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Original Article

Clinical application of ultrasound-guided thoracic nerve block in the operation of benign breast tumors

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Abstract: Objective: To analyze the application of ultrasound-guided thoracic nerve block (TNB) in the operation of benign breast tumors. Methods: A retrospective analysis was conducted on 69 patients who underwent resection of benign breast tumors (fibroma, segment) in the Maternity and Child Care Center of Qinhuangdao from January 2021 to June 2022. Among them, 33 patients who received TNB were assigned to an observation group, and 36 patients who received local infiltration anesthesia were assigned to a control group. The heart rate (HR) and systolic blood pressure (SBP) and diastolic blood pressure (DBP) of patients were recorded before anesthesia (T0), at skin incision (T1), at 0.5 h after operation (T2) and before leaving the operating room (T3). We also recorded the operation indexes, comprising operation time, total propofol dosage administered during operation, anesthesia recovery time and extubation time. The visual analogue scale (VAS) score was evaluated at 0.5, 2, 4 and 6 h after the operation. The two groups were also compared in terms of the levels of immunoglobulin (Ig) A, IgG, interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α). The postoperative adverse reactions in the two groups were statistically analyzed. Results: Compared with the observation group, the control group experienced a longer operation time, anesthesia recovery time and extubation time and consumed more propofol ($P < 0.001$). At T0 and T1, the two groups were not notably different in SBP, DBP and HR ($P > 0.05$), but at T2 and T3, the control group showed higher SBP, DBP and HR than the observation group ($P < 0.001$). The control group exhibited notably higher VAS scores than the observation group ($P < 0.001$). Before operation, the differences in the levels of IgA, IgG, IL-6 and TNF-α were not significantly different between the two groups ($P > 0.05$), while after operation and at 24 h after operation, the control group showed higher levels of IgA, IgG, IL-6 and TNF-α in comparison to the observation group ($P < 0.01$). The incidences of adverse reactions were not significantly different between the two groups ($P > 0.05$). Conclusion: Ultrasound-guided TNB can substantially reduce both the operation time and the postoperative pain in patients with benign breast tumors, without increasing the incidence of adverse reactions.

Keywords: Ultrasound-guided, thoracic nerve block, benign breast tumor, adverse reactions

Introduction

Breast cancer has become the most commonly diagnosed malignancy among women in China, and has emerged as a major public health concern currently in society [1, 2]. Approximate 80% of breast tumor are benign, and breast fibroadenoma is the most common one [3]. A breast lump is a common disease of the female breast. Especially in recent years, an increasing number of women have been experiencing endocrine system dysfunctions and dietary imbalances, often attributable to the pressures of modern work and lifestyle [4]. Breast cancer is showing an increasing incidence. Reportedly, about 60% of adult women are affected by breast-related diseases [5]. Breast lesions can bring great mental stress to the patients, so the diagnosis and therapy of breast masses has become a pressing issues that must be addressed [6]. Although the nodular lesions of breasts are all benign, some benign lesions have the potential to be malignant, such as fibroadenoma and papilloma [7]. According to a survey, the cure rate of patients with early-stage (stage I) breast cancer is 90%, while the 5-year survival rates of patients with advanced (stages II and III) breast cancer are less than 70% and 40%, respectively [8]. Accordingly, even benign lesions can cause great mental stress to the patient, so the patients are usually eager to have a surgical resection.

At present, surgical intervention remains the primary treatment modality for clinical management of benign breast tumors [9]. However, despite its efficacy, surgery can result in serious harm to the body. The routine use of anesthesia during surgery may not effectively suppress the inflammatory response of the body during the perioperative period, and patients may experience complications such as acute pain and pneumothorax after the procedure, which is not conducive to the prognosis [10]. Therefore, it is of crucial importance to select an effective anesthesia method [11]. Ultrasound-guided thoracic nerve block (TNB) is a focus of clinical research within recent years. This technique is simple and feasible, with definite analgesic effect. As an important perioperative multimodal analgesia, nerve block has been found to have many advantages, such as an exact effect, simple implementation, fewer side effects and complications, lower requirement of perioperative dosage of opioids and other analgesic drugs, and good patient acceptance, providing a novel anesthesia method for breast surgery in critical patients [12]. In addition, Eskandr et al. [13] have found that the postoperative pain and opioid consumption in patients undergoing ultrasound-guided nerve block were better than those in patients with routine regional anesthesia.

Prior research has revealed that TNB can effectively improve the perioperative analgesic effect and is safe for patients undergoing radical mastectomy. However, there are few studies on the effects of ultrasound-guided TNB on hemodynamics and inflammatory indexes in patients with benign breast tumors.

Accordingly, this study investigated the intraoperative and postoperative influence of ultrasound-guided TNB in patients with benign breast tumors to provide a reference for the selection of clinical anesthesia schemes.

Methods and data

Ethical statement

This study was performed with approval from the Medical Ethics Committee of the Maternity and Child Care Center of Qinhuangdao, with ethical approval number of 21448 (L).

Inclusion and exclusion criteria

Inclusive criteria: Patients who were diagnosed with breast tumor grade ≤3 in the Breast Imaging Reporting and Data System (BI-RADS) according to the medical history, symptoms and signs, related auxiliary examinations and preoperative ultrasound [14]; patients with non-areolar lesions measuring approximately 2-6 cm in diameter; patients who were confirmed to have benign breast tumor (breast fibroadenoma, breast hyperplasia with fibroadenoma formation, etc.) through postoperative pathology; patients with complete clinical data.

Exclusion criteria: Pregnant women; lactating women; patients with malignant breast tumor; patients with severe malnutrition; patients with coagulation disorder or comorbid dysfunction of important organs; patients with a history of breast, chest or armpit surgery.

Clinical data

A total of 179 patients were collected in this study, and 69 patients were found to meet the inclusion and exclusion criteria. Therefore, a retrospective analysis was conducted on the 69 patients who underwent resection of benign breast tumor (fibroma, segment) in the Maternity and Child Care Center of Qinhuangdao from January 2021 to June 2022. Among them, 33 patients who received TNB were assigned to an observation group, and 36 patients who received local infiltration anesthesia were assigned to a control group.

Anesthesia regimens

In the control group, the patients were checked by a third party after entering the room, followed by disinfection and application of a surgical drape. Then, the patients were given local anesthesia by the surgeons. To be specific, 1% lidocaine hydrochloride was adopted through local infiltration, and the volume was used according to the scope of operation, with a maximum of 40 mL.

In the observation group, the patients were checked by a third party after entering the room. Then, the anesthesiologist administered PECS2 nerve block guided by ultrasound to the patients. During the process, the patients were required to be in a lateral position (healthy side), and the needle was inserted into the T2-6 space outside the paraspinal muscle (right). Using a three-dimensional ultrasound diagnostic instrument (model: X300, Siemens) with the frequency of the probe set to 10 MHz, the block range was determined. The probe was tilted at an angle of 30° with the paraspinal line, in order to expand the vision of the ultrasound image. Additionally, the puncture needle was maintained at a 30° angle with the skin, and positioned as parallel to the probe as possible. The needle was inserted inclinedly to ensure clear visualization of the needle's specific location on the ultrasound image and facilitate adjustments. Thereafter, 10 mL 0.5% ropivacaine (Guangdong Jiabo Pharmaceutical Co., Ltd., approval number: H20173194, specification: 20 mL:200 mg) was injected into the space between pectoralis major and pectoralis minor, and 15 mL 0.5% ropivacaine was injected into the space between the deep surface of pectoralis minor and serratus anterior. During anesthesia, the patient was given 0.5 ug/kg dexmedetomidine and 4-9 mg/(kg*h) propofol by the anesthesiologist, and the input dose of propofol was adjusted according to the patient's reaction during the operation.

Collection of patient indexes

We collected the clinical data and various index data of patients, including age, body mass index (kg/m^2), diameter of lesion (cm), location of lesion, American Association of Anesthesiologists (ASA) classification, BI-RADS classification, medical history, stress response indexes (heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP)) before anesthesia (T0), at skin incision (T1), 0.5 h after operation (T2), and before leaving the operation room (T3). We also collected the operation indexes, comprising operation time, total dosage of propofol during operation, recovery time from anesthesia and extubation time. Visual analogue scale (VAS) score was evaluated at 0.5, 2, 4 and 6 h after operation. Moreover, adverse reactions of the patients were recorded. Immunoglobulin (Ig) A, IgG, interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α) were measured before operation, after operation and at one day after operation.

Outcome measures

Primary outcome measures: The HR, SBP and DBP of patients at T0, T1, T2 and T3 were recorded. The operation indexes (operation time, total propofol dosage during operation, anesthesia recovery time and extubation time) were also recorded. The VAS score of patients at 0.5, 2, 4 and 6 h after the operation were compared [15].

Secondary outcome measures: The clinical data the two groups were compared. The postoperative adverse reactions were compared between the two groups. The immune turbidimetry was adopted for quantifying IgA and IgG with kits from MABSKY BIO-TECH Co., LTD. IL-6 and TNF-α were quantified using enzyme-linked immunosorbent assay with kits from Shanghai Jining Industrial Company. These indexes were measured before operation, after operation and 24 h after operation.

Statistical analyses

This study adopted SPSS 19.0 (Asia Analytics Formerly SPSS China) for statistical analysis, and GraphPad Prism 8 for visualization. Counting data were processed by the Chi-square test. Measurement data (mean ± SD) were subjected to independent-sample t test and paired t test for inter-group comparison and intro-group comparison, respectively. The repeated measures analysis of variance was adopted for data at multiple time points, and Bonferroni was used as post-hoc test. $P < 0.05$ suggests a significant difference.

Results

Comparison of clinical data

According to the inter-group comparisons of clinical data, the observation and control groups showed no significant difference in clinical data ($P > 0.05$, **Table 1**).

Inter-group comparison of operation indexes

Compared with the observation group, the control group experienced a longer operation time, anesthesia recovery time, and extubation time and consumed more propofol ($P < 0.001$, **Table 2**).

Changes in HR, DBP and SBP

At T0 and T1, the two groups were similar in SBP, DBP and HR ($P > 0.05$, 0.05), but at T2 and T3, the control group showed higher SBP,

Table 1. Baseline data

Factor	Control group (n=36)	Observation group (n=33)	χ^2 value	*P* value
Age			0.180	0.671
≥ 45 years old	16	13		
< 45 years old	20	20		
BMI (kg/m^2)			0.057	0.811
≥ 25	10	13		
< 25	26	30		
Diameter of lesion (cm)			2.365	0.124
≥ 3 cm	13	18		
< 3 cm	23	15		
Location of lesion			0.962	0.326
Unilateral	15	10		
Bilateral	21	23		
ASA grading			2.541	0.110
Class I	22	26		
Class II	14	7		
BI-RADS classification			1.394	0.498
Grade I	10	13		
Grade II	12	11		
Grade III	14	9		
Medical history				
Hypertension	12	10	0.072	0.787
Diabetes mellitus	7	8	0.233	0.629

Note: Body Mass Index (BMI); American Association of Anesthesiologists (ASA); Breast Imaging-Reporting and Data System (BI-RADS).

DBP and HR than the observation group ($P < 0.001$, **Figure 1**).

Changes in VAS scores

At 0.5, 2, 4 and 6 h after operation, the control group exhibited notably higher VAS scores in comparison to the observation group ($P < 0.001$, **Table 3**).

Changes in immune indexes

The two groups were similar in preoperative IgA and IgG levels ($P > 0.05$, **Figure 2**), while after operation and at 24 after operation, the control group showed significantly higher levels of IgA and IgG in comparison to the observation group ($P < 0.01$, **Figure 2**).

Changes in inflammatory indexes

The two groups were not significantly different in preoperative IL-6 and TNF-α levels ($P > 0.05$, **Figure 3**), while after operation and at 24 after operation, the control group showed notably higher IL-6 and TNF-α in comparison to the observation group ($P < 0.001$, **Figure 3**).

Adverse reactions in patients

The incidences of adverse reactions were not greatly different between the observation group and the control group ($P > 0.05$, **Table 4**).

Discussion

The incidence of breast diseases is on the rise. Although the majority are benign, there is a risk of malignancy that poses a significant threat to women's health. The array of breast diseases is complex and multifaceted [16]. Approximate 40% of young and middle-aged women in China suffer from breast diseases, among which benign lesions such as fibroadenoma are frequently seen [17]. Breast diseases often do not exhibit apparent symptoms in the early phases, and some may manifest as tumor and nodule that have little impact on the body. However, benign lesions still have a mutation probability, therefore need prevention and treatment [18]. Surgery is the primary treatment for benign breast diseases, but it can easily damage the nerves of chest wall and the tissues around breast, after which complications such as acute pain may occur [19]. Accordingly, choosing anesthesia that provides complete analgesic effect with minimal side effects has become a focus for healthcare professionals.

Thoracic paravertebral nerve block is divided into multi-point nerve block and one-point nerve block [20]. Thoracic paraspinal nerve block is a regional anesthesia that targets the sensory nerves supplying the thoracic (upper back) region of the body [21]. It is used to relief pain during surgical procedures and other treatments in the thoracic region. The block is performed by injecting local anesthetic agents,

Table 2. Comparison of patients' operation indexes

Group	Operation time	Propofol dosage	Anesthesia recovery time	Extubation time
Control group (n=36)	135.50±31.30	697.83±101.20	24.61±3.68	19.02±5.34
Observation group (n=33)	110.67±26.53	504.45±115.89	14.84±1.92	11.54±3.37
T value	3.538	7.368	13.622	6.883
P value	0.001	< 0.001	< 0.001	< 0.001

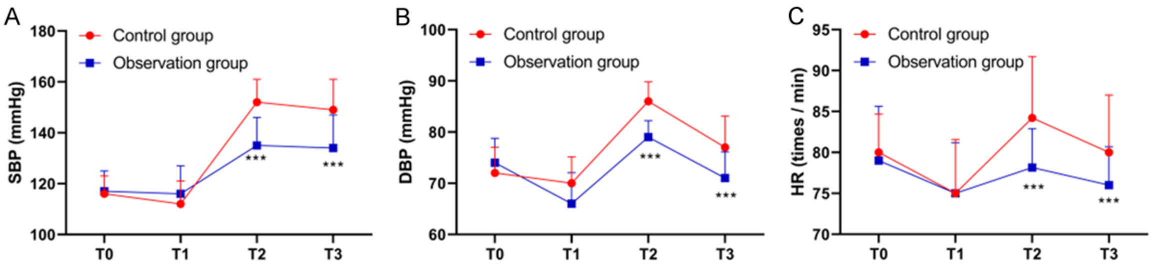

Figure 1. Comparison of the changes in stress response in the two groups during anesthesia. A. Changes in SBP during operation. B. Changes in DBP during operation. C. Changes in HR during operation. Notes: ***P < 0.001. HR: heart rate; SBP: systolic blood pressure; DBP: diastolic blood pressure; T0: before anesthesia; T1: at skin incision; T2: at 0.5 h after operation; T3: before leaving the operation room.

Table 3. Changes in visual analog scale scores

Group	0.5 h	2 h	4 h	6 h
Control group (n=36)	3.94±0.58	4.50±0.73	3.91±0.80	2.52±0.69
Observation group (n=33)	2.48±0.50	2.90±0.57	1.69±0.63	1.24±0.61
T value	11.049	9.910	12.614	8.102
P value	< 0.001	< 0.001	< 0.001	< 0.001

such as lidocaine or bupivacaine, into the paraspinal muscles near the thoracic vertebrae [22]. This numbs the sensory nerves in the area, reducing or eliminating the pain signals from reaching the brain [23]. Studies have shown the efficacy of thoracic paravertebral multi-point nerve block, as it enables a broader block plane that can mitigate incomplete nerve blocks and produce a more significant analgesic effect [24]. Using ultrasound during TNB can aid in the precise measurement of the vascular and nerve injuries in the thoracic tissue, so as to reduce damage to surrounding tissues during needle retention, which is beneficial to the prognosis [25]. However, anesthetic block may block the patient's sympathetic nerve and affect the balance of autonomic nerve, triggering disorder of the patient's immune system [26]. In this study, we analyzed the application value of ultrasound-guided TNB in the operation of benign breast tumors. According to the results, the observation group experienced a shorter operation time, anesthesia recovery time, and extubation time and used less propofol in comparison to the control group, suggesting that ultrasound-guided TNB could significantly reduce the required dosage of general anesthesia while improving the quality of anesthesia recovery. Prior research by Altěparmak et al. [27] revealed that ultrasound-guided intercostal nerve block greatly reduced the required dosage of opioids in patients undergoing breast cancer surgery. We believe that the reasons ultrasound-guided TNB improve the general indexes of patients are accurate puncture location and effective avoidance of important organs and nerve vessels, thus greatly reducing the operation time, minimizing the potential damage to the patient's body and ensuring high operation safety. Moreover, in this study, at T3 and T4, the observation group showed lower SBP, DBP and HR in comparison to the control group. Also, the observation group presented lower IgA and IgG levels than the control group. These results imply that ultrasound-guided TNB has less impact on

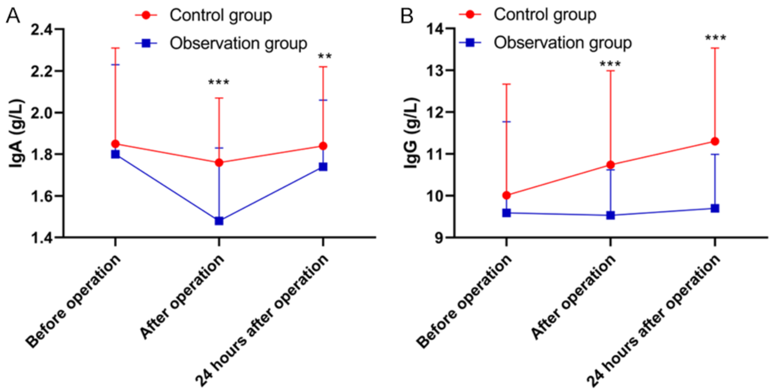

Figure 2. Changes in immune function before and after therapy. A. Changes in IgA at different time points. B. Changes in IgG at different time points. Note: **P < 0.01, ***P < 0.001. IgA: immunoglobulin A; IgG: immunoglobulin G.

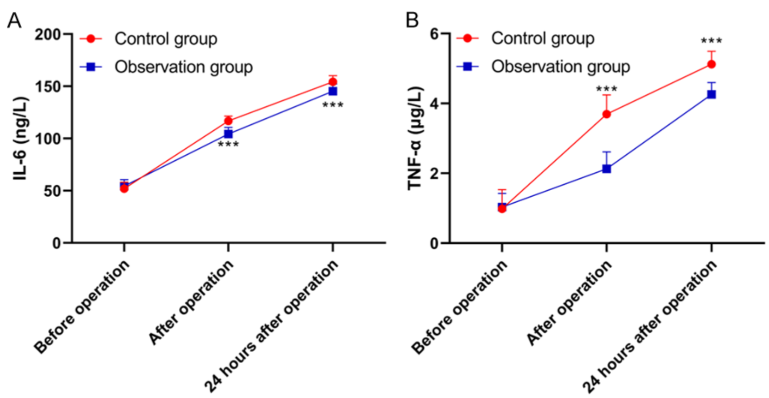

Figure 3. Changes in inflammation function before and after treatment. A. Changes in IL-6 at different time points. B. Changes in TNF-α at different time points. Note: ***P < 0.001, ***P < 0.001. IL-6: Interleukin-6; TNF-α: Tumor necrosis factor-α.

patients' stress and immune function. This is because during modified ultrasound-guided TNB, local anesthetic drugs are injected into the serratus anterior and pectoralis minor to block the lateral intercostal nerve and the long thoracic nerve, which provides an ideal analgesic effect and reduces the stress response. In addition, nerve block anesthesia guided by ultrasound has certain protective effect on immune function.

The effectiveness of postoperative analgesic is directly linked to the recovery of patients' health, and the intensity of pain is positively correlated with the incidence of postoperative inflammatory reactions. A stronger pain level indicates a more significant effect of inflammatory reaction. The increased release of inflammatory factors can inhibit the mechanism of the body's immune response, resulting in systemic inflammatory response and leading to various complications [28, 29]. In this study, the changes in inflammatory indexes before and after operation were analyzed. According to the results, after operation and at 24 h after operation, the observation group presented notably lower IL-6 and TNF-α levels than the control group. Moreover, at every time point, the observation group had notably lower VAS scores compared to the control group. This suggests that ultrasound-guided nerve block can slow down the occurrence of inflammatory reaction in patients, thus alleviating postoperative pain. Prior research by Grasso et al. [30] revealed significantly better postoperative VAS score in patients undergoing ultrasound-guided interfascial plane block than that in those under general anesthesia. In the study by Ciftciet et al. [31], ultrasound-guided type II TNB greatly alleviated the postoperative pain compared with general anesthesia. This is because ultrasound-guided TNB has an ideal effect that improves the overall analgesic efficacy and reduces the postoperative pain in patients.

Our study has determined through analysis that ultrasound-guided TNB can alleviate postoperative pain in patients with benign breast tumors, without increasing the incidence of adverse reactions. However, this study still has some limitations. Firstly, the patients could not be followed up, so whether different anesthesia schemes have an impact on patients' short-term functions requires further verification. Secondly, the sample size is small in this study, so the statistical results may be biased. Therefore, we hope to carry out further experiments in the future to improve the research conclusions.

Table 4. Adverse reactions

Group	Hematoma	Nausea and vomiting	Skin itching	Skin depression	Total number of cases
Control group (n=36)	2	2	0	1	5
Observation group (n=33)	1	2	1	2	6
χ^2 value	0.264	0.008	1.107	0.446	0.236
P value	0.607	0.928	0.292	0.504	0.626

To sum up, ultrasound-guided TNB can substantially reduce the operation time and postoperative pain of patients with benign breast tumors, without increasing the incidence of adverse reactions.

Disclosure of conflict of interest

None.

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