Effect of subarachnoid anesthesia combined with propofol target-controlled infusion on blood loss and transfusion for posterior total hip arthroplasty in elderly patients

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Abstract

Background: Intravertebral and general anesthesia (GA) are two main anesthesia approaches but both have defects. This study was aimed to evaluate the effect of subarachnoid anesthesia combined with propofol target-controlled infusion (TCI) on blood loss and transfusion for total hip arthroplasty (THA) in elderly patients in comparison with combined spinal-epidural anesthesia (CSEA) or GA.

Methods: Totally, 240 patients (aged ≥65 years, American Society of Anesthesiologists [ASA] I–III) scheduled for posterior THA were enrolled from September 1st, 2017 to March 1st, 2018. All cases were randomly divided into three groups to receive CSEA (group C, $n = 80$), GA (group G, $n = 80$), or subarachnoid anesthesia and propofol TCI (group T, $n = 80$), respectively. Primary outcomes measured were intra-operative blood loss, autologous and allogeneic blood transfusion, mean arterial pressure at different time points, length of stay in post-anesthesia care unit (PACU), length of hospital stay, and patient satisfaction degree. Furthermore, post-operative pain scores and complications were also observed. The difference of quantitative index between groups were analyzed by one-way analysis of variance, repeated measurement generalized linear model, Student-Newman-Keuls test or rank-sum test, while ratio index was analyzed by Chi-square test or Fisher exact test.

Results: Basic characteristics were comparable among the three groups. Intra-operative blood loss in group T (331.53 ± 64.33 mL) and group G (308.03 ± 64.90 mL) were significantly less than group C (455.40 ± 120.48 mL, $F = 65.80$, $P < 0.001$). Similarly, the autologous transfusion of group T (130.99 ± 30.36 mL) and group G (124.09 ± 24.34 mL) were also markedly less than group C (178.31 ± 48.68 mL, $F = 52.99$, $P < 0.001$). The allogenetic blood transfusion of group C (0 [0, 100.00]) was also significantly larger than group T (0) and group G (0) ($Z = 2.47$, $P = 0.047$). Except for the baseline, there were significant differences in mean arterial blood pressures before operation ($F = 496.84$, $P < 0.001$), 10-min after the beginning of operation ($F = 351.43$, $P < 0.001$), 30-min after the beginning of operation ($F = 559.89$, $P < 0.001$), 50-min after the beginning of operation ($F = 374.74$, $P < 0.001$), and at the end of operation ($F = 26.14$, $P < 0.001$) among the three groups. Length of stay in PACU of group T (9.41 ± 1.19 min) was comparable with group C (8.83 ± 1.26 min), and both were significantly shorter than group G (16.55 ± 3.10 min, $F = 352.50$, $P < 0.001$). There were no significant differences among the three groups in terms of length of hospitalization and post-operative visual analog scale scores. Patient satisfaction degree of group T (77/80) was significantly higher than group C (66/80, $\chi^2 = 7.96$, $P = 0.004$) and G (69/80, $\chi^2 = 5.01$, $P = 0.025$). One patient complained of post-dural puncture headache and two complained of low back pain in group C, while none in group T. Incidence of post-operative nausea and vomiting in group G (10/80) was significantly higher than group T (3/80, $\chi^2 = 4.10$, $P = 0.043$) and group C (2/80, $\chi^2 = 5.76$, $P = 0.016$). No deep vein thrombosis or delayed post-operative functional exercise was detected.

Conclusions: Single subarachnoid anesthesia combined with propofol TCI seems to perform better than CSEA and GA for posterior THA in elderly patients, with less blood loss and peri-operative transfusion, higher patient satisfaction degree and fewer complications.

Trial registration: chictr.org.cn: ChiCTR-IPR-17013461; http://www.chictr.org.cn/showproj.aspx?proj=23024.

Keywords: Total hip arthroplasty; Subarachnoid anesthesia; Target-controlled infusion; Combined spinal-epidural anesthesia; General anesthesia

Introduction

Posterior total hip arthroplasty (THA) has become one of the most common approaches used in hip surgery, especially among elderly patients.[1] THA is a sophisticated surgical procedure associated with relatively a large amount of blood loss and transfusion. Therefore, controlled hypotension is

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usually required to reduce intra-operative bleeding and provide a clear surgical area.[2]

At present, intravertebral and general anesthesia (GA) are two main anesthesia techniques. Intravertebral anesthesia can provide sufficient analgesia, evade airway manipulation, alleviate complications of GA, and allow continuous communication with patient throughout the whole operation.[3,4] However, it is commonly accompanied with hemorrhage. Sedatives may somewhat lower blood loss, but the control of blood pressure is usually unsatisfactory. Patients may also suffer from post-dural puncture headache (PDPH) and low back pain (LBP), which was mainly caused by epidural puncture needle and local inflammation. Furthermore, spinal anesthesia increases the risk of venous thromboembolism.[5] GA can produce ideal muscle relaxation and facilitate controlled hypotension. But excessive opioids and multifarious anesthetics may prolong recovery process and cause diverse complications, such as drastic hemodynamic fluctuations, cardiac overload, respiratory depression, post-operative nausea and vomiting (PONV), and cognitive dysfunction.[6-8] Hypotensive GA, often managed by combination of deep anesthesia and various agents, usually means increased dose of anesthetic and risk of consequent cerebral hypoperfusion, cardiovascular, respiratory, and renal depression, particularly in fragile and elderly patients.[9,10] However, it is still early to conclude that intravertebral anesthesia is superior to GA and the choice remains controversial.[11]

Target-controlled infusion (TCI) is an easily-performed system for controlling intravenous infusion of anesthetics, analgesics, and sedatives.[12] It provides a more precise control of appropriate anesthesia depth.[13] Propofol TCI can produce a more stable sedation effect and less severe cardiovascular and respiratory depression than intermittent bolus propofol.[14] Besides those, propofol TCI has become increasingly popular due to other advantages, such as fewer hemodynamics fluctuations and reduced PONV.[15] If performed properly, it enables patients enter into a state of unconsciousness with spontaneous breathing.[16,17] Generally speaking, an experienced surgeon can complete THA surgery within 1.5 h while the duration of subarachnoid administration with ropivacaine is about 2 to 3 h, which is enough for the operation.[18] Therefore, we hypothesized that the combination of subarachnoid anesthesia and propofol TCI might be a more suitable choice for reducing blood loss and transfusion in elderly patients receiving posterior THA.

Methods

Ethical approval

This study was approved by the Ethics Committee of Beijing Jishuitan Hospital (No. 201703-23). The work has been reported in line with the Consolidated Standards of Reporting Trial Guidelines. The details were elaborated to each patient and informed consent form was signed.

Participants

Patients (≥65 years old, ASA I–III) scheduled for posterior THA in the Beijing Jishuitan Hospital were enrolled.

The inclusion criteria were: (1) an age of ≥65.0 years; (2) primary hip replacement; and (3) complete medical records.

The exclusion criteria were: (1) severe hypertension (systolic pressure ≥180 mmHg or diastolic pressure ≥110 mmHg); (2) long-term administration of non-steroidal anti-inflammatory drugs (NSAIDs) ; (3) coagulation disorders, such as abnormal prothrombin time (PT), activated partial thromboplastin time (APTT), and thrombin time; (4) low platelet count ($<100 \times 10^9$/L); (5) history of deep vein thrombosis (DVT) or pulmonary embolism; (6) hematological disorder; (7) peripheral vascular disease, such as Klippel-Trenaunay (K-T) syndrome and anemia; and (8) ankylosing spondylitis.

Study design

This randomized controlled trial was conducted from September 1st, 2017 to March 1st, 2018 and 240 patients were enrolled finally. Every patient selected a number randomly from a random number table. The random number was divided by 3 and the case was allocated into specific group according to the remainder: group C (leaving a remainder of 1, receiving CSEA, $n = 80$), group G (leaving a remainder of 2, receiving GA, $n = 80$), and group T (without remainder, receiving single subarachnoid anesthesia combined with propofol TCI, $n = 80$).

Calculating sample size

Sample size was estimated by measuring the blood loss perioperatively. In the pilot trial, blood loss in group C, G, T were respectively 450, 300, and 330 mL (standard deviation = 65 mL), with $\alpha = 0.05$, two-tailed, a power of 0.8 and 1:1:1 ratio, we need at least 74 patients in each group.

The formula was as follows:

$$n_{ij} = \frac{\left(z_{1-\alpha/2T} + z_{1-\beta}\right)^2 \times \delta^2}{d_{ij}^2}, n = \max\{n_{ij}, pair(i,j)\}$$

Surgical procedure

Non-invasive blood pressure, electrocardiogram (ECG) and pulse oximetry (SPO_2) were monitored routinely and supplemental oxygen was delivered with a face mask. A 18G intravenous insertion cannula was placed. Radial artery catheterization was performed after conducting Allen test and subcutaneous infiltration with 1% lidocaine.

Patients of group C were placed in lateral decubitus position. The L2/3 or L3/4 interspace was determined as puncture point and subcutaneously infiltrated with 1% lidocaine. Thereafter, 17G Tuohy needle was pushed slowly via the midline approach until epidural space. Then 27G pencil-point subarachnoid puncture needle was inserted through Tuohy needle. The characteristic "pop" indicated spinal needle punctured the dura. After visualization of cerebrospinal fluid (CSF), 2.5 mL of 0.5% ropivacaine was injected with repeated aspiration. Following removal of spinal needle, a 20G epidural catheter

was inserted 3 to 5 cm into the space between spinal cord and outer membrane and fixed. Patients breathed spontaneously. If sedation was required, 2 mg midazolam was superadded and vital signs were closely monitored. Once puncture attempt failed, GA was conducted and the case was excluded.

Total intravenous anesthesia was performed in group G. Anesthesia induction was conducted with midazolam (2 mg), sulfentanyl (15 μg), propofol (1.3 mg/kg), and rocuronium (50 mg). Thereafter, a tracheal tube (Covidien llc, 7.0# for woman and 7.5# for man) was inserted. Anesthesia was maintained with continuous infusion of propofol (4–12 $mg \cdot kg^{-1} \cdot h^{-1}$) and remifentanil (0.2–0.25 $\mu g \cdot kg^{-1} \cdot min^{-1}$). Pumping speed was modulated with bispectral index (40–60) and intra-operative vital signs. Volume ventilation was controlled to maintain the pressure of end-tidal CO_2 ($ETCO_2$) between 35 and 45 mmHg. Controlled hypotension was performed with continuous injection of esmolol and intermittent administration of isosorbide dinitrate and the intra-operative mean arterial pressure (MAP) was controlled 30% reduction of baseline level.[19] Reduced the dosage of esmolol and isosorbide dinitrate and injected with 6 mg ephedrine if hypopiesia occurred (MAP <60 mmHg) or 0.5 mg atropine if bradycardia occurred (heart rate <50 beats/min). If there was no improvement, then removed the vasoactive medications. Nasal temperature was maintained at 36.0 to 37.0°C.

For group T, 1% lidocaine was subcutaneously infiltrated and single subarachnoid anesthesia was performed with 27G pencil-point spinal needle. Spinal needle was pushed via the midline approach until a slight loss of resistance. Thereafter, stylet was removed and tip was filled with CSF. Then 2.5 mL 0.5% ropivacaine was injected slowly into subarachnoid space. In case no CSF outflowed, aspiration with a syringe or a further advancement of spinal needle might be helpful. If CSF discharged, ropivacaine was given. Once failed, CSEA or GA was conducted and the case was excluded. Thereafter, patients were placed in lateral position with head leaned back and propofol TCI was performed with a TCI pump (CP-700TCI). Initial target concentration was set to 1.0 μg/mL and increased by 0.1 μg/mL every 2 min till patients lost consciousness. The target concentration was titrated based on anesthesia depth. Once hypopiesia (MAP <60 mmHg) occurred, 6 to 12 mg ephedrine was administrated. Once respiratory depression happened, manually assisted ventilation was performed and the target concentration was lowered. If necessary, oropharyngeal airway was inserted. If it did not work, propofol TCI was halted and the case was excluded.

The operation was performed immediately after anesthesia completed. Intra-operative fluid therapy was administrated with 6% hydroxyethyl starch and Ringer solution. Autologous blood recovery equipment (Cell Saver 5+, Hemonetics Corp., Braintree, MA, USA) was used routinely. Vasoactive agents, such as ephedrine and noradrenaline, were used as necessary. All patients were sent into post-anesthesia care unit (PACU) and discharged from recovery area until vital signs were stable. For post-operative analgesia, combination of ultrasound-guided lumbar plexus block with 20 mL 0.5% ropivacaine (mixed with 5 mg of dexamethasone) and patient-controlled analgesia infusion pump filled with 2.0 μg/kg sufentanil and 10 mg tropisetron hydrochloride was used. If needed, NSAIDs or morphine were given [Supplementary Video, http://links.lww.com/CM9/A178].

Measurement

General data including sex, age, height, weight, body mass index (BMI), anesthesia duration, and operation duration were recorded. The primary endpoints were intra-operative blood loss, autologous and allogeneic blood transfusion, MAPs at different time points. The blood loss was the sum of blood volumes from surgical field suction, autotransfusion system reservoirs and weighing sponges from the operative field.[20] The uniform transfusion threshold for allogeneic blood transfusion was 80 g/L.[21] Frozen fresh plasma (FFP) was infused according to the British Committee for Standards in Haematology guidelines and the coagulation function check results. FFP was administrated at least one of the following criteria was matched: (a) PT greater than 1.5 times the mid-point of the normal range; (b) APTT greater than 1.5 times the top of the normal range.[22] The secondary endpoints were length of stay in PACU, length of hospitalization, patient satisfaction degree. Besides, pain scores and complications, such as PDPH and LBP, PONV, throat discomfort, DVT, and delayed post-operative functional exercise, were also verbally questioned and recorded.

Statistical analysis

Statistical analysis was performed with SPSS software 17.0 (SPSS, Chicago, IL, USA). Normally distributed data were presented as mean ± standard deviation and analyzed by one-way analysis of variance, while non-normally distributed data were analyzed by rank-sum test. The difference of sex ratio among the three groups was analyzed by Chi-square test. Repeated measurement generalized linear model and Student-Newman-Keuls test were applied for analysis the MAPs of various time. Fisher exact test was conducted to analyze the differences of PDPH, LBP, PONV, throat discomfort, DVT, and delayed post-operative functional exercise between three groups. $P < 0.05$ was considered as statistically significant.

Results

General information

Of the 259 patients meeting the inclusion and exclusion criteria from September 1st, 2017 to March 1st, 2018, four patients declined to participate later, nine were diagnosed as severe hypertension (systolic pressure ≥180 mmHg or diastolic pressure ≥110 mmHg) and six were excluded because of incomplete medical records. Finally, 240 patients were enrolled and basic characteristics of each group were detailed in Table 1. Age, gender ratio, height, weight, BMI, and operation duration were comparable among the three groups ($P > 0.05$) [Table 1].

Table 1: Basic characteristics of various group patients.

Group	Age (years)	Male	Height (cm)	Weight (kg)	BMI (kg/m^2)	Operation duration (min)
Group C ($n = 80$)	75.6 ± 5.5	35 (43.75)	164.5 ± 7.9	69.7 ± 7.5	24.8 ± 3.5	71.4 ± 8.6
Group G ($n = 80$)	75.4 ± 5.6	37 (46.25)	167.3 ± 8.2	70.5 ± 9.6	25.1 ± 4.2	72.8 ± 7.6
Group T ($n = 80$)	75.0 ± 5.2	41 (51.25)	165.8 ± 7.1	72.1 ± 5.2	25.4 ± 4.2	71.7 ± 6.8
Statistics	0.23*	0.94†	2.06	1.25	0.45*	0.77*
P	0.791	0.626	0.076	0.132	0.636	0.462

Data were presented as n (%) or mean ± standard deviation, respectively. The differences of quantitative indexes among the three groups were analyzed by one-way analysis of variance (ANOVA). * $P < 0.05$ indicates the F statistics value, while ratio index was analyzed by Chi-square test. † $P < 0.05$ indicates the χ^2 statistics value. BMI: Body mass index; Group C: Combined spinal-epidural anesthesia (CSEA); Group G: General anesthesia (GA); Group T: Propofol target-controlled infusion (TCI).

Table 2: Peri-operative blood loss and transfusion among the three groups.

Group	Intra-operative blood loss (mL)	Autologous blood transfusion (mL)	Allogenetic blood transfusion (mL)
Group C ($n = 80$)	455.40 ± 120.48	178.31 ± 48.68	0 (0,100.0)
Group G ($n = 80$)	308.03 ± 64.90	124.09 ± 24.34	0
Group T ($n = 80$)	331.53 ± 64.33	130.99 ± 31.36	0
Statistics	65.80*	52.99*	2.47†
P	<0.001	<0.001	0.047

Data were presented as mean ± standard deviation and median (quartile), respectively. The differences of normally distributed data among the three groups were analyzed by one-way analysis of variance (ANOVA). * $P < 0.05$ indicates the F statistics value, while normally distributed data were analyzed by rank-sum test. † $P < 0.05$ indicates the Z statistics value. Group C: Combined spinal-epidural anesthesia (CSEA); Group G: General anesthesia (GA); Group T: Propofol target-controlled infusion (TCI).

Comparison of intra-operative blood loss and transfusion data

Intra-operative blood loss in group C (455.40 ± 120.48 mL) was significantly larger than group G (308.03 ± 64.90 mL) and group T (331.53 ± 64.33 mL, $F = 65.80$, $P < 0.001$), while there was no significant difference between group G and group C. Similarly, the autologous blood transfusion in group T (130.99 ± 31.36 mL) and group G (124.09 ± 24.34 mL) were comparable but both were markedly less than group C (178.31 ± 48.68 mL, $F = 52.99$, $P < 0.001$). The allogenetic blood transfusion of group C ([0, 100.00]) was also significantly larger than group T (0) and group G (0) ($Z = 2.47$, $P = 0.047$) [Table 2].

Comparison of intra-operative blood pressures

The baseline MAP among the three groups were comparable. There were significant differences in MAPs before operation among the three groups ($F = 496.84$, $P < 0.001$). MAP of group C (97.16 ± 9.12 mmHg) was significantly higher than group G (65.44 ± 5.78 mmHg, $P < 0.001$) and group T (69.18 ± 5.34 mmHg, $P < 0.001$). MAP in group G was markedly lower than group T ($P = 0.001$). At 10 min after the beginning of operation, significant differences were detected among the three groups ($F = 351.43$, $P < 0.001$), while there were also significant differences between group C (97.10 ± 10.06 mmHg), group G (72.81 ± 6.98 mmHg), and group T (65.98 ± 5.73 mmHg) when they were inter-compared ($P < 0.001$). At 30 min after the beginning of operation, there were significant differences among group C (101.54 ± 7.92 mmHg), group G (76.64 ± 7.40 mmHg), and group T (63.29 ± 6.64 mmHg, $F = 559.89$, $P < 0.001$), and significant differences were also found when they were inter-compared ($P < 0.001$). Likewise, there were also significant differences among group C (102.30 ± 6.81 mmHg), group G (88.46 ± 8.83 mmHg), and group T (69.24 ± 7.23 mmHg, $F = 374.74$, $P < 0.001$). At 50 min after the beginning of operation, and significant differences were also found when they were compared with each other ($P < 0.001$). At the end of operation, significant differences were detected among the three groups ($F = 26.14$, $P < 0.001$). The MAPs of group C (107.14 ± 8.44 mmHg) and group G (109.49 ± 7.12 mmHg) were similar, both were significantly higher than group T (101.00 ± 7.37 mmHg, $P < 0.001$) [Table 3 and Figure 1].

Comparison of length of stay in PACU, visual analog scale (VAS), and hospitalization

Length of stay in PACU of group T (9.41 ± 1.19 min) was comparable with group C (8.83 ± 1.26 min), and both were significantly shorter than group G (16.55 ± 3.10 min, $F = 352.50$, $P < 0.001$). Referring to post-operative VAS scores and length of hospitalization, no significant differences were detected among the three groups [Table 4].

Comparison of patient satisfaction and complications

Patient satisfaction degree of group T (77/80) was higher than group C (66/80, $\chi^2 = 7.96$, $P = 0.004$) and G (69/80, $\chi^2 = 5.01$, $P = 0.025$). One patient complained of PDPH and two complained of LBP in group C, while none in group T. Incidence of PONV in group G (10/80) was higher than group T (3/80, $\chi^2 = 4.10$, $P = 0.043$) and

Table 3: MAPs of various groups at different time points during peri-operative period.

Group	Baseline	Before	10 min	30 min	50 min	End
Group C ($n = 80$)	101.49 ± 9.64	97.16 ± 9.12	97.10 ± 10.06	101.54 ± 7.92	102.30 ± 6.81	107.14 ± 8.44
Group G ($n = 80$)	101.45 ± 9.44	65.44 ± 5.78*	72.81 ± 6.98*	76.64 ± 7.40*	88.46 ± 8.83*	109.49 ± 7.12
Group T ($n = 80$)	98.78 ± 9.90	69.18 ± 5.34†,‡	65.98 ± 5.73†,§	63.29 ± 6.64†,‡	69.24 ± 7.23†,‡	101.00 ± 7.37†,‡
Statistics	2.07	496.84	351.43	559.89	374.74	26.14
P	0.128	<0.001	<0.001	<0.001	<0.001	<0.001

Data are presented as mean ± standard deviation. Repeated measurement generalized linear model (GLM) and Student-Newman-Keuls (SNK) test were applied for analysis the MAPs of various time. $^{*}P < 0.05$ indicates the difference between Group G and Group C was statistical significant. $^{\dagger}P < 0.05$ indicates the difference between Group G and Group T was statistical significant. $^{\ddagger}P < 0.05$ indicates the difference between Group T and Group C was statistical significance. MAP: Mean arterial pressure; Group C: Combined spinal-epidural anesthesia (CSEA); Group G: General anesthesia (GA); Group T: Propofol target-controlled infusion (TCI).

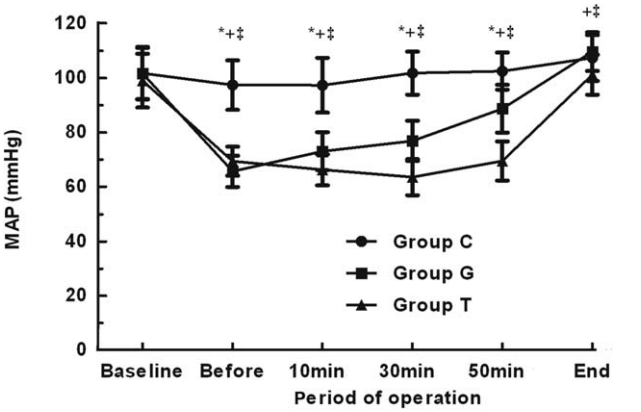

Figure 1: Comparison of MAP at different time points during peri-operative period among the three groups. The baseline MAPs in three groups were comparable. Before and during operation, MAPs of group C (combined spinal-epidural anesthesia) were significantly higher than group G (general anesthesia) and group T (propofol TCI). 10, 30, and 50-min after the beginning of operation and at the end of operation, MAPs in group G were higher than group T. $^{*}P < 0.05$, group C *vs.* group G; $^{\dagger}P < 0.05$, group C *vs.* group T, $^{\ddagger}P < 0.05$, group G *vs.* group T. CSEA: Combined spinal-epidural anesthesia; MAP: Mean arterial pressure; TCI: Target-controlled infusion.

group C (2/80, $\chi^2 = 5.76$, $P = 0.016$). Eleven patients in group G complained of throat discomfort. No DVT or delayed post-operative functional exercise was detected in all cases [Table 5].

Discussion

This randomized controlled study was designed to evaluate the effect of single subarachnoid anesthesia combined with propofol TCI in elderly patients receiving posterior THA. We found that subarachnoid anesthesia combined with propofol TCI performed better in reducing peri-operative blood loss, shortening the duration in PACU, and improving patient satisfaction degree, with less related complications compared to CSEA and GA.

Intra-operative blood loss and autologous transfusion, as well as peri-operative allogeneic blood requirement, were all larger in patients receiving CSEA, which maybe due to higher intra-operative MAP, as no controlled hypotension was performed. Hypotensive epidural anesthesia (HEA) is often managed to decrease intra-operative bleeding in THA.[2,23] However, HEA displays poor stability and

Table 4: Indexes of length of stay in PACU, hospitalization, and VAS.

Group	Length of stay in PACU (min)	VAS	Hospitalization (days)
Group C ($n = 80$)	8.83 ± 1.26	3.36 ± 1.16	4.13 ± 1.10
Group G ($n = 80$)	16.55 ± 3.10*	3.50 ± 1.40	4.28 ± 0.88
Group T ($n = 80$)	9.41 ± 1.19†	3.44 ± 1.31	4.20 ± 0.95
Statistics	352.50	0.23	0.49
P	<0.001	0.797	0.616

Data were presented as mean ± standard deviation. The quantitative indexes were analyzed by one-way analysis of variance (ANOVA). $^{*}P < 0.05$ indicates the difference between Group C and Group G was statistical significant. $^{\dagger}P < 0.05$ indicates the difference between Group G and Group T was statistical significant. PACU: Post-anesthesia care unit; VAS: Visual analog scale; Group C: Combined spinal-epidural anesthesia (CSEA); Group G: General anesthesia (GA); Group T: Propofol target-controlled infusion (TCI).

controllability because of high-dosage local anesthetic, bringing difficulty in control of dermatome. Furthermore, tissue ischemia is likely to occur in HEA.[24] Therefore, HEA is seldom employed now and CSEA is usually accompanied by massive bleeding. Interestingly, patients receiving subarachnoid anesthesia combined with propofol TCI exhibited a greater blood pressure reduction than GA. This phenomenon might be closely correlated with arterial and venous dilatation caused by sympathetic block in subarachnoid anesthesia. Moreover, deep-sleep state under propofol TCI and complete analgesia in subarachnoid anesthesia were also helpful.

By contrast, it is difficult to eliminate pain in GA totally unless excessive analgesics are used. No ganglion blocker or sodium nitroprusside application might be somewhat responsible for the higher intra-operative blood pressure. There were not PDPH or LBP in patients treated with subarachnoid anesthesia using spinal needle or under the assistance of 10 mL syringe needle (21G), while one suffered from PDPH and two complained of post-operative LBP in CSEA using 17G Tuohy needle. And this was well consistent with previous findings.[25-27] In view of that intra-operative consciousness could reduce comfort and induce panic attack, post-operative follow-up was performed. Information indicated complaints of patients in CSEA group mainly centered on emotional reactions, such as anxiety and panic. PDPH and LBP were

Table 5: Post-operative complications of various group patients.

Group	Satisfaction	PDPH	LBP	PONV	Throat discomfort	DVT	Delayed post-operative functional exercise
Group C ($n = 80$)	66 (82.5)	1 (1.3)	2 (2.5)	2 (2.5)	0	0	0
Group G ($n = 80$)	69 (86.3)	0	0	10 (12.5)[‡,§]	11 (13.8)	0	0
Group T ($n = 80$)	77 (96.3)[§,‖]	0	0	3 (3.8)	0	0	0
Statistics	7.84[*]	0.33[†]	0.11[†]	8.10[†]	0[†]	0[†]	0[†]
P	0.019	1.000	0.330	0.017	0.001	1.000	1.000

Data were presented as n (%). The ratio indexes were analyzed by Chi-square test or Fisher exact test. [*] $P < 0.05$ indicates the χ^2 statistics value and [†] $P < 0.05$ indicates the Fisher statistics value. [‡] $P < 0.05$ indicates the difference between Group G and Group C was statistically significant. [§] $P < 0.05$ indicates the difference between Group G and Group T was statistically significant. [‖] $P < 0.05$ indicates the difference between Group T and Group C was statistically significant. PDPH: Post-dural puncture headache; LBP: Low back pain; PONV: Post-operative nausea and vomiting; DVT: Deep venous thrombosis; Group C: Combined spinal-epidural anesthesia (CSEA); Group G: General anesthesia (GA); Group T: Propofol target-controlled infusion (TCI).

also reasons for lower satisfaction degree of CSEA group. Unlike CSEA, patients treated with GA mainly complained of PONV and throat discomfort. All these were not discovered in patients receiving subarachnoid anesthesia combined with propofol TCI.

Duration in PACU of GA group was longer. Ganter reported that PONV was correlated with increased length of stay in PACU.[28] In the study, patients in GA group mainly suffered PONV and throat discomfort, consistent with Ganter viewpoint. Simultaneously, various analgesics and anesthetics administrated intra-operatively, controlled hypotension, post-anesthesia awakening, and tracheal extubation process could all prolong the duration in PACU. However, patients treated with propofol TCI showed similar length in PACU as those dealt with CSEA because propofol was eliminated within only a few minutes. And all three approaches had similar VAS scores and length of hospitalization.

This study also has some limitations. First, patients in CSEA group were not sedated with continuous infusion of sedatives, which might be somewhat responsible for greater intra-operative blood pressure, blood loss and transfusion. Second, the balance between the lower MAP and poor long-term outcomes due to hypotension was not analyzed. Third, the recovery and long-term adverse events, which might be influenced by anesthesia methods, were not investigated.[29]

In conclusion, the study demonstrates that subarachnoid anesthesia combined with propofol TCI performs better than CSEA and GA for posterior THA in elderly patients, with less blood loss and transfusion, higher patient satisfaction degree, less pain and complications.

Conflicts of interest

None.

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