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Effects of patient-controlled analgesia using dexmedetomidine combined with sufentanil on caesarean section and hemodynamics

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This study evaluates the effects of patient-controlled analgesia (PCA) using dexmedetomidine combined with sufentanil on caesarean section and maternal hemodynamics. In this study, a total of 140 eligible puerperal are randomly divided into control and experimental groups (n=70). Control group has received PCA using sufentanil, while experimental group has received PCA using dexmedetomidine plus sufentanil. The analgesic and sedative effects have been evaluated using Bruggemann comfort scale(BCS) score and Ramsay score, respectively. Maternal hemodynamics-related indices heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and oxyhemoglobin saturation (SpO_2) have been detected at the end of operation (T0), upon access to analgesic pump (T1), 24 h after access to analgesic pump (T2) and 48h after access to analgesic pump (T3). The incidence rates of postoperative complications were compared. It has been found that at T2 and T3, BCS and Experimental group had significantly higher Ramsay score and lower HR, SBP, DBP and SpO_2 than those of control group (P<0.05). The incidence rate of complications in experimental group (5.71%) is found to be significantly lower than that of control group (22.86%) (P<0.05).

Keywords: Dexmedetomidine, Sufentanil, Patient-controlled analgesia, Caesarean section

With the implementation of the two-child policy in China in recent years, there have been an increasing number of elderly puerperal, leading to a continuous rise in the caesarean section rate[1]. As an invasive operation, caesarean section will inevitably cause damage to the endometrium and muscle layer of puerperal. The abdominal wall incision and postoperative pain caused by postpartum uterine contraction will create tension, anxiety and other negative emotions in puerperal undergoing caesarean section, and lead to abnormalities in maternal immunity and endocrine function, thus seriously affecting the normal diet and rest, increasing the risk of postoperative complications in puerperal, greatly interfering with the maternal care for the newborn or affecting the establishment of breastfeeding[2].Therefore, analgesia after caesarean section is particularly important. Bergholt *et al.*[3] pointed out that effective analgesics could reduce the postpartum pain reaction of puerperal, reduce the occurrence of venous thrombosis, help puerperal get out of bed as early as possible, and promote the recovery of physical strength and lactation of puerperal. Currently, the analgesic regimen after caesarean section has not been fully unified, and the safe and effective analgesia is the main purpose. At present, fentanyl combined with other anaesthetic drugs is dominated in the analgesic regimen in clinical practice[4]. Sufentanil, a derivative of fentanyl, is often used in supplemental anaesthesia and anaesthesia induction, which is a potent opioid analgesic characterized by long action time and no obvious tissue accumulation. After the clinical use of sufentanil, however, respiratory depression is one of the severest side effects, and its degree is positively correlated with the drug dose[4]. Therefore, it is recommended that combined analgesia using a variety of anesthetics be used in clinic. Besides, dexmedetomidine is an α 2-adrenergic receptor agonist with high efficiency and high selectivity, which can exert anti-sympathetic, analgesic, sedative and anti-anxiety effects[5-10]. Wang *et al.*[11] reported that the use of dexmedetomidine had a positive significance in keeping the hemodynamic stability in patients in general anaesthesia surgery. Patient-controlled analgesia (PCA) is the most widely-used analgesia method after caesarean section, which has a predetermined flow rate, self-controlled dosing and simple operation[12]. In the present study, the clinical application of PCA using dexmedetomidine combined with sufentanilhas been explored through studying postoperative analgesia in 140 puerperal undergoing caesarean section so as to provide new ideas for clinicians.

Experimental Section

Baseline clinical data

A total 140 puerperal undergoing caesarean section in our hospital from June 2017 to June 2019 were selected. They were aged 21-32 years old, with an average (26.15 ± 2.23) years old, and the gestational age was 28-42 weeks, with an average of (39.65 ± 0.50) weeks. All puerperal were divided into control group (n=70) and experimental group (n=70) using a random number table. In control group, puerperal were aged (25.75 ± 1.82) years old, and the gestational age was (39.06 ± 1.02) weeks. The body mass index (BMI) was 20.93-26.53 kg/m^2, with an average of (23.48 ± 1.52) kg/m^2. In terms of the American Society of Anaesthesiologists (ASA) grading, there were 36 cases in grade I and 34 cases in grade II. In experimental group, puerperal were aged (26.35 ± 2.42) years old, and the gestational age was (38.85 ± 1.21) weeks. The BMI was 21.09-26.57kg/m^2, with an average of (23.56 ± 1.42)kg/m^2. In terms of the ASA grading, there were37 cases in grade I and 33 cases in grade II. The age, gestational age, BMI and ASA grade had no statistically significant differences between the two groups (P>0.05), and they were comparable. Inclusion criteria[13]: (i) Puerperal with indications for caesarean section, (ii) those who could not give birth naturally, (iii) full-term primiparae with singleton pregnancy, (iv) thosein ASA grade I-II, (v) those who needed to terminate the pregnancy due to poor physical conditions, and (vi) those with complete clinical dataand compliance in survey. Exclusion criteria[14]: (i) Puerperal who could not describe the analgesia state correctly, (ii) those with abnormalities in liver function, kidney function or electrocardiogram, (iii) those with a history oflong-term use of sedative-hypnotic, opioid or psychotropic drugs, (iv) those with a history of mid-lowerabdominal surgery, (v) those allergic to the drugs used in this paper, 6) those complicated with severe pregnancy complications such as pregnancy-induced hypertension, or (vii) those with severe vision or hearing disorders.

This study was approved by the ethics committee of The Second Affiliated Hospital of Xi'an Jiaotong University, and all puerperal selected and their families were informed and signed the informed consent.

Main reagents

Sufentanil (sufentanil citrate injection, Yichang Humanwell Pharmaceutical Co., Ltd., batch No. NMPN H20054172), and dexmedetomidine hydrochloride (Sichuan Guorui Pharmaceutical Co., Ltd., batch No. NMPN H20110097) were used.

Analgesia methods

Both groups were routinely deprived of food and water for 12 h before operation. The venous channel was established during caesarean section, and puerperal were transferred to the general ward after caesarean section. The disposable portable infusion pump was connected for PCA. In experimental group, dexmedetomidine combined with sufentanil was applied for analgesia: 200μg of dexmedetomidinehydrochloride injection and 100μg of sufentanil citrate injection were added into 50 mL of 0.9% NaCl, and the mixture was pumped under the PCA mode. Each pair of PCA buttons was pressed once, and 0.5 mL of drug liquid was additionally added at the smallest interval of 15 min. In control group, sufentanil alone was applied for analgesia: 100μg of sufentanil citrate injection and 50 mL of 0.9% NaCl were mixed evenly and pumped under the PCA mode, and the drug liquid was additionally added in the same way as above[15].

Assessment of analgesia-related indices

The Bruggemann comfort scale (BCS, 0-4 points) was used to evaluate pain[16]: 0 points: persistent pain in patients; 1 point: no pain when the patient is quiet, but severe pain when the patient coughs and takes a deep breath; 2 points: no pain when the patient lies on back, but mild pain when the patient coughs and takes a deep breath; 3 points: no pain when the patient coughs; 4 points: no pain when the patient turns over.

The Ramsay score (1-6 points)was used to assess the degree of sedation[17]: 1 point: the patient is impatient and restless; 2 points: the patient is quiet and cooperates with medical workers; 3 points: the patient is lethargic, obeys the command and cooperates with medical workers; 4 points: the patient can slightly frown and respond quickly to strong sound stimulus; 5 points: the patient can slightly frown but respond slowly to strong sound stimulus; 6 points: the patient can slightly frown but does not respond to strong sound stimulus.

Monitoring of hemodynamics-related indices

The heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and oxyhemoglobinsaturation (SpO_2) were recorded at the end of operation (T0), at the time of access to analgesic pump (T1), at 24 h after access to analgesic pump (T2) and at 48 h after access to analgesic pump

(T3). Foreign bodies in the mouth and trachea of puerperalwere routinely cleaned up, andthe ventilator was connected for mechanical ventilation (tidal volume: 8 mL/kg, frequency: 15 times/min)[18].

Use of PCA pump within 48 h after operation

The use of PCA pump was recorded in the two groups within 48 h after operation, including the dosage of analgesic drugs and the pressing times of PCA pump.

Detection of plasma prolactin (PRL) level and observation of postoperative complications

At the above 4 time points, 2 mL of venous blood was drawn, and the content of plasma PRL was detected by enzyme-linked immunosorbent assay. The first lactation time (the time when more than 10mL of milk is discharged after bilateral breasts were massaged after operation or the infants sucked the breast) was recorded in the two groups. The complications, mainly including nausea and vomiting, instability of blood pressure, abnormality of respiration and chills, were observed within 48 h after analgesia, puerperal were treated in time, and the incidence rate of complications was calculated in both groups[19].

Scoring of satisfaction degree

Before discharge, the comprehensive evaluation about satisfaction with postoperative analgesia was surveyed by special medical workers (high satisfaction: 3 points, general satisfaction: 2 points, no satisfaction: 1 point)[20].

Statistical analysis

SPSS16.0 software was used for statistical analysis. Numerical data were expressed as percentage (%), and chi-square (χ^2) test was performed for comparison between two groups. Quantitative data were expressed as mean ± standard deviation ($\bar{\chi}$ ± s), and independent *t* test was performed for comparison between two groups. Repeated measurement data analysis of variance was employed for the difference between measured values at multiple time points between two groups, and independent-samples *t* test for the difference between measured values at each time point. $P<0.05$ was considered to be statistically significant.

Results and Discussion

Analgesic effects

There were no significant differences in the BCS score and Ramsay score at T0 and T1 between experimental group and control group ($P>0.05$). Compared with those in control group, both BCS score and Ramsay score significantly rose in experimental group at T2 and T3 ($P<0.05$) (Table 1).

Hemodynamics-related indices

HR, SBP, DBP and SpO_2 had no significant differences at T0 and T1 between experimental group and control group ($P>0.05$). Compared with those in control group, HR, SBP, DBP and SpO_2 significantly declined in experimental group at T2 and T3 ($P<0.05$) (Table 2).

Use of PCA pump within 48 h after operation

Within 48 h after operation, the dosage of analgesic drugs and the pressing times of PCA pump were

Table 1 — Analgesic effects ($\bar{\chi}$ ± s).

	Control group (n=70)	Experimental group (n=70)	*t*	*P*
BCS score				
T0	2.11±0.32	2.08±0.26	0.609	0.544
T1	2.30±0.92	2.22±1.10	0.467	0.641
T2	2.63±0.65	3.11±0.85	3.753	0.000
T3	2.52±1.24	3.18±0.96	3.521	0.001
Ramsay score				
T0	1.26±0.45	1.30±0.29	0.625	0.533
T1	2.10±0.38	2.15±0.22	0.953	0.342
T2	2.41±0.36	3.87±0.46	20.912	0.000
T3	2.91±0.80	4.77±0.76	14.103	0.000

Table 2 — Hemodynamics-related indices ($\bar{\chi}$ ± s).

	Control group (n=70)	Experimental group (n=70)	*t*	*P*
HR (bpm)				
T0	91.92±10.12	91.01±10.92	0.511	0.610
T1	94.26±9.31	94.98±9.36	0.456	0.649
T2	80.64±10.12	62.12±8.85	11.526	0.000
T3	69.45±9.15	62.75±8.16	4.572	0.000
SBP (mmHg)				
T0	141.15±21.61	142.62±21.42	0.404	0.687
T1	103.48±20.56	103.12±20.81	0.103	0.918
T2	124.39±25.68	96.38±22.54	6.859	0.000
T3	130.86±25.45	120.62±20.63	2.615	0.000
DBP (mmHg)				
T0	95.22±11.15	96.89±11.53	0.871	0.385
T1	95.15±10.95	96.12±11.05	0.522	0.603
T2	85.48±10.96	65.33±10.75	10.981	0.000
T3	76.62±9.69	65.62±8.52	7.133	0.000
SpO_2 (%)				
T0	97.38±1.25	97.12±1.21	1.250	0.213
T1	97.32±1.35	97.39±1.36	0.306	0.760
T2	98.56±1.26	93.92±0.96	24.508	0.000
T3	98.78±1.28	93.89±0.98	25.379	0.000

significantly decreased in experimental group compared with those in control group(P<0.05) (Table 3).

Plasma PRL levels and first lactation time

No statistically significant difference was found in the plasma PRL content between experimental group and control group at T0 and T1 (P>0.05). The plasma PRL content was significantly higher in experimental group at T2 and T3 than that in control group (P<0.05). The first lactation time was significantly earlier in experimental group than that in control group (P<0.05) (Table 4).

Complications during PCA

The incidence rate of complications in experimental group (5.71%) was significantly lower than that in control group (22.86%) (χ^2=8.400, P=0.004) (Table 5).

Degree of satisfaction with PCA

The satisfaction score in experimental group was significantly better than that in control group, and the degree of satisfaction (high satisfaction + satisfaction) in experimental group (90%) was significantly higher than that in control group (55.71%) (χ^2=20.805, P=0.000) (Table 6).

Vaginal delivery may cause damage to the health of some puerperal and their newborns, and such a risk can be effectively avoided by caesarean section. Gynecological laparotomy has large trauma, and the acute nociceptive pain after operation is obvious and long-lasting, which can lead to a strong stress response in the body, thereby resulting in large fluctuations in hemodynamics and greatly increasing the risk of cardiovascular and cerebrovascular events. At the same time, the incidence rate of postoperative complications is increased, the length of hospital stay is prolonged, and the medical expenses of puerperae are increased[21].As a special group, puerperae are faced with evident role transition after operation. Satisfactory and effective analgesia after operation can improve puerperae's sleep, enhance their postoperative immune function, and enable them to cough, expectorate and get out of bed early. Therefore, minimizing the use of narcotic analgesics and avoiding the resulting side effects, preparing different analgesic drugs, and determining the optimal analgesic regimen are of great significance in preventing postoperative pain and promoting faster recovery of puerperae[22].

PCA is an important analgesic technique used after caesarean section, in which puerperae can control the dosage of analgesic liquid based on the severity of their own pain, with simple operation and definite efficacy[23]. It has been confirmed that PCA plays an important role in reducing the stress response, preventing complications and relieving tension[24]. Currently, opioids such as sufentanil are the main analgesic drugs used after caesarean section, and they have a good analgesic effect. However, with higher incidence rates, adverse reactions affect the recovery of puerperal, and lead to a low satisfaction with analgesia[25]. Dexmedetomidine, a novel highly selective and potent α2 receptor agonist, acts on theα2 receptor

Table 3—Use of PCA pump within 48 h after operation ($\bar{\chi} \pm s$).

	Control group (n=70)	Experimental group(n=70)	t	P
Dosage of analgesic drugs (mL)	85.37±15.89	65.62±10.65	8.638	0.000
Pressing times of PCApump	5.67±0.45	7.85±0.73	21.269	0.000

Table 4—Plasma PRL levels and first lactation time ($\bar{\chi} \pm s$).

	Control group (n=70)	Experimental group(n=70)	t	P
First lactation time (h)	54.63±4.21	50.24±3.49	6.717	0.000
PRL (μg/L)				
T0	130.73±45.62	132.57±43.45	0.244	0.807
T1	132.64±35.31	133.28±34.73	0.108	0.914
T2	165.94±32.61	188.58±34.94	3.963	0.000
T3	227.08±45.19	250.76±40.69	3.258	0.001

Table 5—Complications during PCA (%).

	Nausea and vomiting	Instability of blood pressure	Abnormality of respiration	Chills	Total
Control group (n=70)	6 (8.57)	4 (5.71)	2 (2.86)	4 (5.71)	16 (22.86)
Experimental group (n=70)	2 (2.86)	2 (2.86)	0 (0.00)	0 (0.00)	4 (2.71)

Table 6—Degrees of satisfaction with PCA (%).

	Satisfaction score (n/%)				Degree of satisfaction (%)
	High satisfaction	Satisfaction	Fine	No satisfaction	
Control group (n=70)	21 (30%)	18 (25.71%)	14 (20%)	17 (24.28%)	39 (55.71)
Experimental group (n=70)	42 (60%)	21 (30%)	6 (8.57%)	1 (1.43%)	63 (90)

to inhibit neuronal discharge, thus exerting a good analgesic effect. Xu and Du[26] pointed out that dexmedetomidine could also exert sedative, anti-anxiety and anti-sympathetic effects after general anaesthesia surgery, with small side effects that usually do not affect breathing, and it could also specifically mediate gastric acid secretion and greatly lower the incidence rate of postoperative nausea and vomiting. Dexmedetomidine and opioids can produce a synergistic effect, which not only have an opioid-sparing effect, but also can reduce the dosage of dexmedetomidine, achieving an ideal analgesic effect and reducing the side effects of opioids[27]. Zhang *et al.*[28] pointed out that dexmedetomidine combined with sufentanil used for analgesia after thoracoscopic surgery could significantly reduce the usage of opioids, alleviate tension and anxiety of patients and improve the analgesic effect. Liu et al.[29]reported that in the case of postoperative analgesia using sufentanil combined with dexmedetomidine for patients in traumatic orthopedics, the pressing times of PCA pump and incidence rate of nausea and vomiting both declined. However, there are few reports about analgesia using dexmedetomidine combined with sufentanil after caesarean section. In this study, the clinical value of analgesia using dexmedetomidine combined with sufentanil after caesarean section was explored. The results showed that compared with those in control group, both BCS score and Ramsay score significantly rose in experimental group at T2 and T3, and the differences were statistically significant (P<0.05), confirming the good analgesic effect of this method. Compared with those in control group, HR, SBP, DBP and SpO_2significantly declined in experimental group at T2 and T3, and the differences were statistically significant (P<0.05). It can be seen that the hemodynamic indices had smaller fluctuation in puerperae in experimental group. Moreover, the dosage of analgesic drugs and the pressing times of PCA pump were significantly decreased in experimental group compared with those in control group, showing statistically significant differences (P<0.05), indicating that puerperae in experimental group were less dependent on analgesics. In experimental group, the PRL content was significantly higher at T2 and T3, the first lactation time was significantly earlier, and the incidence rate of complications significantly declined, showing statistically significant differences (P<0.05). It can be inferred that dexmedetomidine combined with sufentanil lowers the incidence rate of complications and does not affect the lactation of puerperae while achieving an analgesic effect, so puerperae are relatively highly satisfied with this method.

In conclusion, PCA using dexmedetomidine combined with sufentanil has a significant analgesic effect on puerperae undergoing caesarean section, which can reduce the fluctuation in hemodynamic indices and lower the incidence rate of complications. However, multi-center larger-sample research is still needed to further systematically demonstrate the clinical popularization of this analgesic method.

Conflict of interest

No potential conflict of interest was reported by the authors.

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