International Journal of Surgery 12 (2014) 1484–1488

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Combining interscalene brachial plexus block with intravenous-inhalation combined anesthesia for upper extremity fractures surgery: A randomized controlled trial

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HIGHLIGHTS

- Combining IBPB with IV-inhalation combined anesthesia was assessed in elderly.
- It was associated with fewer side effects such as preoperative hypotension.
- It had less consumption of general anesthetics such as propofol and Isoflurane.
- It required a less the recovery time.

ARTICLE INFO

Article history:
Received 9 July 2014
Received in revised form
24 July 2014
Accepted 16 October 2014
Available online 24 October 2014

Keywords:
Interscalene brachial plexus block
Intravenous anesthesia
Inhalational anesthetics
Side effect

ABSTRACT

Background: A parallel-group randomized controlled trial (RCT) was conducted to evaluate the effect of combining the interscalene brachial plexus block (IBPB) with Intravenous–inhalation combined anesthesia to isolated Intravenous–inhalation anesthesia in the upper extremity fractures surgery of elderly patients. **Methods**: One hundred elderly patients who underwent upper extremity surgery were randomly assigned to received isolated Intravenous–inhalation combined anesthesia (group CI, $n = 50$) and IBPB associated with Intravenous–inhalation combined anesthesia (group NB, $n = 50$). Associated side effects, recovery time after operation, as well as the dose of intraoperative vasoactive agents and auxiliary drugs were noted. **Results**: The two groups were not significantly different in gender ($P = 0.539$), ages ($P = 0.683$) and weight ($P = 0.212$). Five patients (10%) in the group NB and 17 patients (34%) in the group CI suffered from preoperative hypotension ($P = 0.004$). Besides, lower incidence of other adverse effects such as mental stress, incision pain and hypertension were also found in the group NB; however, the differences were not statistically significant ($P > 0.05$). The consumption of general anesthetics in the group NB was significantly less than that of the group CI (propofol, $P = 0.004$; Isoflurane, $P < 0.001$), and the recovery time of the group NB was significantly shorter than that of the group CI ($P = 0.020$). **Conclusion**: Combining IBPB with Intravenous–inhalation combined anesthesia in elderly patients hold a greater potential for upper extremity fractures surgery due to its improved clinical effectiveness and fewer side effects.

1. Introduction

The population of the elderly increases rapidly, and this cohort constitutes a greater proportion of medically compromised patients than younger adults. However, elderly patients would not be considered as candidates for surgical intervention due to the low survival rate caused by concomitant diseases [1]. In addition, the elderly seem to be more sensitive to adverse side effects of certain anesthetics than younger individuals. The elderly who undergo noncardiac surgery might be at risk of cardiovascular, neurologic and pulmonary complications as a result of anesthesia and surgery [2]. Therefore, the use of anesthetic on elderly patients must be managed judiciously in connection with the types of surgery required.

Interscalene block, proposed by Winnie in 1970, has gained in popularity owing to its effectiveness and the safety profile [3]. It is often chosen by skilled anesthesiologists as the major anesthetic technique for shoulder surgery [4]. Compared with general

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http://dx.doi.org/10.1016/j.ijsu.2014.10.011
1743-9191/

anesthesia, interscalene blocks show more significant advantages, such as improved postoperative pain, decreased the administration of postoperative opioid, and reduced recovery time. However, this technique also has disadvantages, such as location problem, and a fairly high incidence of side effects [4,5].

Intravenous–inhalation combined anesthesia is a method of general anesthesia which is used in combination with total intravenous anesthesia and inhalation anesthesia. Total intravenous anesthesia is preferable to induction of anesthesia in pediatric patients because of the low risk of respiratory irritation and short recovery time. It is simple and effective for extremity surgery and has become more popular and possible in recent time because of the pharmacokinetic and pharmacodynamic properties of propofol and the availability of short acting synthetic [6]. However, intravenous anesthesia has been limited by its inability to provide postoperative analgesia and the risk of bradycrdia and hypotension after intravenous administration [7]. Inhalational anesthesia is pervasive when used for induction or maintenance of anesthesia because it is effective, reliable, safe, easy to deliver, stable, and without major end-organ sequelae [8]. An inhalational induction is guaranteed to be painless. It might be smelly, but it will never hurt. Besides, there are a few absolute contraindications to inhalational agents for induction of general anesthesia, most notably malignant hyperthermia, probably muscular dystrophy [9].

The purpose of the present study was to evaluate whether combining interscalene brachial plexus block (IBPB) with Intravenous–inhalation combined anesthesia was more effective than isolated Intravenous–inhalation combined anesthesia in upper extremity fractures surgery of elderly patients.

2. Materials and methods

2.1. Trial design

This study was a parallel-group randomized controlled trial (RCT) using a 1:1 allocation ratio, designed to evaluate the effect of combining IBPB with Intravenous–inhalation combined anesthesia to isolated Intravenous–inhalation anesthesia in the upper extremity fractures surgery of elderly patients.

2.2. Participants

One hundred patients admitted to the Department of Anesthesiology, Baoshan District Shanghai Hospital of integrated Traditional and Western Medicine for upper extremity fractures surgery between October 2012 and December 2013 were enrolled. Ethical approval for human subjects was obtained from the Ethics Committee of our hospital, and written informed consent was obtained from each study participant. The inclusion criteria were as follow: (a) patients who were scheduled for upper extremity fractures including ulna fracture, humeral shaft fractures, humerus surgical neck fracture and humeral supracondylar fracture surgery; (b) all of them aged 70 years or older. In addition, the exclusion criteria were listed: (a) contraindications to brachial plexus block and Intravenous–inhalation anesthesia (e.g. coagulopathy, refusal of anesthesia); (b) mental diseases; (c) body mass index > 35; (d) severe congestive heart failure (New York Heart Association class IV), severe chronic obstructive pulmonary disease (Global Initiative for Chronic Obstructive Lung Disease guidelines, stage III–IV) [10]. The weight of these patients ranged from 52 to 70 kg. Among them, 69 cases (69%) were complicated by high blood pressure and cardiac insufficiency. The follow-up period was 4–6 weeks.

Table 1
Comparisons of basic characteristics between the two groups.

Groups	Age (years)	Weight (kg)	Gender (no. of males, %)	Complications (n, case)
CI ($n = 50$)	77.2 ± 5.9	61.2 ± 4.0	32, 64.0%	38, 76.0%
NB ($n = 50$)	76.7 ± 6.3	60.3 ± 3.1	29, 58.0%	36, 72.0%

CI, Intravenous–inhalation combined anesthesia; NB, interscalene brachial plexus block associate associated with Intravenous–inhalation combined anesthesia.

2.3. Randomization

Participants were randomly divided into two groups. The independent institution accomplished the randomization process. A computer random number generator produced the random number. The central web-site was applied to carry out the randomization program. The investigators, participants, surgeons, assistants and nurses were blinded to study treatment allocation.

2.4. Interventions

The enrolled fracture clinic patients were randomly divided into two groups. Fifty patients received isolated Intravenous–inhalation combined anesthesia (group CI), while the other 50 patients underwent IBPB with the ultrasound-guided technique associated with intravenous–inhalation combined anesthesia (group NB). These two anesthetic approaches were performed by two anesthesiologists with extensive experience in this technique. The patients in the group NB were injected with the 25 mL mixing liquid of 0.375% ropivacaine and 1% lidocaine hydrochloride after they acquired of paresthesia [4]. Trachea general anesthesia intubation was applied in Intravenous–inhalation combined anesthesia for both group CI and NB. Before induction of anasthesia, the patients were submitted to intravenous injection of 0.3 mg atropine or scopolamine, 0.02–0.04 mg kg^{-1} midazolam, and 10 min of supplying of oxygen to mask. Then began to undergo endotracheal intubation and mechanical ventilation after the patients were given 2–5 mg kg^{-1} fentanyl, 0.3 mg kg^{-1} etomidate and 0.8 mg kg^{-1} rocuronium bromide. Both CI and NB group patients were received 1–2% isoflurane inhalation and 2–4 mg $(kg\ h^{-1})^{-1}$ infusion of propofol following the induction [11]. All patients were successfully anesthetized. Moreover, the follow-up period was 4–6 weeks.

2.5. Outcomes

Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (Pmean), heart rate (HR) and peripheral oxygen saturation (SpO_2) were monitored before and after anesthesia at different time points (5, 10, 20, 40, 60, 80 and 120 min) by nurses using the Schiller Cardiovit AT-60 electrocardiograph (Schiller AG, Baar, Switzerland). Besides, side effects and use of intraoperative medication of the two groups were also recorded, as well as recovery time.

2.6. Statistics analyses

Categorical variables were analyzed using by $\chi 2$ test. Continuous variables, presented as mean ± SD, were compared using Student t test. All analyses were conducted using statistical package for the social sciences (SPSS) software (version 13.0; SPSS Inc., Chicago, IL). A P value of <0.05 was considered as statistically significant.

Table 2
Comparisons of vital signs before and after anesthesia of patients in group CI and NB.

Parameter		Pre-anesthesia	Post-anesthesia						
			5 min	10 min	20 min	40 min	60 min	80 min	120 min
SBP (mmHg)	CI	128.34 ± 30.06	128.46 ± 28.34	130.52 ± 27.53	134.48 ± 28.5	129.36 ± 28.35	130.96 ± 30.21	132.56 ± 27.85	133.32 ± 28.74
	NB	130.21 ± 29.60	130.45 ± 27.50	131.37 ± 28.60	138.09 ± 29.16	129.76 ± 27.38	133.63 ± 31.36	135.4 ± 26.64	136.39 ± 29.91
DBP(mmHg)	CI	91.23 ± 21.25	90.35 ± 20.13	91.26 ± 20.16	90.35 ± 19.45	90.11 ± 21.36	92.26 ± 19.78	91.25 ± 20.31	91.05 ± 19.52
	NB	90.06 ± 20.94	91.30 ± 19.84	92.28 ± 21.54	90.4 ± 19.70	89.45 ± 22.39	90.26 ± 20.61	89.48 ± 24.31	90.47 ± 20.82
Pmean (mmHg)	CI	112.37 ± 26.23	110.23 ± 25.12	110.56 ± 24.37	111.56 ± 23.45	109.56 ± 26.54	112.35 ± 26.36	111.89 ± 25.34	113.25 ± 26.12
	NB	110.35 ± 25.34	112.36 ± 24.45	115.19 ± 30.40	109.39 ± 31.41	113.53 ± 27.61	114.35 ± 27.61	113.52 ± 27.90	106.36 ± 27.65
HR (bpm)	CI	82.34 ± 26.89	81.12 ± 27.14	80.23 ± 21.63	81.96 ± 26.59	82.12 ± 28.78	80.57 ± 29.52	79.37 ± 28.12	80.32 ± 27.13
	NB	80.68 ± 28.43	79.81 ± 22.60	80.26 ± 27.35	82.35 ± 29.23	81.96 ± 29.46	78.53 ± 21.60	77.6 ± 27.78	78.03 ± 21.40
SpO_2 (%)	CI	94.45 ± 2.03	95.13 ± 3.11	95.13 ± 3.16	95.46 ± 3.15	96.31 ± 3.85	95.39 ± 3.16	94.96 ± 3.87	95.12 ± 3.46
	NB	92.2 ± 3.35	96.09 ± 3.20	96.35 ± 3.82	96.32 ± 3.31	96.5 ± 3.17	96.68 ± 3.21	96.59 ± 3.61	96.08 ± 3.26
R(bpm)	CI	15.78 ± 2.56	16.31 ± 2.12	15.38 ± 2.36	16.78 ± 2.35	15.96 ± 2.15	16.59 ± 2.34	15.89 ± 2.46	15.78 ± 2.14
	NB	16.91 ± 2.30	16.84 ± 2.26	15.82 ± 2.90	16.61 ± 2.80	16.76 ± 2.08	16.62 ± 2.06	16.5 ± 2.49	16.38 ± 2.03

SBP, systolic blood pressure; DBP, diastolic blood pressure; Pmean, mean arterial pressure; HR, heart rate; SpO2, and peripheral oxygen saturation; CI, Intravenous–inhalation combined anesthesia; NB, interscalene brachial plexus block associate associated with Intravenous–inhalation combined anesthesia.

3. Results

In the present study, one hundred patients were enrolled between October 2012 and December 2013 and no one patient in each group dropped out the study. The specific demographic data are shown in Table 1. A total of 50 patients (aged 77.2 ± 5.9 years; 32 males and 18 females) randomized to the group CI, and the other 50 patients (aged 76.7 ± 6.3 years; 29 males and 21 females) randomized to the group NB. There were no statistically significant differences in gender ($P = 0.539$), age ($P = 0.683$), weight ($P = 0.212$) and complication rate ($P = 0.648$) between the CI and NB groups. In addition, three were no significant differences between intraoperative and postoperative periods as regards vital signs (SBP, DBP, Pmean, HR, SpO_2 and R) for both groups (Table 2), which indicated the reliability of both anesthesia methods.

The intra-operative and post-operative adverse reactions and usage of drugs during the surgery in the two groups were shown in Table 3 and Table 4, respectively. Five (10%) patients in group NB and 17 (34%) patients in group CI suffered from hypotension during operation ($P = 0.004$) and the doses of ephedrine were 10 mg and 5–30 mg respectively. Two and six patients had mental stress in the group NB and CI ($P = 0.140$), and received 2–3 and 15–20 mg of midazolam, respectively. One patient in the group NB and eight patients in the group CI produced incision pain ($P = 0.014$) and received intravenous fentanyl in doses of 0.05–0.1 and 0.05–0.15 mg, respectively. Besides, one patient in the group CI had postoperative nausea and vomiting, while no such effects could be demonstrated in the group NB. Anesthetic complications such as headache did not show in the two groups.

The consumption of general anesthesia used during the surgery and the recovery time were presented in Table 5. Compared with the group CI, significantly lower consumption of propofol (294.6 ± 68.8 *vs*. 337.2 ± 77.1 mg; $P = 0.004$) and isoflurane (16 ± 3.2 *vs*. 23 ± 2.9 mg; $P < 0.001$) were found in the NB group. The recovery time was 133.2 ± 37.3 min in the group CI and 116.8 ± 31.9 min in the group NB. The differences between the two groups were statistically significant ($P = 0.020$).

Besides, there was no serious complication occurred among all the cases during the follow-up period. The trail terminated until all patients were back to health and released from the hospital.

4. Discussion

In the present study, we compared the effect of combining the IBPB with Intravenous–inhalation combined anesthesia to isolated Intravenous–inhalation combined anesthesia in the upper extremity fractures surgery of elderly patients. The results showed that there were no statistically significant changes in vital signs such as SBP, DBP, HR and SpO_2 at different time points in intraoperative or postoperative periods between the group CI and NB. However, less adverse effects and shorter recovery time were detected in the group NB compared with the group CI. In addition, the usage of general anesthetics in the group NB was significantly less than that of the group CI.

One of the main concerns about IBPB is its side effects [4,5]. Drummond [12] found that both posterior and lateral approaches to IBPB produced moderate decreases in respiratory function.

Table 3
Side effects of patient in the two groups.

	Intra-operation				Post-operation	
	Hypotension	Mental stress	Incision pain	Hypertension	Nausea and vomiting	Headache
CI (n = 50)	17 (34%)	6 (12%)	8 (16%)	NA	1 (2%)	NA
NB (n = 50)	5 (10%)**	2 (4%)	1 (2%)	4 (8%)	NA	NA

CI, Intravenous–inhalation combined anesthesia; NB, interscalene brachial plexus block associated with Intravenous–inhalation combined anesthesia. **$P < 0.01$ compared with CI group.

Table 4
Intraoperative medication used in the two groups.

Group	AGD	UE
CI (n = 50)	14 (28%)	17 (34%)
NB (n = 50)	3 (6%)**	5 (10%)**

CI, Intravenous–inhalation combined anesthesia; NB, interscalene brachial plexus block associate associated with Intravenous–inhalation combined anesthesia. AGD, ancillary analgesic drugs; UE: the use of ephedrine. **$P < 0.01$ compared with CI group.

Table 5
Consumption of general anesthetics and recovery time of patient in the two groups.

Group	Consumption of general anesthetics (mg)		Recovery time (min)
	Propofol	Isoflurane	
CI (n = 50)	337.2 ± 77.1	23 ± 2.9	133.2 ± 37.3
NB (n = 50)	294.6 ± 68.8**	16 ± 3.2**	116.8 ± 31.9*

CI, Intravenous–inhalation combined anesthesia; NB, interscalene brachial plexus block associated with Intravenous–inhalation combined anesthesia. *$P < 0.05$, **$P < 0.01$ compared with CI group.

Melissa et al. [13] reported a patient who developed acute hypoxia immediately following this block. However, IBPB has achieved in popularity in upper limb surgery owing to its effectiveness and the safety profile associated with ultrasound-guided techniques which could decrease the risks of partial lung paralysis and postoperative anoxia [14]. Ultrasound-guided IBPB was performed in our study, and no such severe adverse effects occurred.

Intraoperative and postoperative nociceptive simulation induced by upper extremity surgery is another major adverse problem, especially during the recovery of the patients [15]. Potentially negative aspects of using isolated Intravenous–inhalation combined anesthesia include necessity of vein catheterization, pain during injection even when the skin has been effectively anesthetized, and the risk of bradycardia and hypotension after intravenous administration, which are in good agreement with our results [16]. In our study, eight patients in group CI showed pain and 17 patients developed hypotension, while associated with interscalene plexus block anesthesia, the number was only one and five respectively. However, a very ideal intraoperative anesthetic and postoperative pain relief was achieved when in conjunction with interscalene plexus block. Consistently, previous study indicated that brachial plexus anesthesia, when used in combination with general anesthesia, has been shown to reduce intraoperative anesthetic and postoperative analgesic requirements [5]. In our study approaches to brachial plexus anesthesia with ultrasound imaging guidance proved to be efficient methods of controlling postoperative pain for patients undergoing proximal upper extremity surgery, in accordance with previous reports on this technique by others [17]. Laurila. *et al* [18] reported that an IBPB with low-dose ropivacaine effectively relieved early postoperative pain and reduced the need for opioids. In a similar surgical setting, Borgeat et al. [19] recently studied interscalene plexus analgesia, using a protocol with administration of a local analgesic as a basal continuous infusion. This was supplemented by patient-controlled additional bolus doses of the local analgesic. In that study, the described way of using plexus analgesia was reported to be superior to patient -controlled intravenous morphine analgesia. However, the plexus block was initiated before surgery and was effective during general anesthesia. Bradycardia and hypotension are common side effects of both intravenous and inhalational induction [16]. This characteristic is particularly relevant to intravenous induction routes because drugs are usually injected relatively rapidly unlike the more incremental and reversible process of inhalation induction. This study found that the addition of interscalene plexus block anesthesia was associated with a lower incidence of hypotension. Similar results were also reported by Casati et al. [20]. Postoperative nausea and vomiting is one of the most common problems following general anesthesia [21], resulting in postsurgical complications, delayed discharge, and psychological and physiological distress for the patient. The use of opioids has been suggested as probable factor in postoperative nausea [22]. However, we found no significant differences between groups with respect to incidence despite lower intra-and postoperative opioid doses in the NB group.

Even though the consumption of propofol and isoflurane administered into the interscalene brachial plexus associated with intravenous–inhalation combined anesthesia was significantly lower in our study, but sufficient anesthesia effect were obtained between the two groups. Local anesthetic would allow IBPB to be performed in these patients reducing compromise in lung function without decreasing analgesic effect [1]. In accordance with our findings the study published by Grossi et al. [15] showed that the combination of IBPB and total intravenous anasthesia permitted a low dosage of narcotics during surgery, a fast recovery and long-lasting analegesia in the postoperative period. In the case of propofol, the greater the duration of administration, the longer recovery time as its pharmacokinetics transform from a rapid recovery paradigm to one that is much slower [8]. As a result, the recovery time after brief anesthesia with intravenous–inhalation combined anesthesia is likely much more protracted than that after combined interscalene brachial plexus. Reduction of total local anesthetic dose also reduces risk of morbidity associated with intravascular injection. There has been at least one case report of local anesthetic toxicity in interscalene plexus block with injection of ropivacaine 0.3% (25 ml) with epinephrine 2.5 $\mu g\ ml^{-1}$ [23].

This study had its limitations. The study only evaluated the short-term efficacy of combining IBPB with IV-inhalation combined anesthesia was assessed in elderly. However, this research provided with alternative and effective method for elderly patients who had to undergo upper extremity fractures surgery.

In conclusion, this study demonstrated that interscalene plexus block associated with intravenous–inhalation combined anesthesia was an excellent anesthesia method used for upper extremity fractures surgery especially for the elderly. This method seemed, in comparison to isolated generally anesthesia, to offer superior postoperative pain relief, lower needs for rescue analgesia, and faster recovery of postoperative motor function.

Ethical approval

None required.

Funding

None.

Author contribution

Conceive and design the experiments: JianSheng Wang,
Acquire and analyze the data: XiaoJun Yang, JianQiang Kong.
Draft and revise the manuscript: Huan Xiao, Miao Bing

Conflict of interest

The authors have declared that no competing interests exist.

Acknowledgments

We wish to express our warm thanks to Fenghe (Shanghai) Information Technology Co., Ltd. Their ideas and help gave a valuable added dimension to our research.

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