inhibition on the blue nuclei\(^\text{[19]}\), which may also explain the slight effect of low-dose dexmedetomidine on evoked potentials. Fourth, a mild effect on SEP may also be related to the anti-inflammatory effects of dexmedetomidine. Studies have found that the main pathological change of cervical spondylosis is intervertebral disc herniation, and intervertebral disc herniation is
mainly caused by inflammatory response\textsuperscript{[21]}. As it happens, previous studies have shown that dexmedetomidine selectively activates alpha-2-adrenoceptors to reduce inflammatory responses\textsuperscript{[11]}. The anti-inflammatory effect of dexmedetomidine may cause a little effect on SEP.

Other factors may also interfere with the results of SEP. With the decrease of blood pressure and cerebral blood flow, the brain metabolism decelerated accordingly, resulting in the interference of neuronal activity\textsuperscript{[22]}. In this study, compared with the baseline value, MAP of both groups decreased at $T_4$-$T_6$, and the N13-P15 and N45-P37 amplitude of both groups decreased at $T_6$, but there was no difference between the two groups. Nevertheless, the influence of blood pressure on SEP should still be emphasized in clinical work. Meanwhile, when the body temperature decreased, the SEP was prolonged or even disappeared along with the reduction of neuroexcitatory transmission due to reduction of neurotransmitters\textsuperscript{[23]}. In this study, all patients were insulated with hydrothermal blankets during surgery to maintain body temperature within the normal range, and the influence of body temperature on SEP was excluded. In clinical studies, a decrease in latency and amplitude of SEP were observed, while decreases in hematocrit (HCT) were less than 10\%\textsuperscript{[24]}. In this study, 45 patients were included, 5 of which were excluded for various reasons, and there was no significant difference in preoperative and postoperative HCT of 40 patients included in the analysis, which excluded the interference of confounding factors on experimental results. At the same time, BIS value is also capable of affecting the evoked potential. In our research, there was no difference in BIS between the two groups, thus excluding the interference of anesthesia depth on the SEP results between the two groups.

There are several limitations in the design of this study. First, the present study lacked multiple dose groups designed to evaluate and analyze the effects of different doses of dexmedetomidine on evoked potentials. This study observed the effect of dexmedetomidine on SEP, which has certain clinical reference value. Secondly, the effect of dexmedetomidine on SEP could not be determined at the molecular level since no inflammatory factors were detected.

Dexmedetomidine has no effect on the amplitude and latency of SEP in patients undergoing cervical spine surgery. More importantly, dexmedetomidine may have a protective effect on nerves during the positioning process.

**List Of Abbreviations**
<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>SEP</td>
<td>Somatosensory evoked potential</td>
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<td>HR</td>
<td>Heart rate</td>
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<tr>
<td>SBP</td>
<td>Systolic blood pressure</td>
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<tr>
<td>DBP</td>
<td>Diastolic blood pressure</td>
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<tr>
<td>MAP</td>
<td>Mean arterial pressure</td>
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<tr>
<td>SpO₂</td>
<td>Percutaneous oxygen saturation</td>
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<tr>
<td>P&lt;sub&gt;ET&lt;/sub&gt;O₂</td>
<td>Partial pressure of end-tidal carbon dioxide</td>
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<tr>
<td>EEG</td>
<td>Electrocardiograph</td>
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<tr>
<td>BIS</td>
<td>Bispectral index</td>
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<td>TOF</td>
<td>Train of four stimulation</td>
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<td>HCT</td>
<td>Red blood cell specific volume</td>
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<tr>
<td>ACDF</td>
<td>Anterior cervical discectomy and fusion</td>
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<td>ACCF</td>
<td>Anterior cervical corpectomy and fusion</td>
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**Declarations**

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**Authors’ contributions**

MHX and YQS designed research protocols, WF, TBY entered data, LWH, CJX, LY, LH analysed data. GYH research protocol implementers was a major contributor in writing the manuscript. All authors read and approved the final manuscript. **Funding**

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**Availability of data and materials**
The data that support the findings of this study are available from the corresponding author, Qingshan Ye, upon reasonable request.

**Ethics approval and consent to participate**

The implementation plan of this study was approved by the Ethics Committee of the General Hospital of Ningxia Medical University, and all subjects knew and signed the informed consent form (Ethics number:2019-472). The research had completed registration with China Clinical Trials Registry (Registration number:ChiCTR2300072621 date:19/06/2023). Written informed consent was obtained all participants. This study was conducted in accordance with the Consolidated Standards of Reporting Trials Checklist. This manuscript adheres to the applicable EQUATOR guidelines.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no conflicts of interest.

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**References**


**Figures**
Figure 1

Flow Chart
Figure 2

Comparison of N13-P15 amplitudes between the two groups.

^ and &: Compared with T0, ^P<0.05, &P<0.01
Figure 3

Comparison of N45-P37 amplitudes between the two groups

Supplementary Files

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