Original Article

Cervical plexus block enhanced pain control for unilateral thermal ablation of thyroid nodules

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Background: Despite being minimally invasive, thermal ablation (TA) of thyroid nodules may still cause significant pain during and shortly afterwards. Conventional analgesia relies on perithyroidal local anesthesia (PLA) with or without sedation. The use of cervical plexus block (CPB) has been extensively studied in thyroidectomy, but never studied in TA of the thyroid gland. This study examined whether adding ultrasound-guided CPB to PLA and sedation could further reduce post-operative pain in unilateral TA of thyroid nodules.

Methods: Consecutive patients aged ≥18 years undergoing unilateral radiofrequency ablation (RFA) or microwave ablation (MWA) of thyroid nodules were reviewed. Group I patients did not receive CPB, and Group II patients received CPB by bupivacaine injection between the sternocleidomastoid muscle (SCM) and prevertebral fascia on the treatment side. Pain was charted immediately and 4 hours after ablation using a numeric rating scale (NRS) of 0–10. The Quality-of-Recovery-9 (QoR9) questionnaire was completed.

Results: Over an 18-month period, 100 patients underwent unilateral thyroid ablation (Group I, n=50; Group II, n=50). Comparable baseline patient demographics, nodule characteristics, ablation parameters were noted (P>0.05). Significantly lower immediate NRS {1 [0–3] *vs.* 4 [1.3–6], P<0.001}, 4-hour NRS {1 [0–3] *vs.* 2 [0–4], P=0.04}, and more zero immediate NRS (44% *vs.* 14%, P=0.001) was observed in Group II. Total QoR9 scores were comparable {16 [12–17] *vs.* 15 [12–17], P=0.72}. No adverse events occurred. All patients were discharged within the same day.

Conclusions: Adding ultrasound-guided CPB further enhanced pain control following unilateral TA of thyroid nodules, without compromising quality of recovery or same-day discharge.

Keywords: Thyroid nodule; pain; radiofrequency ablation (RFA); cervical plexus block (CPB); quality of recovery

Submitted Jun 05, 2024. Accepted for publication Aug 09, 2024. Published online Aug 28, 2024.
doi: 10.21037/gs-24-217
View this article at: https://dx.doi.org/10.21037/gs-24-217

Introduction

Thermal ablation (TA) is an effective minimally invasive treatment for benign, symptomatic thyroid nodules (1-4). Currently, the most commonly performed TA procedures for thyroid nodules include radiofrequency ablation (RFA) and microwave ablation (MWA) (4-10). Both procedures require percutaneous insertion of an electrode into the target nodule. TA is usually well-tolerated under perithyroidal injection of local anesthesia (LA). Nevertheless, it can still cause significant pain, discomfort

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(11-14), cause unnecessary patient anxiety or movement, compromising patient experience and potentially the quality of ablation. A previous study has shown that adding intravenous sedation on top of perithyroidal LA reduced pain further (15), suggesting room for improvement in patient experience in the conventional set up with perithyroidal LA alone.

Cervical plexus block (CPB) has been extensively studied and used in peri-operative analgesia for open thyroidectomy (16-25). It is an effective, simple and safe procedure that could be carried out quickly. Since TA with RFA and MWA also involves a skin wound and manipulation of the thyroid gland, it is postulated that CPB could reduce pain experienced in RFA and MWA. Understandably, both RFA and MWA differ from surgery by being minimally invasive procedures with only one to two tiny skin punctures, and the pain induced by heat within the thyroid gland may be different from that of removing the entire gland and capsular dissection in open surgery. The role of CPB in TA of thyroid nodules has never been studied. This study sets out to be the first study investigating whether the addition of CPB to perithyroidal LA and sedation could further reduce post-operative pain in unilateral TA of thyroid nodules. We present this article in accordance with the STROBE reporting checklist (available at https://gs.amegroups.com/article/view/10.21037/gs-24-217/rc).

Methods

This study was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (No. UW 22-506). All participants gave informed consent. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Highlight box

Key findings

- Cervical plexus block effectively reduced pain in unilateral thermal ablation of thyroid nodules.

What is known and what is new?

- The use of ultrasound guided cervical plexus block has not been studied in thermal ablation of thyroid nodules.
- This study showed that adding cervical plexus block enhanced pain control in unilateral thermal ablation of thyroid nodules, with 44% of patients having no pain at all after the procedure.
- The technique was safe and did not compromise quality of recovery or same-day discharge.

What is the implication, and what should change now?

- Cervical plexus block should be considered to optimize pain control in unilateral thermal ablation of thyroid nodules.

Patients and technique of CPB

From November 2022 to April 2024, consecutive patients who underwent RFA or MWA for unilateral benign thyroid nodules in two tertiary endocrine surgery centers were reviewed. The same surgical team performed all procedures. Exclusion criteria include inability to report pain scores reliably, and/or complete a recovery questionnaire. Before ablation, all received intravenous Midazolam (Cheplarpharm, Greifswald, Germany) (1–3 mg, <0.05 mg/kg), Pethidine (Martindale Pharmaceuticals, Romford, Essex, UK) (15–30 mg, <0.5 mg/kg), and perithyroidal 1% lidocaine (Hospira Inc., Lake Forest, IL, USA) under standardized protocol. In the first half of the study period, patients did not receive CPB (Group I). In the second half of the study period, patients received CPB in addition to perithyroidal LA and sedation (Group II).

For Group II patients, CPB was performed on the treatment side before ablation. Under ultrasound guidance, a 21 G needle was inserted at the midpoint of the neck between the clavicle and mandible. The needle was inserted from medial to lateral through the sternocleidomastoid muscle (SCM), aiming lateral and away from the carotid sheath structures (Figures S1,S2); 10 mL 0.25% bupivacaine was injected between the SCM and prevertebral fascia (*Figure 1*). Patients' vital signs (respiratory rate, oxygen saturation, blood pressure, pulse rate) were monitored from beginning of procedure to discharge. Intra-operative laryngeal ultrasonography was performed after CPB injection, and throughout the ablation procedure to monitor the vocal cord status (26).

Outcomes

The primary outcome of the study is the post-operative pain score. It is rated by a 0–10 numeric rating scale (NRS). A score of 10 indicates the most severe pain and a score of 0 indicates no pain. NRS was charted immediately after TA, and also 4 hours after TA.

The other outcomes include quality of recovery, and any complications related to CPB. Quality of recovery after TA was assessed by the Quality-of-Recovery-9 (QoR9) questionnaire just before discharge, which is 4–6 hours

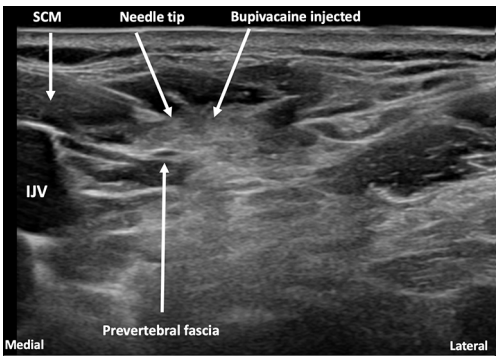

Figure 1 Ultrasound image of cervical plexus block injection to the right neck. The operator stands at the head end of patient, with ultrasound transducer placed at the midpoint of the neck between the clavicle and mandible. Note the 21 G needle tip approaching from medial to lateral, through the SCM, injecting 0.25% bupivacaine into the potential space between the SCM and prevertebral fascia. SCM, sternocleidomastoid muscle; IJV, internal jugular vein.

after TA when patients have already regained consciousness fully. This is a questionnaire that consists of nine items, each carrying two points. The total score would range from 0 to 18. The higher the total score, the better the quality of recovery. This questionnaire has been widely validated and shown to correlate with post-operative quality of recovery (27-29). It is easy to fill in. Since our cohort consists of Chinese patients, a validated Chinese version was also provided in addition to the original English version of the questionnaire to our patients to ensure good understanding (30).

Statistical analysis

Normally distributed data were described with means ± standard deviations, and non-normally distributed data were described with medians (interquartile range). The paired *t*-test, Man Whitney-*U* test were used to compare continuous variables. The Chi-squared test and Fisher's exact test were used to compare categorical variables. Missing data, if any, were removed from analysis. A P value of <0.05 was defined as being statistically significant. The software IBM SPSS (version 28, IBM Corp., Armonk, NY, USA) was used for all analyses.

Results

Over the study period, 104 consecutive patients undergoing unilateral RFA or MWA were considered. After excluding four patients who could not reliably report pain scores and fill in questionnaires due to cognitive impairment, 100 patients were included. Fifty patients belonged to Group I (no CPB), and 50 belonged to Group II (CPB). *Table 1* showed the baseline characteristics between the two groups. Group II patients had older age (54±14 *vs.* 49±13 years, P=0.03), but otherwise comparable baseline characteristics with Group I in terms of sex, body mass index (BMI), thyroid function and comorbidities. Nodule characteristics were comparable in terms of indication for ablation, number of nodules ablated, laterality and method of ablation (P>0.05). There was no statistically significant difference in terms of nodule volume, although a trend of larger nodule volume for Group II was observed (P=0.16). Similarly, no significant difference was observed for the total energy applied, energy applied per unit volume, total ablation time and ablation time per unit volume (P>0.05), although a trend of greater ablation energy and ablation time was noted in Group II. Other treatment parameters in terms of number of skin punctures, lidocaine, midazolam and pethidine dosages were comparable (*Table 2*).

The early post-TA outcomes were compared in *Table 3*. In Group II (CPB), NRS were significantly lower than Group I at both immediately {1 [0–3] *vs.* 4 [1.3–6], P<0.001} and 4 hours {1 [0–3] *vs.* 2 [0–4], P=0.04} after TA. Notably, 44% of Group II patients experienced no pain at all immediately after ablation, versus only 14% of Group I patients had this favourable outcome (P=0.04). Both groups had comparable QoR9 scores (P=0.72), indicating no additional negative effect of CPB on quality of recovery from TA. There were no complications from both groups in terms of vocal cord palsy, skin complications, nodule rupture, hematoma requiring operation and complications from sedation including cardiopulmonary suppression and neuropsychiatric complications. No complications related to CPB occurred. All patients of both groups could be discharged on the day of treatment.

Discussion

To our knowledge, the current study is the first that investigated the use of CPB in TA of thyroid nodules. We found that, in addition to perithyroidal LA and sedation, CPB further reduced procedural related pain immediately and 4 hours after TA. We find this technique helpful in optimizing pain control and improving the overall experience of our patients.

Table 1 Comparing the baseline characteristics of patients receiving unilateral thermal ablation of benign thyroid nodules (n=100)

Characteristics	Group I (n=50)	Group II (n=50)	P value
Age at treatment (years)	49±13	54±14	0.03
Sex			0.61
Male	1 [2]	2 [4]	
Female	49 [98]	48 [96]	
BMI (kg/m^2)	23.9±3.5	24.1±4.0	0.32
Smoking	2	2	>0.99
Drinking	0	0	>0.99
Diabetes mellitus	2	1	>0.99
Baseline TSH (mIU/L)	1.41±0.94	1.23±0.77	0.55
Baseline fT4 (pmol/L)	16.6±5.2	15.7±2.3	0.64
Indication for ablation			0.49
Benign non-functional thyroid nodule	49 [98]	50 [100]	
Toxic thyroid nodule	1 [2]	0	
Number of nodules ablated in the same session			0.09
Single nodule	37 [74]	29 [58]	
Multiple nodules	13 [26]	21 [42]	
Method of ablation			0.42
RFA	24 [48]	28 [56]	
MWA	26 [52]	22 [44]	
Laterality of ablation			
Right	24	30	0.27
Left	25	20	
Nodule width	2.73 [2.23–3.73]	3.23 [2.52–4.04]	0.11
Nodule length	3.52 [2.87–4.20]	3.78 [3.03–4.50]	0.32
Nodule depth	2.28 [1.72–2.76]	2.39 [1.95–2.84]	0.29
Nodule volume	11.3 [5.7–21.4]	14.9 [7.2–27.6]	0.16
Solid component (%)	100 [80–100]	100 [100–100]	0.08

Group I did not receive CPB and Group II received ultrasound-guided CPB. Data are presented as mean ± standard deviation, n [%] or median [interquartile range] as appropriate. BMI, body mass index; TSH, thyroid stimulating hormone; fT4, free T4; RFA, radiofrequency ablation; MWA, microwave ablation; CPB, cervical plexus block.

Despite the smaller wounds involved in TA when compared to open thyroidectomy which may mean less pain, CPB still further improved the pain experience when compared with no CPB. Notably, almost half of our patients experienced no pain at all, suggesting CPB being highly effective. It is important to note that, albeit the difference being statistically insignificant, Group II (CPB) patients had a trend of receiving greater ablation energy, and longer duration of ablation. Receiving more heat energy, and a longer ablation time would generally mean more discomfort and pain to patients, yet Group II (CPB) patients experienced less pain. This further proved the effectiveness of CPB in pain control. In fact, the good pain control provided by CPB may allow more thorough ablations

Table 2 Comparing the treatment parameters of patients receiving unilateral thermal ablation of benign thyroid nodules (n=100)

Treatment parameter	Group I (n=50)	Group II (n=50)	P value
Total ablation energy (Joule)	18,735 [9,900–35,333]	31,672 [12,570–49,915]	0.11
Energy applied per unit volume (Joule/mL)	1,697 [1,121–2,690]	2,034 [1,527–2,460]	0.56
Total ablation time (seconds)	630 [279–965]	814 [434–1,208]	0.09
Ablation time per unit volume (seconds/mL)	49 [38–76]	53 [38–68]	0.81
Number of skin punctures per patient	1 [1–2]	1 [1–1]	>0.99
Volume of perithyroidal 1% lidocaine/kg body weight (mL/kg)	0.11 [0.07–0.14]	0.11 [0.07–0.15]	0.78
Midazolam per kg body weight (mg/kg)	0.04 [0.04–0.05]	0.05 [0.04–0.05]	0.11
Pethidine per kg body weight (mg/kg)	0.4 [0.4–0.5]	0.4 [0.4–0.5]	0.51

Group I did not receive CPB and Group II received ultrasound-guided CPB. Data are presented as median [interquartile range]. CPB, cervical plexus block.

Table 3 Comparison of post-thermal ablation outcomes

Outcome	Group I (n=50)	Group II (n=50)	P value
Pain NRS immediately after ablation	4 [1.3–6]	1 [0–3]	<0.001
Number of patients with zero NRS immediately after ablation, i.e., no pain	7 [14]	22 [44]	0.001
Pain NRS at 4 hours after ablation	2 [0–4]	1 [0–3]	0.04
Total QoR9 score upon discharge	15 [12–17]	16 [12–17]	0.72
Post-operative unilateral VCP	0	0	>0.99
Skin complications	0	0	>0.99
Nodule rupture	0	0	>0.99
Hematoma requiring operation	0	0	>0.99
Severe complications from sedation	0	0	>0.99
Complications from CPB	0	0	>0.99
Discharge within the same day	50 [100]	50 [100]	>0.99

Group I did not receive CPB and Group II received ultrasound-guided CPB. Data are presented as median [interquartile range] or n [%]. NRS, numeric rating scale; QoR9, Quality-of-Recovery-9 score; VCP, vocal cord palsy; CPB, cervical plexus block.

with more energy and time. It would be interesting and important to compare the volume reduction rates of Group I (no CPB) and Group II (CPB) nodules in future follow-up studies, in order to prove this hypothesis.

None of the patients who received CPB had complications, proving the safety of CPB. Moreover, CPB did not affect quality of recovery. All patients that received CPB could be discharged in the same day. These suggest that CPB could be safely added to TA, without compromising the advantages of it being an ambulatory procedure. In our previous paper, we find intravenous sedation safe and effective in pain control for TA, without compromising quality of recovery or same-day discharge. However, the authors acknowledge that there are certain centers where only qualified professionals, such as an anesthetist or someone who is not conducting the ablation, are permitted to administer intravenous sedation. This would have increased the cost of TA. Therefore, in settings where intravenous sedation is not practical, CPB may be a good alternative to enhance pain control, in addition to perithyroidal LA. We understand that it would take another study with subjects not receiving sedation at all to allow a more robust proof to this hypothesis.

We find the technique of ultrasound-guided CPB easy

to learn, as thyroid TA operators are already familiar with the anatomy of the neck and also needle manipulation under ultrasound guidance. We suggest a technique of injecting CPB from medial to lateral through the SCM, into the space between the SCM and prevertebral fascia where the cervical plexus traverses. With this technique, the needle orientation and angulation would be similar to that to the trans-isthmic approach in TA, which TA operators are familiar with. Moreover, since the needle tip is always aiming lateral and away from the carotid sheath structures, we find this technique helpful in avoiding accidental injection into the carotid sheath. Injection into the carotid sheath could cause paralysis of the vagus nerve and hence vocal cord paralysis. Although this is usually a transient condition, it would complicate the scenario in thyroid TA. This is because it would be difficult to differentiate true recurrent laryngeal nerve (RLN) injury due to overheating/accidental ablation of the RLN which would mean true damage which typically puts an end to the procedure, versus a transient reversible event due to incorrect injection of anaesthesia into the carotid sheath. With our medial to lateral technique, there were no cases of vocal cord paralysis caused by CPB. This highlighted the merits of our approach of CPB injection.

The limitations of this study included: first, the cohort consisted of all ethnic Chinese. This may make our findings less generalizable. Second, whether CPB could achieve equally effective pain control in a setting without sedation remains to be elucidated. This is particularly relevant to centers in which sedation was not routine or difficult to arrange. Third, numbness was not evaluated objectively. It is possible that prolonged numbness potentially caused by CPB could impair patient experience. Nevertheless, the comparable QoR scores would suggest that the patient discomfort induced by CPB was minimal. Forth, although both groups received comparable amount of perithyroidal LA, the fact that Group II receiving an overall higher volume of anesthetic drug itself, due to the addition of 10 mL of 0.25% bupivacaine for CPB, may somehow account for the better pain control. It was not shown in this study whether simply adding a 10 mL volume to perithyroidal LA alone (i.e., a total of 15 to 20 mL for a unilateral ablation) would achieve comparable results to the combined approach of CPB plus perithyroidal LA. Nevertheless, the rationale of utilizing CPB was never to replace perithyroidal LA, but rather, to further optimize pain control by adding the element of regional anesthesia in addition to LA for the procedure. Moreover, flooding the perithyroidal space with large doses of local anesthetic drug carries the risk of drug seepage posteriorly and medially into the tracheal esophageal groove, which may lead to RLN paralysis. Therefore, we find it reasonable and safe to use a combined approach of CPB plus perithyroidal LA. Finally, this study only addressed the effect of CPB in unilateral ablation. It would be important to study whether bilateral CPB could be safely given in bilateral ablations, and achieve equally good pain control.

Conclusions

Adding ultrasound guided CPB to perithyroidal local anesthesia (PLA) and sedation further enhanced pain control in unilateral TA of thyroid nodules. The technique was safe and did not compromise quality of recovery or same-day discharge.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://gs.amegroups.com/article/view/10.21037/gs-24-217/rc

Data Sharing Statement: Available at https://gs.amegroups.com/article/view/10.21037/gs-24-217/dss

Peer Review File: Available at https://gs.amegroups.com/article/view/10.21037/gs-24-217/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://gs.amegroups.com/article/view/10.21037/gs-24-217/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (No. UW 22-506). All participants gave informed consent.

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Cite this article as: Fung MMH, Luk Y, Lang BHH. Cervical plexus block enhanced pain control for unilateral thermal ablation of thyroid nodules. Gland Surg 2024;13(8):1469-1476. doi: 10.21037/gs-24-217

Supplementary

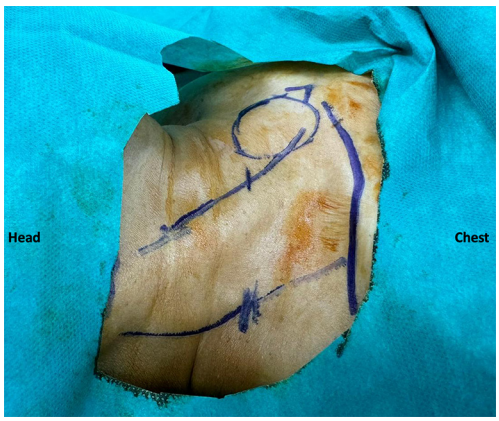

Figure S1 Surface anatomical landmarks in cervical plexus block for the right neck. Left—head end; right—foot end; circle—thyroid nodule to be ablated; V—sternal notch; foot end long line—clavicle; trapezoid outline by two oblique lines—sternocleidomastoid muscle; mid-point between clavicle and mandible marked as level of injection for cervical plexus block.

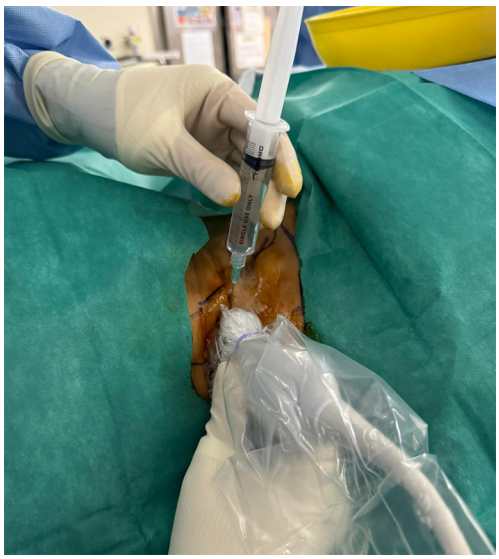

Figure S2 Live image of cervical plexus block injection to the right neck. Note the operator standing on the head end, with needle approaching from medial to lateral under ultrasound guidance at the mid-point between the clavicle and mandible.

https://dx.doi.org/10.21037/gs-24-217