

## Original Article

# Clinical advantages of ultrasound-guided acupotomy targeting the suboccipital muscles versus the posterior occipital tendinous arch for cervicogenic dizziness: a controlled trial

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**Abstract:** Objective: To compare the efficacy and safety of ultrasound-guided acupotomy targeting the suboccipital muscles versus the posterior occipital tendinous arch in patients with cervicogenic dizziness. Methods: A retrospective study was conducted on 80 patients with cervicogenic dizziness treated at the First People's Hospital of Yunnan Province and Dali Bai Autonomous Prefecture People's Hospital between September 2023 and December 2024. Patients were allocated into the groups of suboccipital muscles (n=40) and posterior occipital tendinous arch (n=40). All patients underwent ultrasound-guided acupotomy. Evaluated outcomes included Visual Analogue Scale (VAS), Cervical Vertigo Symptom and Functional Assessment scores, pressure pain threshold of the greater occipital nerve, cervical range of motion, ultrasound-measured tissue thickness, shear wave elastography indices, overall clinical efficacy, and adverse events. Results: At 1 week and 1 month, the suboccipital muscle group demonstrated significantly lower VAS scores and higher functional scores, pain thresholds, and cervical mobility compared with the posterior arch group (all  $P < 0.05$ ). After treatment, tissue thickness and Young's modulus were lower, while elasticity scores were higher in the suboccipital group (both  $P < 0.05$ ). Clinical efficacy was greater (95.0% vs. 80.0%,  $P = 0.023$ ), with fewer adverse events (17.5% vs. 40.0%,  $P = 0.026$ ). Conclusion: Ultrasound-guided acupotomy at both sites effectively alleviates cervicogenic dizziness. However, targeting the suboccipital muscles yields superior pain relief, functional recovery, and cervical mobility, with a lower incidence of adverse effects. This method is particularly suitable for patients with suboccipital muscle hypertrophy or tension.

**Keywords:** Acupotomy therapy, ultrasound guidance, suboccipital muscles, posterior occipital tendinous arch, efficacy

## Introduction

Cervicogenic dizziness is a common functional disorder in clinical practice, characterized by dizziness, blurred vision, nausea, and vomiting, which significantly impair daily life and work capacity [1]. Epidemiological surveys indicate a prevalence of 10-30% in adults, with the highest incidence in the 40-60 years age group, and a steadily rising trend due to lifestyle changes such as prolonged use of electronic

devices, poor posture, and chronic neck strain [2, 3].

The pathogenesis is multifactorial, involving excessive neck muscle tension, fascial adhesions, and restricted mobility of cervical joints. Irritation or compression of the occipital nerve is regarded as an important contributing factor [4]. The occipital nerve originates from the medial branch of the posterior ramus of C2-3 and passes through the suboccipital muscles

and the posterior occipital tendinous arch. Prolonged abnormal posture, repetitive strain, or trauma may cause suboccipital muscle hypertrophy and tension, leading to occipital nerve compression and subsequent dizziness and pain [5].

Current treatment options include pharmacotherapy, physical rehabilitation, Tuina massage, acupuncture, and, in some cases, surgical intervention. However, each has limitations and medications may cause dependence and adverse effects. Tuina and physical therapy often provide only transient relief with high recurrence rates; acupuncture outcomes vary depending on practitioner skill; and surgery is invasive and indicated only under strict conditions [6, 7].

Acupotomy, integrating principles of acupuncture and minimally invasive surgery, has shown distinct advantages in cervical disorders [8]. By releasing adhesions, disrupting pathological fibrous bands, and improving local blood circulation and neural nutrition, it alleviates muscle spasms and nerve compression symptoms [9, 10]. Traditional acupotomy, however, relies heavily on physician experience, which may limit precision and increase complications. Ultrasound guidance enables real-time visualization of insertion depth, trajectory, and adjacent structures, improving accuracy and safety. Favorable results have been reported in cervicogenic dizziness and cervical-shoulder pain [11].

Despite these advances, controversy remains regarding the optimal anatomical target for ultrasound-guided acupotomy in cervicogenic dizziness. Clinically, two main sites are used: the suboccipital muscles and the posterior occipital tendinous arch. Yet, direct comparative evidence is lacking, and treatment selection largely depends on physician experience rather than evidence-based standards.

This study systematically compared the clinical efficacy and safety of ultrasound-guided acupotomy targeting the suboccipital muscles versus the posterior occipital tendinous arch in patients with cervicogenic dizziness. Multidimensional outcomes - including pain scores, functional assessments, pressure pain threshold, cervical mobility, ultrasound-based tissue measurements, and shear wave elastography

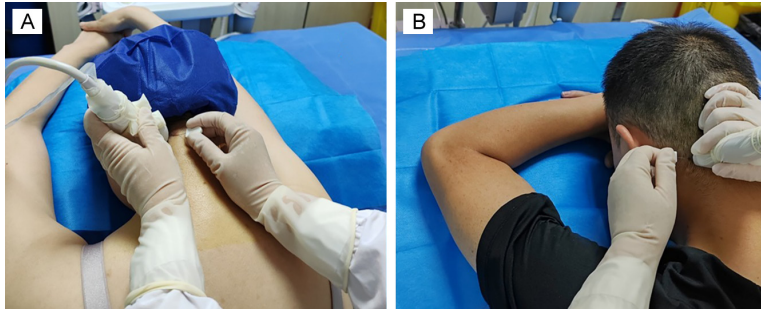
(SWE) - were evaluated. The results provide evidence-based guidance for selecting the optimal intervention site, improving treatment accuracy and efficacy, and reducing adverse effects, thereby supporting broader clinical application.

### Materials and methods

#### *Source of patients*

This retrospective study was approved by the Ethics Committee of the First People's Hospital of Yunnan Province, and all procedures complied with the Declaration of Helsinki. Patients diagnosed with cervicogenic dizziness and treated in either outpatient rehabilitation clinics or inpatient wards from September 2023 to December 2024 were identified through the Health Information Technology systems of the First People's Hospital of Yunnan Province and Dali Bai Autonomous Prefecture People's Hospital.

*Inclusion criteria:* (1) Documented diagnosis of cervicogenic dizziness with clinical manifestations of neck pain and dizziness, or dizziness aggravated or triggered by changes in head position. Diagnosis was based on the criteria of the *Minutes of the Third National Symposium on Cervical Spondylosis* [12] (2008) and the *Expert Consensus on Dizziness Diagnosis and Treatment* [13] (2010). Mild cases were typically brief and transient, whereas severe episodes could last from days to weeks. Patients presented with dizziness or vertigo accompanied by neck discomfort, tension, or pain, often provoked by cervical rotation or postural change. Some exhibited positive cervical torsion tests and palpable cord-like tender trigger points in the neck. Common associated symptoms included blurred vision, headache, tinnitus, or hearing loss. Cervical imaging abnormalities (e.g., cervical kyphosis, vertebral instability, or disc herniation) were present, while ocular, cardiogenic, cerebral, and otologic causes of vertigo were excluded. (2) Age 18-65 years, any sex. (3) Ability to understand the study and willingness to comply with physician-directed treatment. (4) No pharmacological or other therapeutic interventions for dizziness within two weeks prior to enrollment. (5) Complete medical records, including baseline and follow-up data.



**Figure 1.** Representative images of two treatment sites. A: Posterior occipital tendinous arch; B: Suboccipital muscles.

**Exclusion criteria:** (1) Radiological evidence of cervical tuberculosis, tumor, or infection. (2) Severe systemic diseases (cardiovascular, cerebrovascular, hepatic, renal, or hematologic disorders). (3) Vertigo or dizziness of cardiac, otologic, cerebral, or ocular origin, or due to psychiatric factors. (4) Pregnant or lactating women, individuals with severe allergic history, or those with adverse effects related to therapy. (5) Patients receiving other concurrent treatments for dizziness (e.g., vestibular rehabilitation, other acupuncture methods). (6) Incomplete or missing medical data.

After screening, 98 patients were initially included. Following secondary exclusion, 80 patients remained and were allocated into the suboccipital muscle group (n=40) or the posterior occipital tendinous arch group (n=40) according to the treatment method.

### *Sample size calculation*

Based on previous studies, an effect size of 0.80 was determined using G\*Power version 3.1.9.2. With a statistical power of 0.80 and  $\alpha=0.05$ , the estimated sample size was 72. Allowing for a 10% dropout rate, the minimum required sample size was 79. The final cohort of 80 patients met this requirement.

### *Intervention measures*

**Posterior occipital tendinous arch group:** Patients were positioned prone or in a desk-leaning posture and fitted with disposable surgical caps to secure cervical hair, fully exposing the neck, shoulders, and occipital region. Palpation was used to locate trigger points along the posterior occipital tendinous arch corresponding to the foot Shaoyang and

foot Taiyang meridians. When no distinct trigger points were palpable, regions of stress concentration were selected. Four bilateral sites were marked with a surgical marker, and ultrasound probes were aligned to obtain both longitudinal and transverse images. The morphology and depth of each target were documented in the longitudinal view.

A high-frequency ultrasound probe, coated with coupling agent and covered with a sterile glove, was used for scanning. After precise localization, a No. 3 Hanzhang acupotomy needle was inserted along the probe axis under ultrasound guidance. The needle was advanced along the needle tract, and 2-3 longitudinal dissections were performed along the myofascial layer from proximal to distal. The operator confirmed the release of trigger points through tactile feedback. Once tissue resistance disappeared, the needle was withdrawn. The puncture site was covered with a sterile adhesive bandage, removed on the first postoperative day. Patients were instructed to avoid strenuous activities for seven days. Treatment was performed once every two days, three times per course, over one week (**Figure 1A**).

**Suboccipital muscle group:** Preoperative preparation was identical to the posterior arch group. Four myofascial trigger points were identified bilaterally in the suboccipital muscles along the foot Shaoyang and foot Taiyang meridians. Following local anesthesia, 2-3 parallel dissections were performed along the superficial and deep fascia, aligned with the orientation of fascial fibers. Observation methods, postoperative precautions, and treatment frequency were consistent with the posterior arch group (**Figure 1B**).

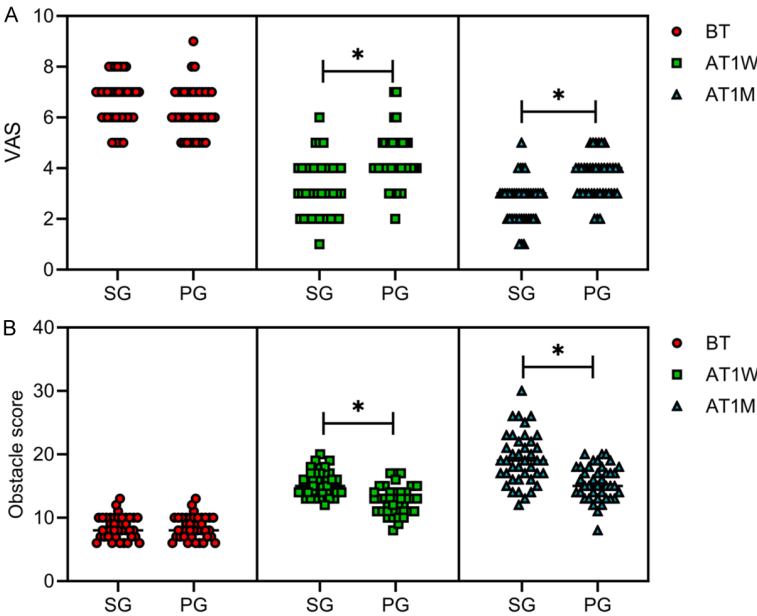
### *Patient education*

Before therapy, participants received health education, including maintaining cervical warmth, adopting proper sleep and working postures, avoiding prolonged static positions, and self-protection strategies to prevent head and neck injuries. Efficacy was evaluated one

**Table 1.** Comparison of baseline data between the two groups (mean ± SD)/[n (%)]

| General clinical data         |                 | Suboccipital muscle group (n=40) | Posterior occipital tendinous arch group (n=40) | $\chi^2/t$ | P     |
|-------------------------------|-----------------|----------------------------------|-------------------------------------------------|------------|-------|
| Sex                           | Male            | 17                               | 15                                              | 0.200      | 0.678 |
|                               | Female          | 23                               | 25                                              |            |       |
| Mean age (years)              |                 | 42.36±8.51                       | 42.98±8.99                                      | 0.315      | 0.826 |
| Mean BMI (kg/m <sup>2</sup> ) |                 | 24.32±2.65                       | 23.98±3.05                                      | 0.536      | 0.751 |
| Mean disease duration (month) |                 | 18.56±10.21                      | 17.96±11.22                                     | 0.250      | 0.811 |
| Onset triggers                | Trauma          | 9                                | 12                                              | 1.429      | 0.699 |
|                               | Chronic fatigue | 26                               | 23                                              |            |       |
|                               | Other/Unknown   | 5                                | 5                                               |            |       |
| Smoking                       |                 | 11                               | 12                                              | 0.114      | 0.735 |
| Alcohol consumption           |                 | 8                                | 9                                               | 0.051      | 0.822 |
| Hypertension                  |                 | 7                                | 9                                               | 0.222      | 0.637 |
| Diabetes mellitus             |                 | 3                                | 3                                               | 0.000      | 1.000 |

BMI: body mass index.



**Figure 2.** Comparison of pain intensity and cervical vertigo symptom and functional assessment scale scores before and after treatment. A: VAS scores; B: Cervical vertigo symptom and function scores. Note: VAS: Visual Analogue Scale; SG: suboccipital muscle group; PG: posterior occipital tendinous arch group; BT: before treatment; AT1W: 1 week after treatment; AT1M: 1 month after treatment. \*P<0.05.

week after treatment and one month after completion.

*Observation indicators and evaluation criteria*

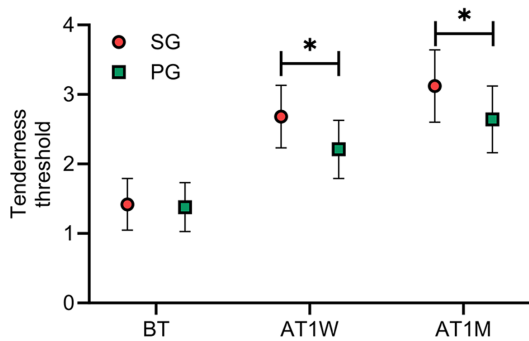
**Primary outcome measure:** Clinical efficacy: Evaluation criteria for vertigo were based on the diagnostic and therapeutic standards of

traditional Chinese medicine [14]. To align with international reporting, the outcomes were categorized as follows: (1) Complete remission: Complete disappearance of vertigo and associated symptoms. (2) Marked improvement: Significant reduction of vertigo and related manifestations. (3) Partial improvement: Noticeable but incomplete relief of vertigo symptoms. (4) No response: No improvement or worsening of vertigo and related symptoms.

**Secondary outcome measure:** (1) Pain intensity and functional assessment: The Cervical Vertigo Symptom and Functional Assessment Scale [15], a validated scale for Chinese patients with cervicogenic dizziness, has a total score of 30. Lower scores

indicate more severe symptoms. It comprises five domains: vertigo (severity, frequency, duration, 16 points), neck and shoulder pain (4 points), headache (2 points), activities of daily living and work (2 points), and psychological/social adaptation (2 points). Pain intensity was evaluated using a 0-10 Visual Analogue Scale (VAS), with higher scores representing greater

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**Figure 3.** Comparison of pressure pain thresholds before and after treatment. Note: SG: suboccipital muscle group; PG: posterior occipital tendinous arch group; BT: before treatment; AT1W: 1 week after treatment; AT1M: 1 month after treatment. \* $P < 0.05$ .

severity. (2) Pressure pain threshold of the greater occipital nerve: Measured with a pressure algometer applied perpendicularly along the nerve pathway between the external occipital protuberance and mastoid process. Pressure was gradually increased until the patient reported pain, and the threshold value was recorded. Each site was measured 2-3 times, and the mean was used for analysis. Higher thresholds indicated reduced sensitivity and clinical improvement. (3) Cervical range of motion: Flexion, extension, bilateral lateral flexion, and bilateral rotation were assessed before and after treatment. (4) Ultrasound measurement of tissue thickness: With the patient in a prone position or seated, a probe was placed at the external occipital protuberance. Transverse and longitudinal scans at the C1-C2 level were used to measure the vertical distance from the deep fascia to the bony surface of the suboccipital muscles, and the fascial thickness at the posterior occipital tendinous arch. (5) SWE: Patients were positioned prone with the head slightly elevated and arms relaxed. After routine ultrasound of the trapezius and inferior oblique muscles, the probe was rotated 90° for longitudinal scans. The system was switched to SWE mode, and a 10×10 mm region of interest (ROI) was positioned at a depth of 1-2 cm. Elasticity maps were obtained, and the Q-BOX function was used to calculate the Young's modulus within a 10-mm circular ROI. Each site was measured three times, and the mean was recorded. (6) Safety: Adverse events, including local pain, bleeding, and infection, were recorded within one month after treatment.

### Statistical methods

Data were analyzed using SPSS version 26.0. Categorical variables were expressed as percentages and compared using the chi-square test. Continuous variables were expressed as mean ± standard deviation (SD) and analyzed with independent-samples t-tests, paired-samples t-tests, or repeated-measures ANOVA with Bonferroni correction. Ordinal data were assessed using the Mann-Whitney U test. A  $P$  value  $< 0.05$  was considered statistically significant.

### Results

#### Comparison of baseline data

There were no significant differences between the two groups in sex distribution, mean age, body mass index, or disease duration ( $P > 0.05$ ), indicating good baseline comparability (Table 1).

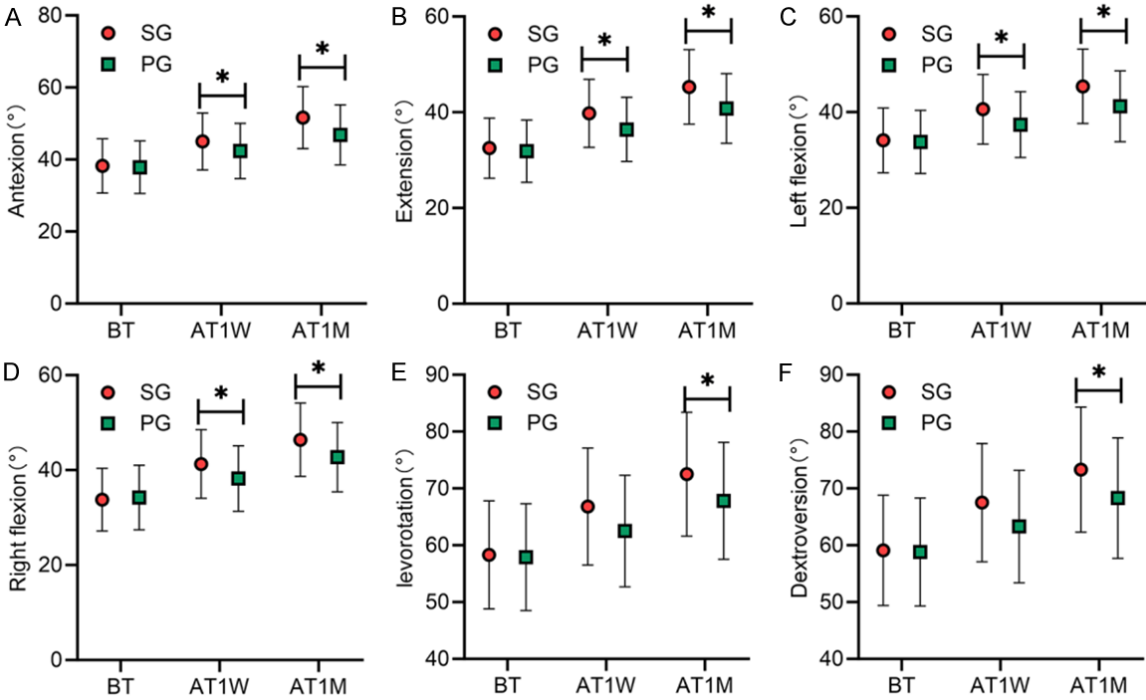
#### Comparison of pain intensity and cervical vertigo symptom and functional assessment

Before treatment, there were no significant differences in VAS or Cervical Vertigo Symptom and Functional Assessment Scale scores between the two groups (both  $P > 0.05$ ). At 1 week and 1 month after treatment, the suboccipital muscle group had significantly lower VAS scores than the posterior occipital tendinous arch group ( $P < 0.05$ ) (Figure 2A). Compared with baseline, VAS scores in the suboccipital group decreased significantly at 1 week, while both groups showed significant reductions at 1 month ( $P < 0.05$ ). Similarly, at 1 week and 1 month, functional assessment scores were significantly higher in the suboccipital group compared with the posterior arch group ( $P < 0.05$ ) (Figure 2B). Both groups showed significant improvement compared with baseline at 1 month ( $P < 0.05$ ).

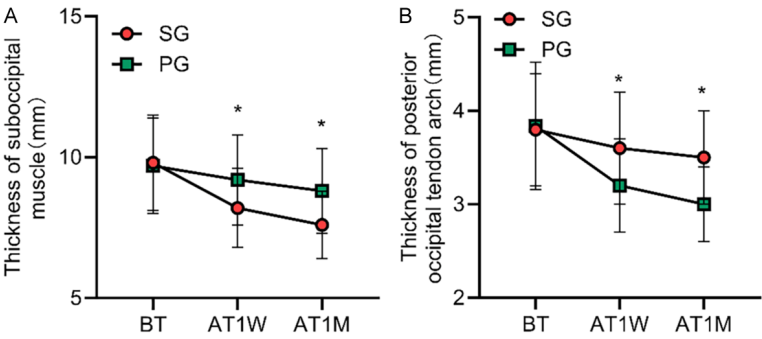
#### Comparison of pressure pain thresholds

No significant difference was observed between the groups before treatment ( $P > 0.05$ ). At 1 week and 1 month, the suboccipital group exhibited significantly higher pressure pain thresholds than the posterior arch group ( $P < 0.05$ ) (Figure 3). Compared with baseline, both groups showed significant increases at both time points (both  $P < 0.05$ ).

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**Figure 4.** Comparison of cervical range of motion before and after treatment. A: Flexion angle; B: Extension angle; C: Left lateral flexion angle; D: Right lateral flexion angle; E: Left rotation angle; F: Right rotation angle. Note: SG: suboccipital muscle group; PG: posterior occipital tendinous arch group; BT: before treatment; AT1W: 1 week after treatment; AT1M: 1 month after treatment. \* $P<0.05$ .



**Figure 5.** Comparison of ultrasound measurement of tissue thickness before and after treatment. A: Thickness of suboccipital muscles; B: Thickness of posterior occipital tendinous arch. Note: SG: suboccipital muscle group; PG: posterior occipital tendinous arch group; BT: before treatment; AT1W: 1 week after treatment; AT1M: 1 month after treatment. \* $P<0.05$ .

## Comparison of cervical range of motion

Baseline cervical flexion, extension, lateral flexion, and rotation angles did not differ significantly between the groups (all  $P>0.05$ ). At 1 week and 1 month, the suboccipital group demonstrated significantly greater improvements in flexion, extension, and bilateral lateral flexion compared with the posterior arch group (all

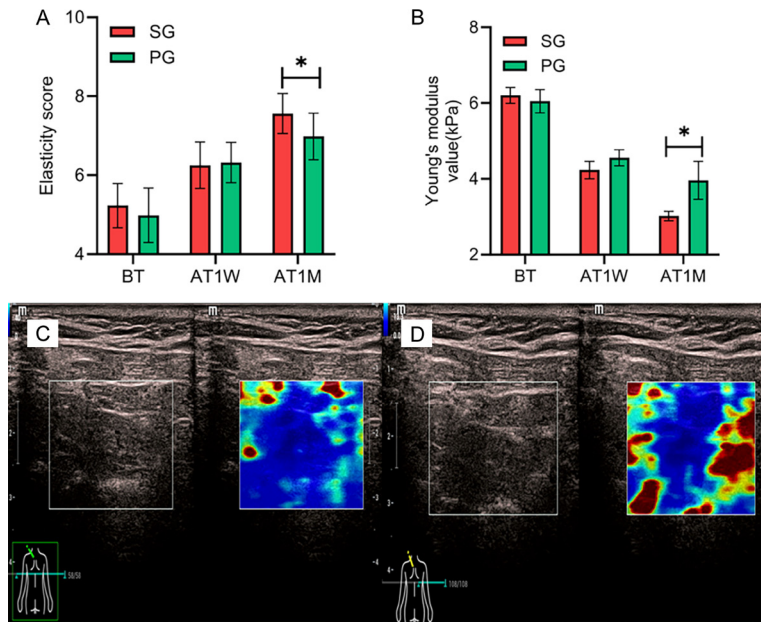
both  $P<0.05$ ). By 1 month, left and right rotation angles were also significantly greater in the suboccipital group ( $P<0.05$ ) (Figure 4). Both groups showed significant overall improvements compared with baseline at 1 month (all  $P<0.05$ ).

## Comparison of ultrasound measurement of tissue thickness

Before treatment, no significant differences were observed in the thickness of the suboccipital muscles or the

posterior occipital tendinous arch between the two groups (both  $P>0.05$ ). At 1 week and 1 month after treatment, the suboccipital muscle group demonstrated significantly lower thickness values for both structures compared with the posterior arch group (both  $P<0.05$ ) (Figure 5). Within the suboccipital group, thickness was also significantly reduced at 1 month compared with baseline (both  $P<0.05$ ).

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**Figure 6.** Comparison of SWE before and after treatment. A: Tissue elasticity scores; B: Young's modulus values; C: SWE before treatment from the suboccipital muscle group; D: SWE after treatment from the suboccipital muscle group. Note: SWE: shear wave elastography; SG: suboccipital muscle group; PG: posterior occipital tendinous arch group; BT: before treatment; AT1W: 1 week after treatment; AT1M: 1 month after treatment. \* $P<0.05$ .

### Comparison of SWE

Baseline comparisons showed no significant differences in tissue elasticity scores or Young's modulus values between the two groups (both  $P>0.05$ ). After 1 month of treatment, the suboccipital muscle group exhibited significantly higher elasticity scores and lower Young's modulus values than the posterior arch group ( $P<0.05$ ) (both **Figure 6A**, **6B**). In both groups, elasticity scores increased and Young's modulus values decreased significantly at 1 week and 1 month compared with baseline ( $P<0.05$ ). Representative SWE images from the suboccipital group showed a marked reduction in adhesion area after treatment (**Figure 6C**, **6D**).

### Comparison of clinical efficacy

The overall efficacy rate in the suboccipital group was 95.0% (38/40), comprising 16 complete remissions, 14 marked improvements, and 8 partial improvements. In the posterior arch group, the overall efficacy rate was 80.0% (32/40), including 10 complete remissions, 12 marked improvements, and 10 partial improvements. The difference between the two groups

was statistically significant ( $\chi^2=5.165$ ,  $P=0.023$ ) (**Table 2**).

### Comparison of incidence of adverse reactions

Within 1 month of treatment, the suboccipital group reported 4 cases of localized pain, 2 cases of bleeding, and 1 infection, for an incidence of 17.5% (7/40). This rate was significantly lower than that in the posterior arch group (40.0%, 16/40;  $P<0.05$ ) (**Table 3**).

### Discussion

Acupotomy therapy, which integrates traditional acupuncture with modern minimally invasive techniques, has been increasingly applied in recent years for cervical spine-related disorders. In the present

study, ultrasound-guided acupotomy release targeting the suboccipital muscles produced more pronounced improvements in patients with cervicogenic dizziness, consistent with previous findings. Earlier studies have shown that suboccipital release therapy alleviates pain in patients with cervicogenic headache and improves cervical mobility [15]. However, those studies did not directly compare suboccipital muscles with the posterior occipital tendinous arch, nor did they employ ultrasound guidance, which represents a key innovation of our study. Ultrasound guidance enhances procedural precision and safety, likely explaining the relatively low incidence of adverse events observed.

Consistent with a prior research [16], which reported improved quality of life and functional outcomes following acupotomy for cervicogenic dizziness, our study demonstrated that patients treated at the suboccipital muscles showed greater improvement in dizziness symptoms and functional scores. These findings align with that of Hou et al. [17] but extend their work by highlighting the superiority of suboccipital targeting. This advantage may be related

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**Table 2.** Comparison of clinical efficacy between the two groups

| Group                                    | Number of cases | Complete remission | Markedly improvement | Partial improvement | No response | Overall efficacy rate |
|------------------------------------------|-----------------|--------------------|----------------------|---------------------|-------------|-----------------------|
| Suboccipital muscle group                | 40              | 16                 | 14                   | 8                   | 2           | 38 (95.00)            |
| Posterior occipital tendinous arch group | 40              | 10                 | 12                   | 10                  | 8           | 32 (80.00)            |
| $\chi^2$                                 | -               |                    |                      |                     |             | 5.165                 |
| <i>P</i>                                 | -               |                    |                      |                     |             | 0.023                 |

**Table 3.** Comparison of incidence of adverse reactions between the two groups [n (%)]

| Group                                    | Number of cases | Localized pain | Localized bleeding | Infection | Nerve injury | Total incidence |
|------------------------------------------|-----------------|----------------|--------------------|-----------|--------------|-----------------|
| Suboccipital muscle group                | 40              | 4              | 2                  | 1         | 0            | 7 (17.50)       |
| Posterior occipital tendinous arch group | 40              | 8              | 4                  | 3         | 1            | 16 (40.00)      |
| $\chi^2$                                 | -               |                |                    |           |              | 4.943           |
| <i>P</i>                                 | -               |                |                    |           |              | 0.026           |

to the essential role of the suboccipital muscles - including the rectus capitis posterior major and minor, and the obliquus capitis superior and inferior - in cervical stability, proprioception, and posture control [18]. Enhancing the functional status and proprioceptive input of these muscles may explain the superior recovery in mobility and function.

In terms of pain relief, Lang et al. [19] reported that combining acupotomy with ultrasound reduced VAS scores in cervicogenic headache patients. Similarly, our study showed a greater reduction in VAS scores when targeting the suboccipital muscles, confirming the clinical advantage of this anatomical site [20, 21]. Furthermore, quantitative assessment with SWE revealed higher elasticity scores and lower Young's modulus values in the suboccipital group after one month, indicating better recovery of tissue elasticity. This result is consistent with that of Li et al. [22], who demonstrated that acupotomy improves cervical muscle elasticity, although their study did not compare different anatomical sites. Our findings thus provide objective evidence that targeting the suboccipital muscles confers superior benefits in restoring tissue elasticity and overall clinical efficacy.

In terms of tissue thickness, both anatomical sites showed reductions, but the decrease was more pronounced in the suboccipital muscle group. This result is consistent with that of Yang et al. [23], who reported significant muscle thinning after acupotomy release, though without

distinguishing specific anatomical targets. Our findings suggest that acupotomy therapy directed at the suboccipital muscles is more effective in reducing tissue hypertrophy, likely due to their deeper anatomical location and close relationship with the occipital nerve [24, 25].

Regarding safety, the incidence of adverse reactions was significantly lower in the suboccipital muscle group compared with the posterior arch group. This suggests that, even under ultrasound guidance, procedural safety may vary by anatomical site. The higher risk in the posterior arch region may be attributed to its greater vascular and neural distribution and more complex anatomy, which increase procedural difficulty [26]. These findings emphasize the need for individualized treatment planning in patients with cervicogenic dizziness.

The innovation of this study lies in its systematic comparison of ultrasound-guided acupotomy at two anatomical targets - the suboccipital muscles and the posterior occipital tendinous arch - using multidimensional indicators, including both conventional clinical outcomes and advanced SWE parameters. Nonetheless, several limitations should be acknowledged. First, the follow-up period was limited to one month, preventing evaluation of long-term efficacy and recurrence. Second, the sample size was relatively small, which may affect generalizability. Third, only two anatomical targets were compared, without exploring other potential sites. Fourth, subgroup analyses based on etiology and disease duration were not performed.

Future studies should extend follow-up to assess long-term outcomes, increase sample size with multicenter participation, and explore additional intervention sites or combined therapeutic approaches.

## Conclusion

This study demonstrated that ultrasound-guided acupotomy targeting the suboccipital muscles was more effective than treatment at the posterior occipital tendinous arch in alleviating pain, improving neck function, increasing the pressure pain threshold of the greater occipital nerve, and enhancing cervical mobility, while also resulting in fewer adverse reactions. These findings provide a scientific basis for clinical practice, supporting the selection of suboccipital muscle release, particularly in patients with marked tension or hypertrophy. Moreover, the integration of ultrasound guidance enhances procedural precision and safety, underscoring its value for broader clinical application.

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## Disclosure of conflict of interest

None.

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