The effect of perineural dexamethasone on rebound pain after ropivacaine single-injection nerve block: A randomized controlled trial

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Abstract

Background Rebound pain after single shot nerve block challenges the real benefit of this technique. We aimed to investigate whether perineural dexamethasone addition decreased the incidence of rebound pain after a single shot nerve block.

Methods We randomly allocated 132 patients scheduled for open reduction, and internal fixation of upper extremity closed fracture under single-shot peripheral nerve block and sedation into two groups. Patients in the dexamethasone group receiving nerve block with 0.375% ropivacaine and 8 mg dexamethasone while those in the control group received ropivacaine only. Sixty-three cases in the dexamethasone group and 60 cases in the control group were analyzed for the incidence of rebound pain in 48 h after the block administration. The primary outcome was the incidence of rebound pain in 48 h after the block administration. Secondary outcomes included the self-reported highest NRS score, pain intensity at 8h, 12h, 24h, 48h after the block, sufentanil consumption, sleep quality on the night of surgery, patient's satisfaction to the pain therapy, blood glucose at 6h after the block, pain and paresthesia at 30 days after surgery.

Results: The incidence of rebound pain was significantly lower in the dexamethasone group (7[11.1%] of 63 patients) than that in the control group (28[48.8%] of 60 patients; Relative risk (RR) is 0.238, 95% CI 0.113-0.504,p=0.001). Dexamethasone decreased the opioid consumption in 24 h after the surgery (p<0.001), improved the sleep quality score on the night of surgery(p=0.01) and satisfaction to the pain therapy(p=0.001). Multivariate logistic regression analysis showed that only group allocation was significantly associated with the occurrence of rebound pain[OR=0.131,95%CI (0.047-0.364)].Patients in the dexamethasone group reported later onset (19.7±6.6 h vs 14.7±4.8 h since block administration, mean±SD, p<0.001) lower peak NRS score [5 (3,6) vs 8 (5,9) , median(IQR), p<0.001] compared with those in the control group.

Conclusions: Perineural administration of 8mg dexamethasone reduces rebound pain after a single-shot nerve block in patients receiving ORIF of upper limb fracture.

Trial registration: This study was registered in Chinese Clinical Trial Registry (ChiCTR-IPR-17011365). The study was registered on May 11th , 2017. Retrospectively registered.

Background

Peripheral nerve block (PNB) plays an essential role in anaesthesia and multimodal postoperative analgesia in extremity surgeries. It provides multiple benefits, including reducing opioid consumption, better early postoperative pain control and fast hospital discharge[1–3]. However, rebound pain during nerve block wears off challenges the real benefit of this technique, especially in ambulatory surgery settings[4]. For patients receiving ambulatory surgery, the rebound pain is challenging to prevent or control, especially when it happens at home, which is a common cause of unplanned readmission to hospital[5]. Initially brought out by orthopaedic surgeons, rebound pain after nerve block are gaining more

and more attention from anesthesiologists[6–8]. It has been reported after different kinds of surgeries, such as ankle fracture surgery under popliteal sciatic nerve block[9], distal radius fracture fixation under brachial plexus block[10] and shoulder arthroscopy surgery under interscalene brachial plexus block[11].Understanding the mechanism and searching for strategies to prevent rebound pain is integral to the effective utilization of regional anaesthesia.

Uncompliant bridging therapy is supposed to be the main reason for the rebound phenomenon during PNB wears off. However, based on the duration of ropivacaine or bupivacaine action, the most commonly used local anaesthetics for nerve block, there is a chance that the pain burst happens at night when the patient cannot take bridging medicine beforehand. Continuous infusion of local anaesthetics through the perineural catheter may reduce the incidence of rebound pain[12]. Nevertheless, perineural catheterization is technically challenging and has the disadvantages of possible dislocation and local infection[13]. If proved to be safe and effective, adjuvants to local anaesthetics could be a useful and economic strategy to prevent rebound pain. The effect of adjuvants to local anaesthetics on rebound pain has not yet been thoroughly investigated. Dexamethasone, as a commonly accepted adjuvant to local anaesthetics, prolongs the duration of brachial plexus block without adverse reaction[14]. An K et al. found that perineural, not systemic, dexamethasone added to a clinical concentration of bupivacaine may not only prolong the duration of sensory and motor blockade but also prevent the bupivacaine-induced reversible neurotoxicity and short-term "rebound hyperalgesia" in mouse sciatic nerve block model[15]. To our knowledge, there have been no randomized controlled studies examining the effect of dexamethasone addition on the incidence of rebound pain. We hypothesized that dexamethasone addition into ropivacaine could reduce the incidence of rebound pain after single-injection nerve block.

Methods

This single-centre, randomized, double-blind controlled study was approved by Ethics Committee of Zhongshan Hospital, Fudan University (B2016-079R). Written informed consent was obtained from patients before study enrollment by the investigator. This study followed the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline.

Participants

We enrolled patients scheduled for open reduction internal fixation (ORIF) of upper extremity closed fracture under single-shot peripheral nerve block and sedation at Zhongshan Hospital, Fudan University between November 2016 and February 2018. Inclusion criteria were age over 18 years old, ASA physical status 1 or 2 who has adequate Chinese language skills and a clear understanding of the numerical rating scale (NRS) of pain. Exclusion criteria included patient refusal, multiple injuries requiring other surgeries or pain medications, preoperative nerve injury, known allergy to ropivacaine or dexamethasone and chronic analgesic use. Patients were randomly assigned in a 1:1 ratio to one of two groups (Dex and Control groups) according to computer-generated random number table with SPSS version 23.0. This allocation was concealed using a sealed opaque envelope that was opened only after the patients were

enrolled. Regional medications were prepared by a research nurse who was not involved in the follow-up or care of the patients. Patients, anesthesiologists and outcome assessors were blinded to the group allocation. The physician in charge for generation of allocation sequence and concealment (Fang Du) was not directly implicated in treatment administration or data collection.

Application of PNB

Patients received ultrasound-guided single-shot nerve block with 0.375% ropivacaine and 8 mg dexamethasone in Dex group (n = 66) and with 0.375% ropivacaine alone in Control group (n = 66). Premedication included midazolam 1–2 mg i.v. and fentanyl 50 μg i.v. The same regional anesthetist performed the ultrasound-guided nerve block using a high-frequency linear ultrasound probe. The timing of block administration was recorded. Axillary brachial plexus and musculocutaneous nerve block were employed for ORIF of distal arm fracture. For the combined blocks, forty milliliters local anesthetic was divided into 10 ml for superficial cervical plexus block or musculocutaneous nerve block and 30 ml for the brachial plexus block. The effect of the block was evaluated based on the sense of pin-prick thirty minutes after the block.

Anesthesia

Surgeries on the upper arm were performed under combined superficial cervical plexus with interscalene or supraclavicular brachial plexus block. Standard monitoring was applied including ECG, BP, HR and SpO_2. Patients were sedated with dexmedetomidine infusion with a loading dose of $1\mu g \cdot kg^{-1}$ in 15 min and then at the rate of $0.5\ \mu g \cdot kg^{-1} \cdot h^{-1}$ till the surgeon finished the internal fixation. Tropisetron 5 mg i.v. was given at the end of the surgery for postoperative nausea and vomiting (PONV) prevention.

Postoperative analgesia protocol

Paracetamol 2 g intravenous (i.v.) drip and parecoxib 40 mg i.v. were given 30 min before the end of surgery. Postoperative multimodal analgesia included patient control intravenous analgesia (PCIA) with $2\mu g \cdot h^{-1}$ background infusion of sufentanil, 4 μg per bolus, and lockout time of 6 min as well as parecoxib 40 mg i.v. every 12 h. Patients were instructed to push the self-control button when they felt the numbness of arm was waning. Background infusion was set to maintain a stable blood concentration of sulfentanil when rebound pain broke through.

Outcomes

One of our investigators blinded to the allocation details followed the patients' pain intensity evaluated by NRS (0–10) at 8 h, 12 h, 24 h, and 48 h after the block and asked them to describe the experience when the block wore off. To avoid interrupting the patients' night sleep, if the prescheduled follow up time point fell into 9 pm-8 am, the patient recorded a pain dairy (supplement 1) when moderate or severe pain broke through. The other investigator who did not know the group allocation and was not involved in the follow-up decided whether it fit the criteria of rebound pain according to patients' descriptions. Based on our preliminary observation, we empirically define the rebound pain as severe pain (NRS > 7) which breaks out suddenly and cannot be relieved after PCIA bolus in 30 minutes; and if the pain occurs at the sleep time, it

wakes up the patients and makes them difficult to go back to sleep. A self-reported sleep questionnaire (Supplement 2) was used to investigate postoperative sleep quality, which included six yes-or-no questions. A score of 1 represents the best and the score of 6 for the worst sleep.

The primary outcome of this study was the incidence of rebound pain in 48 h after the block administration. Secondary outcomes included self-reported highest NRS score and the hours elapsed since the block administration when the worst pain happened, pain intensity at 8 h, 12 h, 24 h, 48 h after the block, sufentanil consumption in 24 h and 48 h after the block, sleep quality on the night of surgery, patient's satisfaction to the postoperative pain therapy grading from 1 (strongly unsatisfied) to 5 (strongly satisfied), blood glucose at 6 h after the block, pain and paresthesia at 30 days after surgery followed by phone call.

Statistical analysis

Sample size calculation was based on our preliminary observational results that 60% of patients suffered from severe pain (NRS≥7) after ORIF with a single shot nerve block. We assumed a 22% decrease in rebound pain incidence with the addition of dexamethasone was clinically significant. With 80% power, 61 patients in each group would be required to detect this difference at the significance level of 0.05. We recruited 132 patients with 66 per group to compensate for the potential drop out.

Statistical analysis was conducted using SPSS version 23.0 (SPSS Inc., Chicago, Illinois, USA). Continuous data are expressed as median and interquartile range unless it was verified to be a normal distribution. The level of significance was set at $p < 0.05$, and 95% confidence intervals were calculated for the primary outcome measures. We did a preliminary explanatory analysis to exam the relationship between the potential covariates with the dependent variable, rebound pain, and with the independent variable, group allocation, respectively. Mann-Whitney U test was used for the continuous variables including days after injury based on the type of the distribution; chi-square tests were used to assess the associations between the categorical covariates including surgeon, block type (single or combined approach), brachial nerve approach, use of tourniquet, NRS pain score (during rest and activity) before surgery and sleep quality score the night before surgery.

If the prescheduled follow-up time point fell into 9 pm-8 am, we used the following data reconciliation strategy for the NRS score: according to the patient's pain diary, if the follow-up time point was before the first reported pain appeared, the resting and exercise NRS scores at that time point were considered to be 0; if the follow-up time point was later than the initial pain appeared and earlier than the most severe pain happened, the NRS score at this point was considered to be the mean value of the first NRS higher than 0 and the highest NRS score (rounded down); if the follow-up time point was later than the most severe pain happened, and the patient described the pain did not alleviate, the highest pain score was taken as the NRS at that point. If the patient did not describe when the pain relieved, the data at that time point was considered missing.

Results

We assessed 140 patients for eligibility; of these, eight patients were excluded for declining to participate. Totally 132 patients were enrolled and randomized. The CONSORT flow diagram is as in Fig. 1. Three patients in each group were lost in follow-up due to being discharged after the surgery without any follow up data. Three patients in the control group were excluded because of refusal to use PCIA right after the surgery. Finally, 63 patients in the dexamethasone group and 60 patients in the control group were included in the per-protocol analysis.

The baseline demographic, anaesthetic and surgical characteristics in both groups were comparable, with no statistically significant difference (Table 1). The PNBs provided sufficient anaesthesia for all the operations.

Table 1
Demographic, anaesthetic and surgical characteristics of patients. Values are mean (SD) or number

	Dexamethasone (n = 63)	**Control (n = 60)**	***p* value**
Age; y	54.6 (17.3)	54.1 (16.1)	
Gender (Male/Female)	23/40	24/36	
ASA classification (I/II)	30/33	29/31	
Time from injury to surgery, days	5.2 (3.1)	6.2 (4.8)	0.08
Fracture location			
Clavicle	6	11	
Proximal humerus	23	24	
Elbow joint	12	5	
Wrist joint	15	11	
Metacarpal	6	8	
Phalange	1	1	
Surgeon			0.95
A	36	36	
B	18	16	
Others	9	8	
Tourniquet (Y/N)	32/31	23/37	0.17
Combined/Single block approach	24/39	32/28	0.09
Brachial nerve block approach			0.062
Interscalene approach	30	33	
Supraclavicular approach	9	15	
Axillary approach	24	12	
Combined approach: combination of interscalene brachial plexus and superficial cervical plexus block or axillary brachial plexus and musculocutaneous nerve block			

Table 1

The incidence of rebound pain was significantly lower in the dexamethasone group [7(11.1%) of 63 patients] than that in the control group [28(48.8%) of 60 patients]; Relative risk (RR) is 0.238, 95% CI

0.113–0.504, p = 0.001)

Patients in the two groups showed different pain profiles during block wore off. The self-reported highest NRS score and the onset time since PNB administration according to patients' pain diary of all the participants were shown in Fig. 2. The self-reported highest pain scores were 5 (3,6) [median(IQR)]in the dexamethasone group and 8 (5,9) [median(IQR)] in the control group respectively ($p < 0.001$). The patients in dexamethasone group reported highest pain score at 19.7±6.6 h (mean±SD)since block administration while in the control group, the self-reported most severe pain happened at 14.7±4.8 h (mean±SD) after block.

In univariate analysis, block type (single or combination, p = 0.042), brachial nerve block approach (p = 0.070),the usage of tourniquet (p = 0.070), the NRS pain score with movement (p = 0.047) before block administration and the sleep quality score on the night before surgery (p = 0.066) were found to be significantly associated with rebound pain (marginally significant), thus we included these factors into multivariate logistic regression analysis. Finally, only group allocation was found to be significantly related to the occurrence of rebound pain [OR = 0.131，95%CI (0.047–0.364)].

Preoperatively, there was no difference in NRS scores both at rest and with movement between the two groups. For the NRS scores at postoperative follow-up time points, significant difference between groups existed only at 12 h after the block administration, both at rest (p = 0.006) and during activity (p = 0.001) (Table 2).

Table 2
NRS scores before and after the block. Values are median (IQR)

	Dexamethasone n = 63	**Control n = 60**	***p* value**
Preoperative rest pain	0.00 (0.00, 0.00)	0.00 (0.00, 0.75)	0.809
Preoperative motion pain	5.00(3.00, 7.00)	4.00 (3.00, 6.00)	0.403
Rest pain after block, 8 h	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.058
Motion pain after block, 8 h	0.00(0.00, 0.00)	0.00 (0.00, 0.00)	0.090
Rest pain after block,12 h	0.00(0.00, 0.00)	0.00 (0.00, 4.00)	0.006
Motion pain after block,12 h	0.00(0.00, 0.00)	0.00(0.00, 6.00)	0.001
Rest pain after block, 24 h	0.00(0.00, 3.00)	1.00(0.00, 4.00)	0.115
Motion pain after block, 24 h	2.00(0.00, 4.00)	3.00(1.00, 5.00)	0.086
Rest pain after block, 48 h	0.00(0.00, 2.00)	0.00(0.00, 2.00)	0.812
Motion pain after block, 48 h	2.00(0.00, 3.00)	2.00(0.00, 3.00)	0.550

Table 2

Cumulative sufentanil consumption and invalid press percentage were significantly lower in patients receiving ropivacaine with dexamethasone in comparison to those without dexamethasone in 24 h after the block ($p < 0.05$). No difference was found in opioid consumption between two groups in 48 h after the block administration (Table 3).

Table 3
Postoperative sufentanil consumption and invalid press of PCA. Values are mean (SD), median (IQR)

	Dexamethasone (n = 63)	**Control (n = 60)**	***p* value**
Sufentanil consumption 24 h, μg	50.49 ± 2.62	66.22 ± 4.05	< 0.001
Sufentanil consumption 48 h, μg	97.76 ± 6.01	108.01 ± 7.13	0.391
Percentage of invalid press 24 h (%)	0.0(0.0,22.2)	13.2(0.0,29.6)	0.039
Percentage of invalid press 48 h (%)	0.0(0.0,20.0)	11.1(0.0,29.4)	0.043

We also compared the sleep quality scores and patients' satisfaction to the pain control therapy and found patients received ropivacaine and dexamethasone mixture reported better sleep quality on the night of surgery and satisfaction to pain therapy (Table 4).

Table 4
Sleep quality score and patients' satisfaction to the pain therapy. Values are expressed as median (IQR)

	Dexamethasone n = 63	**Control n = 60**	***p* value**
sleep score on the night before surgery	1 (0, 3)	1 (0, 2)	0.82
sleep score on the night of surgery	1 (0, 1)	2 (0, 5)	0.01
Patients' satisfaction	5 (4, 5)	4 (2, 5)	0.001

We then investigated whether the addition of dexamethasone caused hyperglycemia. It appeared that patients in both groups showed blood glucose elevation at 8 h after the surgery, but no statistically difference between the two groups. During the telephone follow up at 30 days after the surgery, no one complained paresthesia in the block area or chronic pain at the surgical site.

Discussion

Perineural dexamethasone is an effective adjuvant used to prolong the duration of the sensory block after regional anaesthesia[16]. However, whether it can alleviate the rebound phenomenon after nerve

block is remained to be investigated. Our study demonstrated that when being added into 0.375% ropivacaine, 8 mg dexamethasone effectively reduced the incidence of rebound pain in patients receiving ORIF for upper extremity fracture under single-injection nerve block. Dexamethasone addition not only prolonged the duration of sensory block, reduced the opioid consumption in 24 h after the block administration; it also decreased the pain intensity at the point patients described it as the most severe pain after the block. Patients received perineural dexamethasone addition reported better sleep quality on the night of surgery and higher satisfaction to the postoperative pain therapy.

Rebound pain following single-shot nerve block is a clinically relevant but less valued phenomenon which even diminishes the real benefit of peripheral nerve block in some surgeries[7, 8, 17].Patients undergoing surgical repair of distal radius fractures experienced different pain profile after general anaesthesia compared with a peripheral nerve block. Although patients with brachial plexus block had less pain immediately after the procedure, 12 h to 24 h later when the block wore off, their pain was higher than those in the general anaesthetic group[10].

The mechanism of rebound pain remains poorly understood. Fading of nerve block could not explain that there are a certain number of patients who do not experience the outbreak of excruciating pain during the block wear off. It is also noticed that the rebound pain does not respond to intravenous opioids administration[6]. We found that although we provided a background infusion of a high lipid-soluble opioid-sufentanil to maintain a steady blood concentration and a relatively short lockout time of 6 min in PCA, the patients who suffered from rebound pain still could not get relieved by PCA administration. In Williams' study [18] some patients described rebound pain as an intense burning pain initially as the nerve block resolves. This evidence might suggest the neuropathic instead of a nociceptive component of rebound pain after nerve block. Kolarczyk's study on rats[19] found that 0.5%ropivacaine induced transient heat hyperalgesia in the setting of resolved mechanical analgesia. Early studies have also suggested that local anaesthetics can cause nerve swelling and alter the permeability of the outer membrane of the nerve, leading to abnormal nerve conduction[14]. Therefore, local anaesthetic toxicity and the proinflammatory effect of local anaesthetics[20] might contribute to the occurrence of rebound pain.

Dexamethasone is a highly potent long-acting glucocorticoid. It improves the quality and prolongs the duration of PNB over LA alone[21]. The mechanism is not fully understood but suggested possible mechanism includes attenuating the release of inflammatory mediators, reducing ectopic neuronal discharge, and inhibiting potassium channel-mediated discharge of nociceptive C-fiber[22–24]. An K et al. found that perineural dexamethasone added to a clinical concentration of bupivacaine prevent the bupivacaine-induced reversible neurotoxicity and short-term "rebound hyperalgesia" in mouse sciatic nerve block model [15]. We demonstrated that adding 8 mg dexamethasone to 0.375% ropivacaine reduced the incidence of rebound pain from 48.8–11.1% after ORIF of upper extremity fracture under single-shot nerve block.

In Brian Williams's retrospective study[25] on the additives to a single-injection nerve block, 2 mg perineural dexamethasone addition provides favourable rebound pain profile than dosing of "other than 2mg" (i.e., no dexamethasone or 4 mg total perineural dexamethasone). We chose 8 mg because it is a commonly selected dosage in the study regarding the effect of dexamethasone as an adjuvant to local anaesthetics[26]. We did not investigate the dose-effect of dexamethasone addition. Whether a lower dosage of dexamethasone provides the same or better rebound pain profile needs to be investigated, especially in some population, such as diabetic patients.

Rune S et al. prospectively followed 21 patients scheduled for acute open reduction and internal fixation rebound phenomenon was less pronounced in patients older than 60 years old, whereas most of them suffered from moderate pain (NRS 4–6) during block effect wears off[8]. We did not find the association between rebound pain incidence and age in the correlation study. However, if grouping the patients by > 60 yrs or ≤ 60 yrs, the patients younger than 60 years old thus possessed a relatively higher incidence of rebound pain (31% vs 23%). Whether the pain trajectory after nerve block changes gradually with ageing or display a drastic change in a certain age needs to be clarified in the future study.

It is challenging to define rebound pain after nerve block. Williams BA et al[18]described rebound pain scores as a quantifiable difference between the highest NRS score after the nerve block wore off and the last NRS score when the nerve block was still providing pain relief. From our preliminary results, under most circumstances, rebound pain happens all in a sudden, at night or elicited by movements. Based on the findings from our preliminary observational study, we empirically define the rebound pain as "severe pain (NRS > 7) which breaks out in 48 hours after single-shot nerve block, whether at rest or elicited by movement, and cannot be relieved by multiple PCIA bolus in 30 minutes; if the pain occurs at the sleep time, it wakes up the patients and makes them difficult to go back to sleep". Lavand'homme P[17] gave a detailed description of the definition and characteristics of rebound pain. Our definition is similar to that of Lavand'homme P except that we extend the time limit to 48 hours because dexamethasone addition elongates the block duration. We failed to find a unique description of the pain character as burning or aching, so we eliminated the pain character as one of the criteria. Since the rebound phenomenon is hard to detect during regular follow up, we gave the diagnosis based on the patients' self-report and pain diary. Further studies are needed to unify the definition of rebound pain to facilitate more randomized trials in this area.

Although dexamethasone is one of the most common additives to a nerve block, there are still some safety concerns. Desmet[27] reported an increase in blood glucose concentrations in the group with dexamethasone, which needed insulin therapy. We found that the blood glucose at 6 h after the surgery increased but no statistical difference between the two groups and none of our patients required insulin therapy. This might because we ruled out the patients with diabetes.

There are limitations to our study. We did not investigate the effect of intravenous dexamethasone on rebound pain occurrence. So we cannot decide the reduction of rebound phenomenon is the perineural or systemic effect from absorption of dexamethasone. Comparison between intravenous and perineural

dexamethasone showed conflict results on whether the prolongation of nerve block is the systemic or perineural origin. Results from the meta-analysis showed that for bupivacaine, perineural dexamethasone addition leads to a statistically significant prolongation of analgesic duration by 21% compared with intravenous administration. While for ropivacaine, the mean duration of analgesia was increased by 12% with perineural dexamethasone compared with systemic dexamethasone, which did not reach statistical significance. The author concluded that the finding of equivalence between both routes of administration remains underpowered for ropivacaine, and a total of 1124 patients would be needed before suggesting a definitive conclusion[28]. Because intravenous dexamethasone has a strong anti-inflammatory effect and perineural administration is still off-label, further study is necessary to investigate the effect of intravenous dexamethasone on incidence of rebound pain.

Conclusion

This single-center, randomized, double-blind controlled study revealed that 8 mg dexamethasone addition to ropivacaine provides the benefit of of reducing rebound pain after a single-shot nerve block in patients receiving ORIF of upper limb fracture. It also reduces the opioid consumption in 48 h after the block and decreases the pain intensity at the point patients describes it as the most severe pain after the block. Dexamethasone addition improves sleep quality on the night of surgery and patients' satisfaction with postoperative pain therapy.

Declarations

Ethics approval and consent to participate

This study was approved by Ethics Committee of Zhongshan Hospital, Fudan University (B2016-079R). Written informed consent was obtained from patients before study enrollment by the investigator.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and analysed during the current study are available in the Mendeley Data, V2, doi: 10.17632/mvy4tjfdcj.2.

Competing interests

The authors declare that they have no competing interests

Funding

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Authors' contributions

SYC and DF performed the PNB block. FJ finished all the follow-up,analyzed the patient data and wrote the manuscript. XZG, CJ and ZXG decided whether the pain fit the criteria of rebound pain. ZXG conceived the present idea and revised the manuscript. All authors read and approved the final manuscript.

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Abbreviations

PNB: Peripheral nerve block; ORIF: open reduction internal fixation; PONV: postoperative nausea and vomiting; PCIA: patient control intravenous analgesia

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Figures

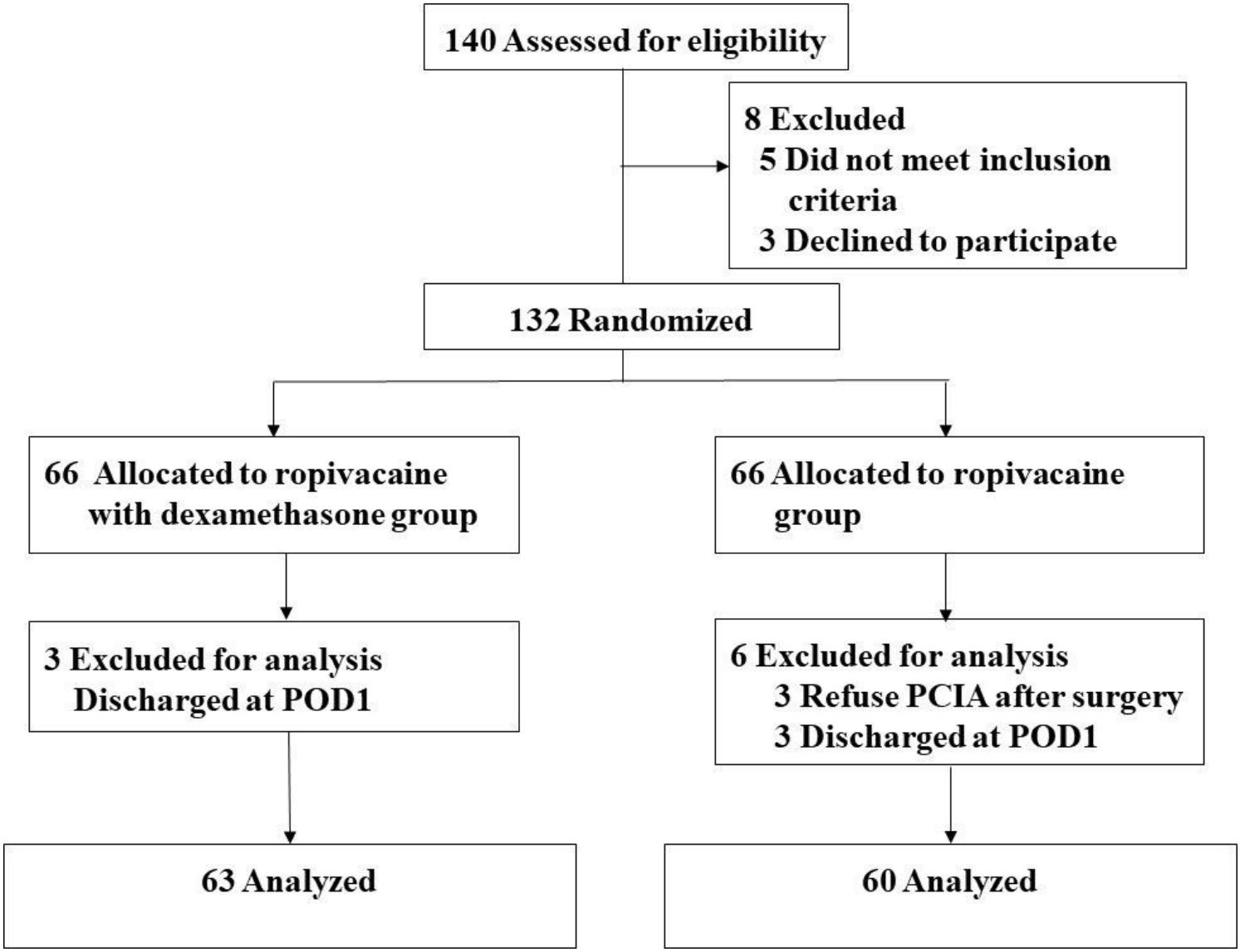

Figure 1

CONSORT diagram of patient recruitment

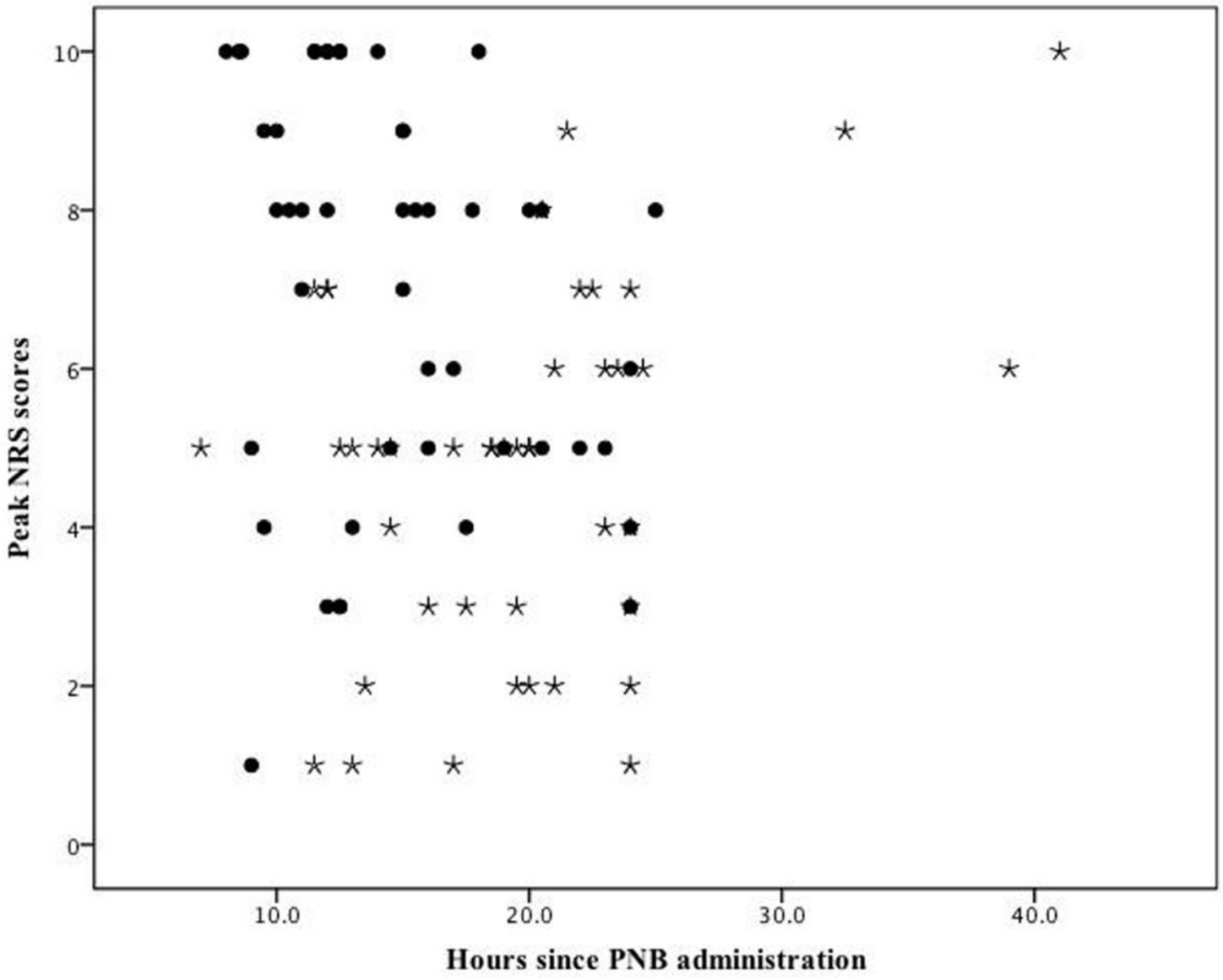

Figure 2

Scatter plots of the reported highest NRS scores in 48 h after the block administration in the dexamethasone group (circles) and the control group (asterisk)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CONSORT2010Checkliststatement.doc
- supplement2sleepqualityquestionaire.docx
- supplement1paindiary.docx