

Effects of fascia iliaca compartment block combined with general laryngeal mask airway anesthesia in children undergoing femoral fracture surgery: a randomized trial

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Background: Postoperative agitation after general anesthesia is a common complication in children; however, pain or uncomfortable feeling is the main reason of emergence agitation. Here, we have investigated the effects of fascia iliaca compartment block (FICB) combined with general laryngeal mask airway (LMA) anesthesia in children undergoing femoral surgery.

Methods: Eighty children undergoing femoral surgery were randomly divided into two groups: FICB + LMA group and control group (n=40). The FICB + LMA group received FICB combined with general LMA anesthesia, and the control group received tracheal intubation general anesthesia alone. Anesthesia was maintained with nitrous oxide and sevoflurane. Hemodynamic parameters were monitored, and pain was assessed by verbal numeric score within 24 hours postoperatively. Time to extubation, time to discharge from the postanesthesia care unit and postoperative complications were recorded.

Results: Hemodynamic parameters were more stable in the FICB + LMA group than in the control group during anesthesia induction ($P < 0.05$). Verbal numeric score values were lower in the FICB + LMA group than in the control group at 2–8 hours postoperatively ($P > 0.05$). Compared with the control group, the time to extubation and time to discharge from postanesthesia care unit were shorter in the FICB + LMA group ($P < 0.05$). Additionally, postoperative complications were less in the FICB + LMA group.

Conclusion: The FICB combined with general LMA anesthesia may provide intra- and postoperative analgesia, shorten emergence time and reduce postoperative agitation in children undergoing femoral surgery.

Trial registration: This study is registered at <http://www.chictr.org.cn> (registration number: ChiCTR-IOR-17012725).

Keywords: analgesia, iliaca compartment block, laryngeal mask airway, children

Introduction

Pain or discomfort is the main reason for emergence agitation. Analgesic strategies such as femoral nerve block, lumbar plexus nerve block, spinal anesthesia and epidural anesthesia have been proposed for lower limb surgery. Each of these methods has its limitations which may include femoral nerve injury, hematoma, post-dural puncture headache and so on. With the development of peripheral nerve block technique, FICB has been widely used for postoperative analgesia in patients undergoing hip, femoral bone and knee surgical procedures.^{1–3} FICB was first introduced by Dalens et al in 1989.⁴ This regional block technique was used to block the lateral femoral cutaneous

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nerve of the thigh and the obturator nerve with a high level of safety and success.^{2,3}

LMA has been widely used for ventilation during general anesthesia, and it has lower incidence of postoperative airway-connected complications.^{5–9} However, there are few clinical studies of FICB combined with general LMA anesthesia. In this study, we investigated the effect of FICB combined with general LMA anesthesia in children undergoing femoral fracture surgery.

Materials and methods

Clinical materials

This study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee (Chairman Prof Yin X) of Jiaying Women and Children's Hospital on 5 January 2017, and informed consent was signed by each child's guardian (<http://www.chictr.org.cn>; registration number: ChiCTR-IOR-17012725). From January 2017 to August 2017, 80 children undergoing femoral fracture surgery (a proximal or mid-shaft fracture) with the American Society of Anesthesiologists (ASA) I–II status, age 7–12 years and weight 20–40 kg were enrolled. The children were randomly divided into FICB + LMA group and control group (n=40) by computer-generated random number list. The FICB + LMA group received FICB combined with general LMA anesthesia, and the control group received tracheal intubation general anesthesia. Children with serious cardiopulmonary disease, expected operation duration of more than 2 hours and BMI more than 26 kg/m² were excluded.

Anesthesia protocol

All children were premedicated with midazolam syrup (Enhua Pharmaceutical Co. Ltd., Jiangsu, China) 0.4 mg/kg 30 minutes before entering the operating room. Upon arrival in the operating room, monitoring including electrocardiogram, noninvasive SBP, DBP, HR and pulse oxygen saturation was applied with anesthetic monitor and venous access was established. After preoxygenation, anesthesia was induced by intravenous fentanyl 3 µg/kg, propofol 2.5 mg/kg and cis-atracurium 0.15 mg/kg. The lungs were mechanically ventilated with pressure-controlled ventilation mode after tracheal intubation or insertion of LMA (classical type II; Tuoren, Henan, China) in both groups. Subsequently, FICB was performed with 0.3% ropivacaine (AstraZeneca, Cambridge, UK) 0.5 mL/kg under ultrasound guide in FICB + LMA group. Respiratory parameters were set as follows: airway pressure, 12–15 cm H₂O; respiratory rate, 15–20 breaths/min; positive end-expiratory pressure, 0; oxygen flow, 1 L/min; fraction of inspired oxygen,

0.5; and inspiratory/expiratory (I:E) ratio, 1:2. The respiratory rate or airway pressure was adjusted to maintain end-tidal CO₂ partial pressure between 35 and 45 mmHg.

Anesthesia was maintained with 50% nitrous oxide and 2%–3% end-tidal sevoflurane to control the hemodynamic response to the surgical procedure within a 20% range of the baseline value and keep the bispectral index value between 45 and 55. Cis-atracurium (0.1 mg/kg/h) was infused continuously to maintain a train-of-four stimulation value of less than 5% in both groups. SBP, DBP and HR were recorded at 5 minutes before anesthesia induction (T0), immediately after endotracheal intubation or insertion of LMA (T1), skin incision (T2), 30 minutes after initiation of operation (T3) and at the end of surgery (T4). Arterial blood gases were analyzed using a blood gas analyzer at 1 hour after the beginning of mechanical ventilation. Pain was assessed using a VNS ranging from 0 to 10 (0= no pain; 10= maximum imaginable pain) at 2, 4, 8, 10 and 24 hours postoperatively. The time to extubation or time to removal of the LMA and time to discharge from PACU were also recorded. Emergence time was defined as the time from the end of surgery to leaving PACU. The child was discharged from PACU when the modified Aldrete score was appropriate (score ≥9).¹⁰ Side effects were observed, such as sore throat, postoperative agitation, hypoxemia and other pulmonary complications.

All the children were transferred to PACU when operation was finished. The endotracheal tube or LMA was removed when spontaneous breath was recovered, tidal volume was more than 6 mL/kg, respiratory frequency was less than 30 times/min and pulse oxygen saturation was greater than 94% without oxygen. Throughout the study period, lactated Ringer's solution was infused at a rate of 5–6 mL/kg/h.

Statistical methods

As the primary outcome was the emergence agitation, 37 samples were needed in each group. Data analysis was performed using the statistical software package SPSS 17.0 (SPSS Inc., Chicago, IL, USA). Comparisons between the two groups were analyzed by Student's *t*-test or repeated measures ANOVA for normally distributed data and Mann–Whitney *U*-test for non-normally distributed data. Categorical variables were evaluated with the chi-squared test. The quantitative parameters were presented as mean ± SD. Significance was considered at *P*<0.05.

Results

Eighty-two patients were enrolled in the study, with two not meeting the inclusion criteria (Figure 1). There were no

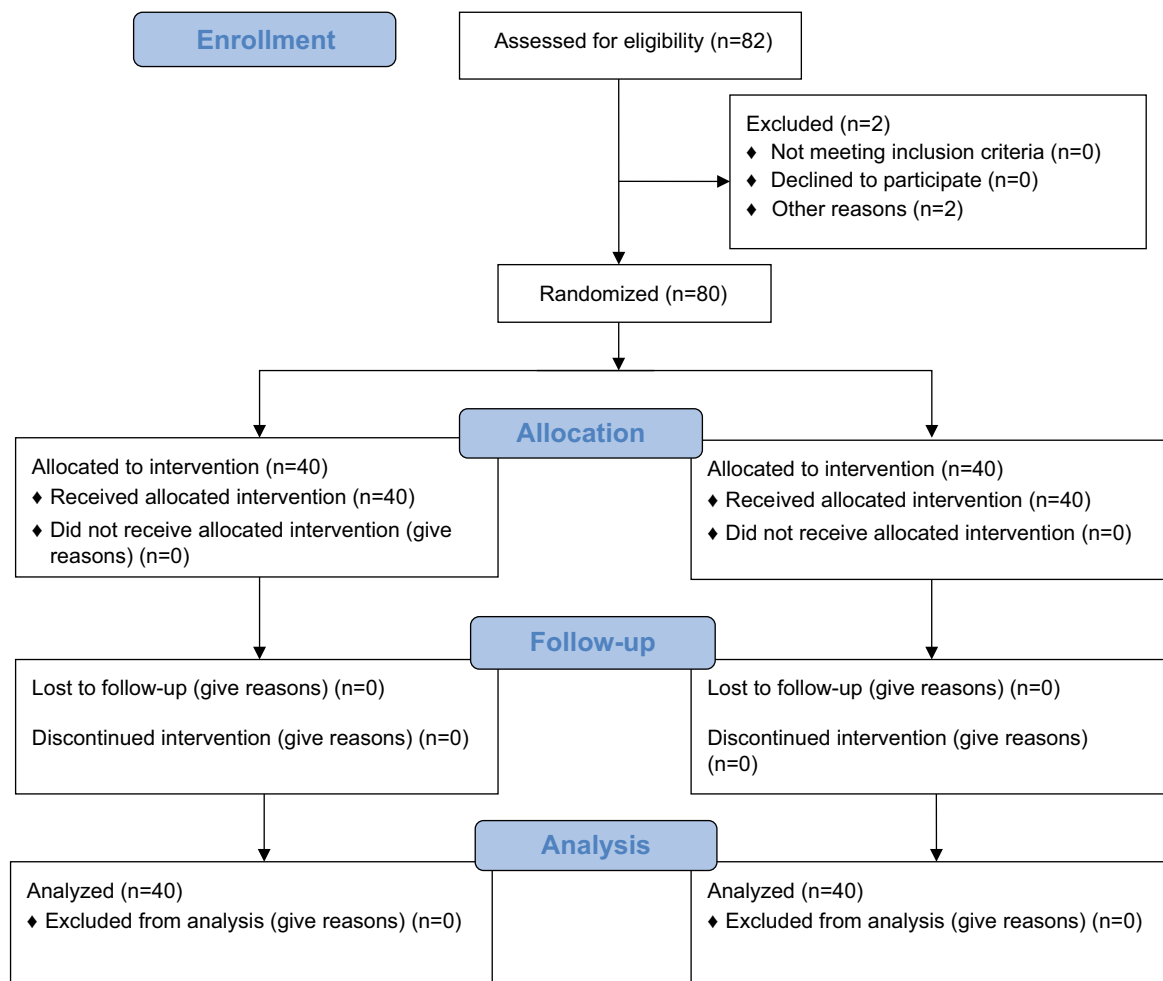


Figure 1 CONSORT 2010 flow diagram.

significant differences in terms of age, gender, BMI, duration of operation and intraoperative pH between the two groups ($P>0.05$; Table 1).

The SBP, DBP and HR were lower in the FICB + LMA group than in the control group at T1, T2 and T3. There were significant differences in SBP, DBP and HR between the two groups at T1, T2 and T3 ($P<0.05$), but no significant differences at T4 ($P>0.05$; Figure 2).

The time to extubation or time to removal of LMA and time to discharge from PACU were significantly shorter in the FICB + LMA group than in the control group; there were significant differences between the groups (Table 1).

The VNS values were lower in the FICB + LMA group than in the control group within the postoperative 6 hours. There were significant differences between the groups, but the VNS values were similar between the groups at the postoperative 8 hours. The postoperative VNS values were more than 5 in both groups at time points of postoperative 8 hours (Figure 3).

There were two cases of sore throat, one case of postoperative agitation and no other complication in the FICB + LMA group. There were six cases of sore throat and seven cases of postoperative agitation and no other complications in the control group. The incidence of emergence agitation and sore throat was lower in the FICB + LMA group than in the control group. Postoperative hypoxemia and other respiratory complications were not observed in both groups during the study period. There were no complications related to FICB.

Discussion

It is difficult to achieve a perfect analgesic effect in lower limb surgery using a single peripheral nerve block because lower limb has multiple nerves distributed to this region. However, the success rate of FICB was high in lower limb surgery. We found that the FICB combined with general anesthesia using LMA could stabilize hemodynamic parameters, shorten emergence time and reduce the incidence of emergence agitation without additional side effects in children undergoing femoral surgery.

Table 1 Data of children

Index	FICB + LMA group	Control group	P-value
Age (years)	8.7±2.2	8.4±1.7	0.498
BMI (kg/m ²)	23.8±3.4	25.3±4.2	0.087
Gender (M/F)	28/12	24/16	0.385
Duration of anesthesia (minutes)	98.3±24.2	95.2±22.7	0.326
Duration of surgery (minutes)	92.8±23.6	86.5±21.8	0.241
pH	7.49±0.06	7.47±0.05	0.113
Time to discharge from PACU (minutes)	32.2±4.6	40.5±7.8	<0.001
Time to extubation (minutes)	6.5±2.4	8.7±3.2	<0.001
Emergence time (minutes)	39.1±6.2	48.7±7.5	<0.001
Consumption of fentanyl (µg)	92.5±8.2	116.2±15.1	<0.001
Emergence agitation (n)	1	7	0.025
Sore throat (n)	2	6	0.142
Hypoxemia (n)	0	0	1

Note: Data are expressed as mean ± SD or number.

Abbreviations: BMI, body mass index; FICB, fascia iliaca compartment block; LMA, laryngeal mask airway; PACU, postanesthesia care unit.

The SBP, DBP and HR fluctuated sharply after endotracheal intubation in the control group, but the hemodynamic parameters were relatively stable in the FICB + LMA group. Insertion of the LMA had little effect on throat irritation, and almost no effect on hemodynamic parameters. The blood pressure was more stable in the FICB + LMA group at T2 and T3 during surgery because the lateral femoral cutaneous nerve of the thigh and the obturator nerve were blocked and FICB effectively alleviated pain in the surgical incision area. There were significant differences in SBP, DBP and HR at T2 and T3 during surgery between the groups, which were attributed to the multi-nerve block in lower limb.

There were no significant differences in VNS values at 8 hours postoperatively between the two groups. The VNS values were more than 5 in both groups at 8 hours postoperatively, but VNS values within the postoperative 6 hours were below 5 in the FICB + LMA group, indicating that FICB could maintain long-term effective analgesia. The duration of FICB in our study was similar to that of a study by Høgh et al,¹¹ However, our finding was not consistent with the studies by Kumie et al and Yun et al.^{1,12} In these studies, VNS values in the study group were lower than the control group during 24 hours postoperatively. This difference may be due to the severity of postoperative pain caused by differences in genetics and cultural and social factors.^{13,14} In addition, the tolerance for pain is known to be poor in children.

VNS values were lower in the FICB + LMA group than in the control group within the postoperative 8 hours, but the VNS values were similar between the groups after postoperative 8 hours, because the analgesic effects of FICB gradually disappeared in the FICB + LMA group, indicating that the FICB provided lasting analgesia for patients during the intraoperative and postoperative period. Our study showed that incidence of emergence agitation was lower in the FICB + LMA group than in the control group. There are many reasons for emergence agitation which can include use of inhalation anesthetics, rapid recovery, type of surgical procedure, postoperative pain, hypoxia and airway obstruction. Postoperative pain or discomfort is the main reason for emergence agitation. Since LMA causes only very little throat irritation, children easily tolerated LMA and emergence agitation decreased during emergence. Therefore, LMA can reduce emergence agitation for general anesthesia in children undergoing femoral fracture surgery.

The time to removal of LMA and time to discharge from PACU were shorter in the FICB + LMA group than in the control group because the consumption of fentanyl was reduced during operation when FICB was combined with general anesthesia. The incidence of emergence agitation and sore throat was lower in the FICB + LMA group than in the control group. There were no complications related to FICB because the needle puncture site for FICB was not located near the blood vessels or the femoral nerve. Thus, accidental vascular and nerve injury were very low,¹⁵⁻¹⁷ especially under ultrasound guidance.

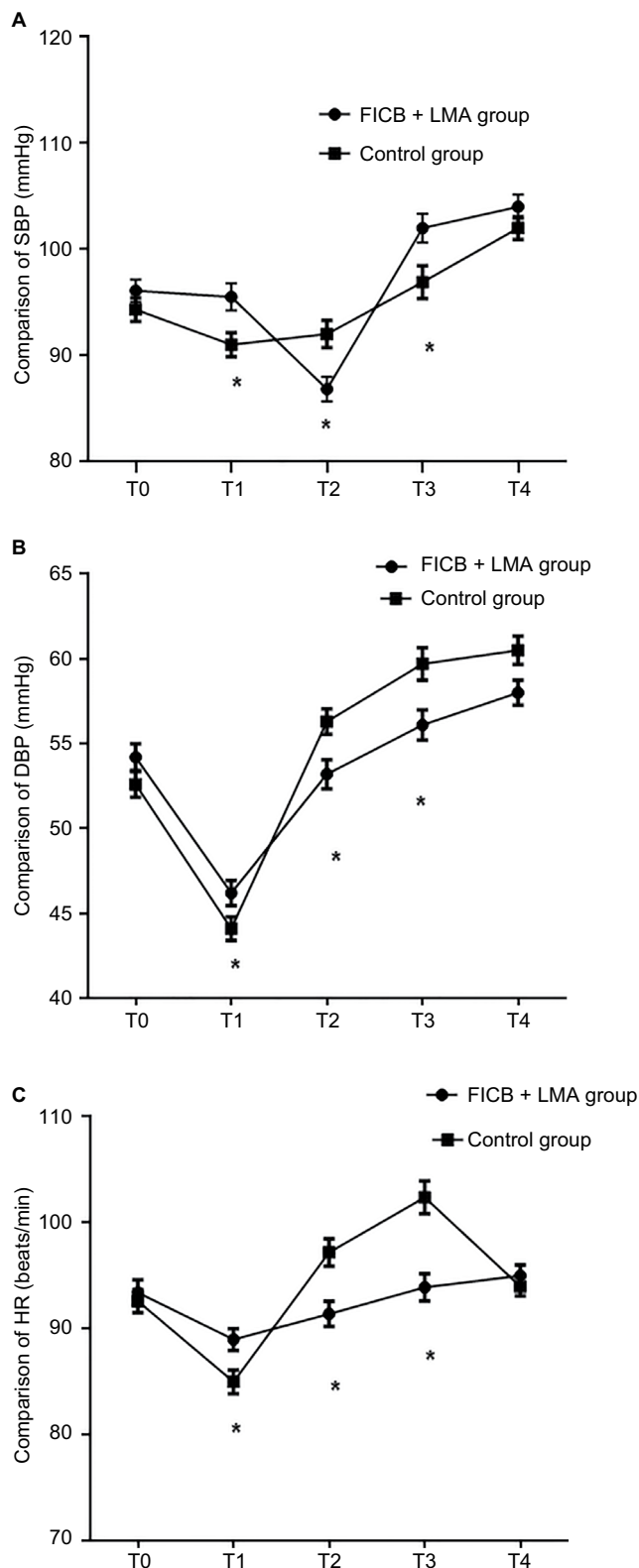


Figure 2 Comparison of hemodynamic parameters. (A) Comparison of systolic blood pressure; (B) Comparison of diastolic blood pressure; (C) Comparison of heart rate.

Note: * $P < 0.05$ compared with the control group. T0: at 5 minutes before anesthesia induction; T1: immediately after tracheal intubation or insertion of LMA; T2: skin incision; T3: 30 minutes after initiation of operation; and T4: at the end of surgery. **Abbreviations:** FICB, fascia iliaca compartment block; HR, heart rate; LMA, laryngeal mask airway.

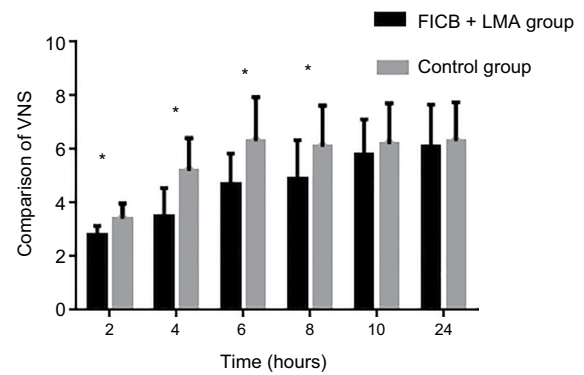


Figure 3 Comparison of postoperative VNS values.

Notes: * $P < 0.05$ compared with the control group.

Abbreviations: FICB, fascia iliaca compartment block; LMA, laryngeal mask airway; VNS, verbal numeric score.

Limitations

This study has some limitations. First, we did not accurately evaluate the VNS values in children aged from 6 to 12 years. In addition, as FICB was performed under ultrasound guidance, the success rate was approximately 90%, but there was some inadequate block in FICB.

Conclusion

In summary, FICB combined with general LMA anesthesia may provide intra- and postoperative analgesia, shorten emergence time and reduce postoperative agitation in children undergoing femoral surgery.

Abbreviations

BMI, body mass index; FICB, fascia iliaca compartment block; HR, heart rate; LMA, laryngeal mask airway; PACU, postanesthesia care unit; VNS, verbal numeric score

Data sharing

The authors will allow sharing participant data, such as pain scores and Ramsay sedation scores. No other study-related documents will be available. The data will be accessible 6 months after publication. The documents will be available at <http://www.163.com>.

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Author contributions

Z Wang acquired the data. HY Zhong and XB Deng drafted the manuscript. All authors contributed to data analysis, drafting or revising the article, gave final approval of the

version to be published, and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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