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ORIGINAL RESEARCH

Effects of controlled low central venous pressure combined with dexmedetomidine on the blood loss, renal function and cognitive function in patients undergoing laparoscopic hepatectomy

Yang Zhang[1], Lin Li[1], Jianbo Xu[2], Wei Cheng[1,*]

[1]Department of Anesthesiology, The Affiliated Huaian No.1 People's Hospital of Nanjing Medical University, 223300 Huai'an, Jiangsu, China
[2]Department of Hepatobiliary and Pancreatic Surgery, The Affiliated Huaian No.1 People's Hospital of Nanjing Medical University, 223300 Huai'an, Jiangsu, China

***Correspondence**
wcheng2088@163.com
(Wei Cheng)

Abstract

This study aims to investigate the effects of controlled low central venous pressure combined with dexmedetomidine on the blood loss, renal function and cognitive function in patients undergoing laparoscopic hepatectomy. From January 2021 to October 2022, 90 patients treated with laparoscopic hepatectomy in Huai'an First People's Hospital were selected as subject objects and equally divided into the study group and control group in a random method. The blood loss, surgical duration, duration of hepatic portal occlusion, serum bilirubin, creatinine, urea nitrogen, hemoglobin, plasma albumin, interleukin (IL)-6 and cognitive function in the two groups were compared. Patients in the study group receiving the combination of controlled low central venous pressure and dexmedetomidine showed less blood loss and shorter time of hepatic portal occlusion as compared to the control group. The levels of serum bilirubin, creatinine and urea nitrogen were significantly increased at postoperative 3 days compared with pre-operation in the study and control groups. In particular, these factors were higher in control group than that in the control group at postoperative 3 days, indicating better liver function and renal function of patients in the study group than those in the control group. The levels of hemoglobin and plasma albumin observed in study group 3 days after surgery were higher than those in the control group. At 1 day after surgery, the level of IL-6 was significantly lower in the study group than that in the control group. Patients in the study group achieved significantly higher mini-mental state examination (MMES) scores than those in the control group at postoperative 1 day, 3 days and 7 days. The controlled low central venous pressure combined with dexmedetomidine is a promising clinical practice in decreasing blood loss, improving the liver and kidney function, and protecting the cognitive function of patients during laparoscopic hepatectomy.

Keywords

Controlled low central venous pressure; Dexmedetomidine; Laparoscopic hepatectomy; Cognitive function

1. Introduction

Hepatectomy is currently one of the common clinical treatments for diseases such as liver cancer and cirrhosis. In particular, the five-year survival rate of patients with hepatocellular carcinoma is quite low due to its high degree of malignancy [1]. Therefore, early targeted therapy for patients who have undergone hepatectomy should be considered to improve the state of illness and prolong survival [2, 3]. The liver is physiologically featured by abundant vascular networks, which makes it at high risk of intraoperative bleeding if improper manipulations happen during hepatectomy, which directly threatens patient's life and health [4, 5]. In the past, blocking technique has been used in the clinical practice to restrain intraoperative bleeding, but it leads to ischemic reperfusion injury to liver tissue during the blockade recovery process, which adversely affects the cognitive function of the patients [6, 7]. As clinical research in medicine continues to advance, medical humanistic care is becoming more and more important in clinical practice. Protecting the cognitive function of patients after surgery has become one of the core issues of clinical research. To this end, a large number of clinical studies in this field have been conducted in our hospital, and based on the accumulated experience of clinical cases [8, 9], it is gradually found that the controlled low central venous pressure combined with dexmedetomidine plays an important role in protecting the cognitive function of patients undergoing laparoscopic hepatectomy. In view of this, the present study

further explored the effects of controlled low central venous pressure combined with dexmedetomidine on blood loss, renal function and cognitive function in patients undergoing laparoscopic hepatectomy. A total of 90 laparoscopic hepatectomy patients clinically admitted from January 2021 to October 2022 in Huai'an First People's Hospital were selected as the study subjects for this comparative study.

2. Materials and methods

2.1 General information

A total of 90 patients undergoing clinically laparoscopic hepatectomy at the Huai'an First People's Hospital from January 2021 to October 2022 were selected as the study subjects. Among them, there were 55 males and 35 females, aged 49–61 years old, with an average age of 55.37 ± 2.15 years. The whole cohort includes 60 patients with cirrhosis and 30 patients with liver cancer, with an average body weight of 64.35 ± 2.16 kg. Patients were randomly divided into a study group and a control group (45 in each group). Of the 45 patients in the study group, 28 were males and 17 were females, aged 51–60 years old, with an average age of 55.31 ± 2.14 years and an average body weight of 64.38 ± 2.11 kg, including 31 patients with cirrhosis and 14 patients with liver cancer. Of the 45 patients in the control group, 27 were males and 18 were females, aged 49–61 years old, with an average age of 55.44 ± 2.19 years and an average body weight of 64.31 ± 2.17 kg, including 29 patients with cirrhosis and 16 patients with liver cancer. The general data were comparable and there was no significant difference between the two groups.

2.1.1 Inclusion criteria

(1) Patients who met the clinical indications for laparoscopic liver resection; (2) Patients who had no allergic history or contraindications to the drugs or related procedures used in the study; (3) Patients without cognitive impairment prior to admission; (4) Patients who had signed an informed consent form.

2.1.2 Exclusion criteria

(1) Patients with congenital heart disease, hypertension, diabetes, and asthma; (2) Patients with a history of previous abdominal surgery; (3) Patients with organic lesions of the heart, lungs and kidneys; (4) Patients with poor compliance or mental illness who are unable to cooperate in completing the study. General data for patients were summarized in Table 1.

2.2 Methodology

After entering the operating room, the vein access of the patient was established. The patient's clinical data were dynamically monitored using a vital signs monitor. A puncture of left radial artery was performed on the patient and the invasive arterial blood pressure was monitored. A puncture of subclavian vein was performed on the patient and central venous pressure was monitored. The same method of induction and maintenance of anesthesia were used in all patients as described follows:

Anesthesia was induced by the combination of dexmedetomidine (approval number, SFDA H20090248; manufacturer, Heng Rui Pharmaceutical Group Co., Ltd., Shanghai, China; specification, 2 mL:200 μg), sufentanil (approval number, SFDA H20054171; manufacturer, Yichang Renfu Pharmaceutical Co., Ltd., Hubei, China; specification: 1 mL:50 μg), propofol (approval number, SFDA ZH20030114, manufacturer, SiChuan GuoRui Pharmaceutical Co., Ltd., Sichuan, China; specification, 50 mL:0.5 g), and rocuronium bromide (approval number, SFDA ZH20093186; manufacturer, XianJu Pharmaceutical Co., Ltd., Zhejiang, China; specifications, 5 mL:50 mg). Specifically, dexmedetomidine was administered at a dose of 1 μg/kg by a micro-pump for 10 min; sufentanil, propofol and rocuronium bromide were administered by intravenous injection at doses of 0.3 μg/kg, 2.0 mg/kg and 0.6 mg/kg, respectively. Anesthesia was maintained by the combination of propofol (approval number, SFDA ZH20030114; Manufacturer, SiChuan GuoRui Pharmaceutical Co., Ltd., Sichuan, China; specification, 50 mL:0.5 g), remifentanil (approval number, SFDA H20123421; manufacturer, Langfang Branch of Sinopharm Group Industrial Co., Ltd., Heibei, China; specification, 2 mg), and rocuronium bromide (approval number, SFDA ZH20093186; manufacturer, XianJu Pharmaceutical Co., Ltd., Zhejiang, China; specifications, 5 mL:50 mg)). Propofol, refentanil and rocuronium bromide were administered by micro-pump infusion at doses of 4–10 mg/(kg·h), 20 μg/(kg·h), and 0.1 mg/(kg·h).

On this basis, central venous pressure of patients in the control group was controlled at 6–12 cmH_2O; as for patients in the study group, central venous pressure was controlled at 2–4 cmH_2O using a controlled low central venous pressure technique, combined with the perfusion of nitroglycerin by an intravenous micro-pump via a dorsal elevated position.

2.3 Observational index

Blood loss, surgical duration, duration of hepatic portal occlusion, serum bilirubin, creatinine, urea nitrogen, hemoglobin, plasma albumin, IL-6 and cognitive function were evaluated and compared between the study and control groups. Cognitive function was scored using the mini-mental state examination (MMSE) with a total score of 30, with higher score indicating better cognitive function.

2.4 Statistics

SPSS 23.0 software (SPSS Inc., Chicago, IL, USA) was used for data analysis. Quantitative data and enumeration data were respectively represented as mean ± standard deviation ($\bar{x} \pm s$) and proportion (%), using *t*-test for the former and Chi-square test for the latter. A p value less than 0.05 was considered statistically significant.

3. Result

3.1 Comparisons of the surgical indicators in the study and control groups

As shown in Table 2, patients from the study group showed significantly less blood loss and shorter time of hepatic portal occlusion than those in the control group. The differences were

TABLE 1. General data between the study and control groups.

Group	N	Gender (n, %)		Average age (year)	Average body weight (kg)	Disease type (n, %)	
		Male	Female			liver cirrhosis	liver cancer
Study group	45	28	17	55.31 ± 2.14	64.38 ± 2.11	31	14
Control group	45	27	18	55.44 ± 2.19	64.31 ± 2.17	29	16
Statistical value	—	0.0468		0.2848	0.1551	0.2000	
p value	—	0.8288		0.7765	0.8771	0.6547	

TABLE 2. Comparisons of the surgical indicators in the control and study groups ($\bar{x} \pm s$).

Group	N	Blood loss (mL)	Surgical duration (min)	Duration of hepatic portal occlusion (min)
Study group	45	331.24 ± 20.15	190.33 ± 8.15	14.02 ± 1.06
Control group	45	361.24 ± 22.61	187.33 ± 8.24	16.00 ± 1.15
t value	—	6.6449	1.7364	8.1315
p value	—	0.0000	0.0860	0.0000

statistically significant ($p < 0.05$). There was no difference regarding the surgical duration between the study and control groups ($p > 0.05$).

3.2 Comparisons of the liver function and kidney function in the study and control groups

As shown in Table 3, prior to the surgery, there was little difference in the levels of serum bilirubin, creatinine and urea nitrogen between the study and control groups. The levels of these indicators were significantly increased at postoperative 3 days compared with pre-operation in the study and control groups ($p < 0.05$). In particular, these factors were higher in control group than that in the control group at postoperative 3 days, indicating better liver function and renal function of patients in the study group than those in the control group ($p < 0.05$).

3.3 Comparisons of the levels of hemoglobin and plasma albumin in the study and control groups

As shown in Table 4, prior to the surgery, there was little difference in the levels of hemoglobin and plasma albumin between the study and control groups. 3 days after surgery, the levels of hemoglobin and plasma albumin were significantly decreased in the two groups compared with those before surgery ($p < 0.05$). In particular, the levels of hemoglobin and plasma albumin observed in study group 3 days after surgery were higher than those in the control group ($p < 0.05$).

3.4 Comparisons of IL-6 level in the study and control groups

As shown in Table 5, the level of IL-6 in the study group was significantly lower than those in the control group both right after surgery and at postoperative 1 day ($p < 0.05$). At 1 day after surgery, the level of IL-6 was significantly lower in the study group than that in the control group ($p < 0.05$).

3.5 Comparisons of MMES scores in the study and control groups

As shown in Table 6, prior to the surgery, there was no significant difference in the MMES scores between the study and control groups. Patients in the study group achieved significantly higher MMES scores than those in the control group at postoperative 1 day, 3 days and 7 days ($p < 0.05$).

4. Discussion

With the rapid increase in the incidence of liver cancer and cirrhosis, research focusing on the effective treatment of these diseases has gradually accumulated some clinical experience [10, 11]. It has been shown that significant efficacy could be achieved in the clinical treatment of liver cancer and cirrhosis by laparoscopic hepatectomy [12, 13]. However, due to the abundance of blood circulation in the liver, there is a risk of massive hemorrhage if the hepatic artery, hepatic vein, and portal vein are damaged during surgery, which not only affects the clinician's surgical vision for further operation, but also directly threatens the patient's life and health [14, 15]. Therefore, it has become a critical issue in clinical research about how to effectively control the intraoperative blood loss, reduce postoperative complications and promote early rehabilitation of patient undergoing laparoscopic hepatectomy.

At present, hepatic portal occlusion is a clinically established technique that can effectively restrain blood loss during laparoscopic hepatectomy [16]. However, the ischemia-reperfusion injury occurs as a results of hepatic portal occlusion and recovery of blood supply can adversely affect the patient's physiological functions [17]. Among them, clinical data have reported postoperative cognitive dysfunction in patients undergoing hepatectomy [18, 19], which is closely attributed to ischemic reperfusion injury and the use of anesthetic drugs [20, 21].

Clinical experience has showed that hepatic venous pressure could be effectively ameliorated by controlling low central venous pressure, thereby controlling blood loss and promoting separation of the liver parenchymal [22, 23]. Other studies

TABLE 3. Comparisons of the liver function and kidney function in the control and study groups ($\bar{x} \pm s$).

Group	N	Serum bilirubin (μmol/L)				Creatinine (μmol/L)				Urea nitrogen (mmol/L)			
		Pre-operation	Post-operative 3 days	*t* value	*p* value	Pre-operation	Post-operative 3 days	*t* value	*p* value	Pre-operation	Post-operative 3 days	*t* value	*p* value
Study group	45	42.25 ± 1.25	43.25 ± 1.15	3.9494	0.0002	65.35 ± 1.65	70.24 ± 1.57	14.4026	0.0000	5.93 ± 0.21	6.09 ± 0.31	2.8665	0.0052
Control group	45	42.29 ± 1.21	46.98 ± 1.31	17.6422	0.0000	65.41 ± 1.59	75.98 ± 1.63	31.1392	0.0000	5.89 ± 0.26	6.95 ± 0.35	16.3088	0.0000
t value	—	0.1542	14.3542	—	—	0.1757	17.014	—	—	0.8029	12.339	—	—
p value	—	0.8778	0.0000	—	—	0.8610	0.0000	—	—	0.4242	0.0000	—	—

TABLE 4. Comparisons of the hemoglobin and plasma albumin in the control and study groups ($\bar{x} \pm s$).

Group	N	Hemoglobin (g/L)				Plasma albumin (g/L)			
		Pre-operation	Post-operative 3 days	*t* value	*p* value	Pre-operation	Post-operative 3 days	*t* value	*p* value
Study group	45	132.25 ± 6.35	117.35 ± 5.26	12.1219	0.0000	55.26 ± 1.34	53.37 ± 1.27	6.8673	0.0000
Control group	45	133.25 ± 6.19	101.25 ± 5.16	26.6376	0.0000	55.29 ± 1.32	48.24 ± 1.19	26.6106	0.0000
t value	—	0.7565	14.6575	—	—	0.1070	19.7731	—	—
p value	—	0.4514	0.0000	—	—	0.9150	0.0000	—	—

TABLE 5. Comparisons of IL-6 level in the control and study groups ($\bar{x} \pm s$).

Group	N	Interleukin (IL)-6 (pg/mL)			
		Right after surgery	Postoperative 1 day	*t* value	*p* value
Study group	45	24.35 ± 1.02	35.26 ± 2.16	30.6383	0.0000
Control group	45	39.15 ± 2.04	40.25 ± 1.95	2.6148	0.0105
t value	—	43.5294	11.5031	—	—
p value	—	0.0000	0.0000	—	—

TABLE 6. Comparisons of MMES scores in the control and study groups ($\bar{x} \pm s$).

Group	N	Pre-operation	Postoperative 1 day	Postoperative 3 days	Postoperative 7 days
Study group	45	27.20 ± 1.01	26.73 ± 1.05	25.64 ± 1.21	27.44 ± 1.24
Control group	45	27.27 ± 1.14	25.00 ± 1.21	24.11 ± 1.28	26.00 ± 1.31
t value	—	0.3083	7.2439	5.827	5.3553
p value	—	0.7586	0.0000	0.0000	0.0000

have reported that dexmedetomidine is one of the commonly used sedative and analgesic drugs in clinical practice with a high safety and reliability profile [24, 25]. It can effectively inhibit sympathetic excitability, protect liver and kidney function by improving arteriole diameter, minimize the degree of ischemic reperfusion injury, and improve impaired cognitive function in patients [26, 27]. Meanwhile, dexmedetomidine can also exert significant anti-inflammatory and antioxidant effects in clinical practice [28].

On this basis, it is found that the blood loss, renal function and cognitive function were significantly improved by the implement of controlled low central venous pressure combined with dexmedetomidine during laparoscopic hepatectomy. Patients in the study group receiving the combination of controlled low central venous pressure and dexmedetomidine showed less blood loss and shorter time of hepatic portal occlusion as compared to the control group ($p < 0.05$). The levels of serum bilirubin, creatinine and urea nitrogen were significantly increased at postoperative 3 days compared with pre-operation in the study and control groups ($p < 0.05$). In particular, these factors were higher in control group than that in the control group at postoperative 3 days, indicating better liver function and renal function of patients in the study group than those in the control group ($p < 0.05$). Prior to the surgery, there was little difference in the levels of hemoglobin and plasma albumin between the study and control groups. 3 days after surgery, the levels of hemoglobin and plasma albumin were significantly decreased in the two groups compared with those before surgery ($p < 0.05$). In particular, the levels of hemoglobin and plasma albumin observed in study group 3 days after surgery were higher than those in the control group ($p < 0.05$). The level of IL-6 in the study group was significantly lower than those in the control group both right after surgery and at postoperative 1 day ($p < 0.05$). At 1 day after surgery, the level of IL-6 was significantly lower in the study group than that in the control group ($p < 0.05$). Prior to the surgery, there was no significant difference in the MMES scores between the study and control groups. Patients in the study group achieved significantly higher MMES scores than those in the control group at postoperative 1 day, 3 days and 7 days ($p < 0.05$). These results were consistent with previous studies [29, 30], which further confirmed the advantage of controlled low central venous pressure combined with dexmedetomidine during laparoscopic hepatectomy resection.

It was foreign scholars who first proposed the concept of low central venous pressure, but no unanimous conclusion has been reached in current clinical studies regarding the criteria for low central venous pressure. It has been reported abroad that the intraoperative bleeding volume could be significantly decreased without impairing the liver function and renal function of the patient during the process of hepatectomy by controlling central venous pressure below 5 cmH_2O. In the present study, the patient's central venous pressure was controlled at 2–4 cmH_2O. Whether this criterion is optimal remains to be studied accurately by increasing the sample size.

Due to the limited number of cases, this study is limited in that it focuses on a specific patient admitted to our hospital. Future studies on the effectiveness of controlled low central venous pressure combined with dexmedetomidine in different surgical procedures will help to determine whether this method has clinical comparative advantages and greater application value.

5. Conclusions

In summary, the present study indicated that controlled low central venous pressure combined with dexmedetomidine is a promising clinical practice in terms of decreasing blood loss, improving hepatic and kidney function, and protecting the cognitive function of patients during laparoscopic hepatectomy.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

YZ and WC—designed the research study. YZ, LL and JBX—performed the research. YZ, LL and JBX—analyzed the data. YZ and WC—wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of the Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University (Approval no. YX-2021-136-01). Written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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