Needle contact test in auricular acupuncture for shoulder pain and where effective auricular acupoints identified are positioned on the map: A controlled study

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Abstract

Active Points Test on auricle was renamed Needle Contact Test (or NCT), considered an extremely effective method to select most efficient auricle acupoint for Auricular Acupuncture (or AA) therapy. Our aims were to evaluate NCT efficiency as viable diagnostic option to identify the most appropriate AA acupoints to be selected for SupraSpinatus Tendinopathy (SST) associated shoulder pain treatment and to evaluate which auricle area has greater concentration of NCT positive acupoints in subjects with SST shoulder pain, comparing results with available AA ear maps. 45 subjects with SST diagnosis were enrolled. On 30 subjects in treatment group, NCT was performed on acupoints of the auricle shoulder representation areas (i.e., Scaphoid Fossa), while in 15 subjects of control group, NCT was performed on auricle areas not shoulder associated. Statistically significant lower Numeric Pain Rating Scale scores were seen for study group over time and compared to control. A small sample showed statistically significant increase of SST shoulder maximum abduction range of Movements. NCT identified best SST shoulder pain AA acupoints in Scaphoid Fossa (or SF1 and SF2). In conclusion NCT is a viable tool to efficiently identify the best AA acupoints in SST shoulder pain treatment.

Key Words: Needle contact test; auricular acupuncture; ear acupuncture; shoulder pain trial.

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Auricular acupuncture (AA) is a therapeutic procedure that has probably been used for centuries.[1] AA as known today, came to existence empirically in the fifties, based on observations made by Dr. Paul Nogier on patients who suffered from sciatic pain treated with cauterizations done on the auricle.[2] AA is considered a microsystem in Traditional Chinese Medicine acupuncture, with the characteristic of being used both for therapeutic and diagnostic purposes.[3] Marco Romoli investigated how the auricle can reflect the patient's health status by recording the decrease in number of tender AA points corresponding to the lumbar region following the decrease of lumbar pain obtained with epidural infiltrations.[4] Stefano Marcelli in 1995 suggested the Active Points Test (APT) for somatic acupuncture. How to do APT was explained as follows: "position the needle perpendicular to the surface of the somatic acupoint, touching the surface without penetrating the skin with the needle". The test proved to be diagnostic when, if the point was "active", the patient would experience a transient but significant improvement in reported symptoms.[5,6] Romoli investigated the APT, as proposed by Marcelli, on the auricle and renamed it Needle Contact Test (NCT) describing NCT as an extremely effective method to select the most efficient acupoint on the auricle for AA therapy.[7] NCT is as follows. First ear inspection is carried out followed by detection of AA points with diagnostic procedures such as the Pressure Pain Test (PPT) and/or Electrical Skin Resistance Test (ESRT) to identify the most active AA points.[8] Each point is then "challenged" with NCT, where an acupuncture needle (from which the tip was removed earlier) is placed on a selected AA acupoint for about 10 seconds, without skin penetration but with enough pressure to create a small area around the needle of skin blanching (due to the

ischemic effect of the pressure from the needle) (Figure 1). After 60 seconds from removal, the NCT is to be considered positive if the subject reports a significant modification of assessed symptom (i.e., a reduction of acute pain). If there are no appreciable symptom differences, then other identified AA points can be challenged to ascertain the best AA point for the most efficient AA therapy. In a study conducted at the University of Turin on 15 women examined during migraine crisis, 62 sensitive auricular points were detected, with a mean of 4.1 points identified per subject. Of these identified acupoints, 64.5% (mean 2.6 points per subject) were found with NCT to be effective on reducing pain and to be exceptionally effective if found on the auricle ipsilateral to the pain.[9] A following study enrolled 94 women observed during migraine crisis (the crisis could not have started more than 4 hours from the moment of investigation of the auricle) and randomized in 2 groups. Pain was measured using a Visual Analogue Scale (VAS) at different moments throughout the study. In one group NCT was carried out on the auricle ipsilateral to migraine pain and ASP Sedatelec® semi-permanent needles were positioned on the active acupoints as identified by NCT. In the control group, the lower root of the antihelix (i.e., area of representation of the sciatic nerve, thus not being representative of migraine areas on the auricle) was inspected with NCT and similarly treated with ASP Sedatelec® semi-permanent needles. Of the 89 women who completed the study, those in the NCT group obtained a statistically significant reduction in VAS measured pain ($p < 0.001$) while the control group did not obtain any significant decrease, suggesting the therapeutic specificity of identified active acupoints found with NCT on the auricle.[10] Shoulder pain affects about 18-26% of the adult population.[11] A differential diagnosis is necessary as shoulder pain is often not localized but referred and/or projected.[12] The shoulder is an intricate complex of joints with extraordinary flexibility whose stability necessarily depends on the muscle and tendon support inside (i.e. the rotator cuff) and outside of the joint capsule.[12] There is abundant literature on how to classify shoulder pain.[13] Shoulder pain can be classified on the basis of clinical practice into: rotator cuff tendinopathy, including Supraspinatus tendinopathy (SST),[14] biceps tendinopathy,[15] adhesive capsulitis (or frozen shoulder),[16] acromioclavicular joint syndrome,[17] specific shoulder disorders and non-specific pain,[18] and neck/shoulder disorders.[19] SST frequently is due to chronic overuse in overhead shoulder movement associated with subacromial impingement and vascular deficit resulting in chronic tendon inflammation. SST is typical in individuals who move their arms above shoulder level for a long time and /or repeatedly due to work and/or sports activities.[20] Diagnostic criteria for SST evaluation include pain and range of Movements (ROM) assessment. The upper limb representation on the auricle is located on the Scaphoid Fossa (SF). Oleson's map divides the SF into six areas. The shoulder is represented in the areas SF1 and SF2 (Figure 2).[21] Primary objective was to evaluate efficiency of NCT as viable diagnostic option to identify the most appropriate AA acupoints to be selected for treatment of shoulder pain associated with SST. Outcome measurements used were pain assessment with Numeric Pain Rating Scale (NPRS) and affected shoulder Range of Movements (ROM). Secondary objective was to evaluate which area of the auricle showed a greater concentration of NCT positive acupoints in subjects with shoulder pain due to SST and to compare the results with available AA ear maps.

Materials and Methods

Subjects with a diagnosis of SST were enrolled. Subjects were enrolled from a local family doctor's outpatient clinic with a limited catchment area of about 6000 patients. All subjects gave written informed consent for study participation. Baseline demographic data was collected (i.e., age and gender).

The inclusion criteria for the study were: to have ongoing shoulder pain or shoulder pain elicited by a movement of the arm, to be 18 years of age or more, positive empty can test, MRI or Ultrasound confirmation for SST.

Exclusion criteria: pregnancy, tendinopathy due to systemic pathologies, autoimmune diseases, neoplastic pathology, degenerative diseases of the central and/or peripheral nervous system, non-compensated diabetes, benzodiazepine therapy and patients suffering with psychiatric disorders.

Subjects were randomly allocated in two groups as follows. 30 subjects were assigned to the treatment group (or group NCT) where NCT was performed on acupoints on the shoulder representation areas of the auricle, while 15 subjects were assigned to the control group (or group SHAM) where NCT was performed on an area of the auricle that is not considered to be associated with the shoulder (i.e., the inferior hemi concha). The asymmetrical number of subjects allocated to the 2 groups was decided to allow a higher number to be investigated in the NCT group, so much so allocation was done on a 2 to 1 basis (i.e., for every 2 subjects given to the NCT group 1 subject was allocated to the SHAM group in order of arrival). In both groups the auricle ipsilateral to the painful shoulder was examined to identify active AA points. Areas inspected for shoulder pain were chosen as given by Oleson's AA map for where the shoulder is represented (i.e., areas SF1 and SF2) (Figure 2).[22] In group NCT a first evaluation to identify tender AA points was carried out by PPT in the SF1 and SF2 areas (as in Oleson's AA map) using the 250 g blue Sedatelec® palpeur. The detected tender AA point was marked with a demographic pen. If several tender AA points were detected, PPT was repeated in order to raise the sensitivity threshold of the points to identify a

Table 1. *Subject characteristics.*

	Total	Group SHAM	Group NCT	p-value
No. of patients	45	15 (33.4%)	30 (66.6%)	
Age, years mean (SD)	52.3 (19.9)	58.3 (18.7)	49.3 (20.2)	0.206
Gender, n (%)				
Female	21 (46.7%)	6 (40.0%)	15 (50.0%)	0.752
Male	24 (53.3%)	9 (60.0%)	15 (50.0%)	

NCT: Needle Contact Test; SD: Standard Deviation.

maximum of two points per subject. In group SHAM the NCT was performed with the same technique but in an area that did not represent the shoulder (i.e. inferior hemi concha) and without prior PPT detection. The NCT was performed with a Seirin® type B needle 0.30 x 30 mm brown handle. Before performing the NCT, the pointed tip of the needle was removed using a bandage scissors, to be able to place the pointless needle on the skin of the auricle without risking skin penetration. To perform NCT the identified detected tender AA acupoint was challenged by placing the pointless needle on the skin with enough pressure to obtain skin blanching for 10 seconds, without skin penetration (Figure 1). Shoulder pain was assessed with Numeric Pain Rating Scale (NPRS) for pain where 0 represents “no pain at all” and 10 represents “the worst pain ever possible”. NPRS was assessed on all subjects before performing NCT (or at T0), after 1 minute (or T1) and at 5 minutes (or T2) from performing NCT, respectively. Furthermore, on 15 subjects in group NCT, measurement of maximum ROM abduction of the painful SST shoulder using a 2-arm medical goniometer was carried out at T0, T1 and T2. Only 15 subjects were investigated as regarded ROM due to resource constraints. Data was collected and analyzed nevertheless since it was regarded that results would aid the studies objective. Descriptive statistics are reported as the mean and standard deviation for quantitative data and as frequencies and percentages for qualitative data. Pre vs post comparisons were performed with ANOVA, while comparisons between the two groups were performed with independent samples t-test. The normality of the quantitative variables was tested using the Shapiro-Wilk test. The significance was set at 0.02 after application of the Bonferroni correction. Comparison between groups with respect to the variable Gender was performed by Fisher's exact test. As regards ANOVA, Box's conservative epsilon was used to adjust for the lack of independence between repeated observations. Effect sizes were determined for both statistical tests. Statistical analyses were performed using STATA17 (StataCorp., College Station, TX, USA).

Results

~~A~~ total of 45 subjects were recruited and completed all evaluation and treatment sessions for the study. Demographic data showed a total of 21 females and 24 males with mean age of 52.3 ± 19.9 years. Mean age of group SHAM (mean 58.3 ± 18.7 years) was slightly higher than group NCT (mean 49.3 ± 20.2 years), though not statistically significant (p= 0.206). Gender difference between groups resulted not statistically significant. Subject characteristics are shown in Table 1. NPRS assessed at T0 was slightly higher in group NCT (mean 6.4 ± 1.0) than in group SHAM (mean 5.6 ± 1.7) with no statistically significant difference between the two groups (p = 0.0551). At T1, group NCT (mean 2.9 ± 1.4) reported statistically significant (p = 0.0005) lower NPRS scores than group SHAM (mean 4.7 ± 1.7). The same trend was observed at T2 where group NCT (mean 3.4 ± 1.4) reported statistically significant (p = 0.

Table 2. *NPRS assessment at T0, T1 and T2 for all subjects evaluated as a whole (or Total), for group SHAM and for group NCT, respectively. NPRS scores are shown as mean and standard deviation.*

	Total (n = 45)	Group SHAM (n = 15)	Group NCT (n = 30)	p-value*	Cohen’s d
T0	6.1 (1.3)	5.6 (1.7)	6.4 (1.0)	0.0551	0.623
T1	3.5 (1.7)	4.7 (1.7)	2.9 (1.4)	0.0005	1.190
T2	3.8 (1.5)	4.7 (1.3)	3.4 (1.4)	0.0028	1.002
p-value§	< 0.0001	0.0008	< 0.0001		
Effect-size	1.547	3.299	1.922		

*NPRS Numeric Pain Rating Scale (from 0 minimum to 10 maximum), NCT Needle Contact Test, T0 baseline assessment, T1 assessment at 1 minute after NCT, T2 assessment at 5 minutes after NCT; * T-test on independent samples, § ANOVA with Box's conservative epsilon.*

Fig 1. *The needle contact test.*

0028) lower NPRS scores than group SHAM (mean 4.7 ± 1.3). ANOVA revealed a significant decrease in NPRS value from T0 to T2 on all subjects ($p < 0.0001$, effect-size 1.547), in group NCT ($p < 0.0001$, effect size 1.922) and in group SHAM ($p = 0.0008$, effect-size 3.299), respectively. The greatest decrease was observed in group NCT where mean NPRS at T0 was 6.4 ± 1.0, at T1 was 2.9 ± 1.4 and at T2 was 3.4 ± 1, 4, respectively ($p < 0.0001$). Full results are in Table 2 and

Table 3. *ROM assessment at T0, T1 and T2. Analysis done on 15 subjects in Group NCT. ROM scores are shown as mean and standard deviation.*

	Mean (SD)
ROM T0	110.7 (18.3)
ROM T1	148.3 (11.8)
ROM T2	167.7 (7.5)
p-value§	< 0,0001
Effect-size	2.674

ROM Range of Motion in degrees; NCT Needle Contact Test; T0 baseline assessment; T1 assessment at 1 minute after NCT; T2 assessment at 5 minutes after NCT.

Figures 3 to 6. A subgroup analysis was performed on a small sample of 15 subjects from group NCT where measurement of maximum ROM of the painful SST shoulder abduction was assessed at T0, T1 and T2, respectively. This sample showed a statistically significant increase ($p < 0.0001$, effect-size: 2.674) in ROM from T0 (mean ROM 110.7° ± 18.3°) to T2 (mean ROM 167.7° ± 7.5°). Results in Table 3. On the 30 subjects in group NCT, an AA point tender to PPT was found on 18 subjects in the SF2 area and on 12 subjects in the SF1 area of Oleson's AA map.

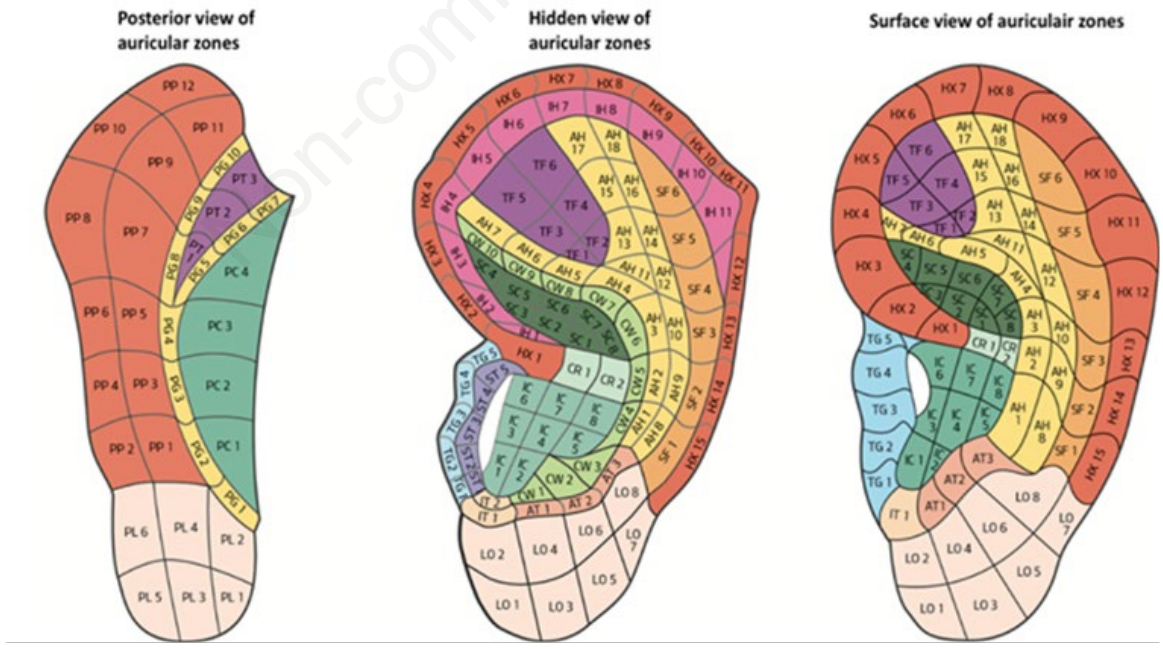

Fig 2. *Image taken from "Agopuntura Auricolare teoria e clinica", Antonello Lovato, NOI Edizioni 2019 with the division into areas according to the nomenclature of T. Oleson 1980.*

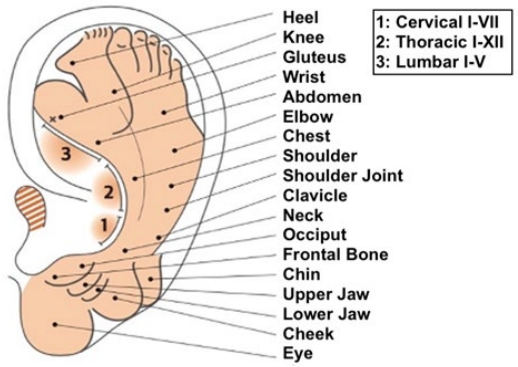

Fig 3. *Image taken from "Agopuntura Auricolare teoria e clinica", Antonello Lovato, NOI Edizioni, 2019, representing the historical map of P. Nogier drawn by G. Bachman..*

Discussion

Both the Chinese and the French AA schools identify the representation of the shoulder on AA maps to be in the Scaphoid Fossa (or SF), in SF1 and SF2 as shown in Oleson's AA maps. Nevertheless, the AA points that represent the shoulder are three for the Chinese AA school and one for the French AA school. In 1957 Paul Nogier published his first AA map, as drawn by G. Bachmann.[2] As regards the shoulder, this map identified three representative AA points, namely: shoulder, shoulder joint and clavicle (Figure 3). The French school then changed from three AA points representing the shoulder in the SF to a single AA point. This single AA point representing the shoulder is located in an area of the SF which is found on a line drawn passing through Point Zero and between the cervical vertebra

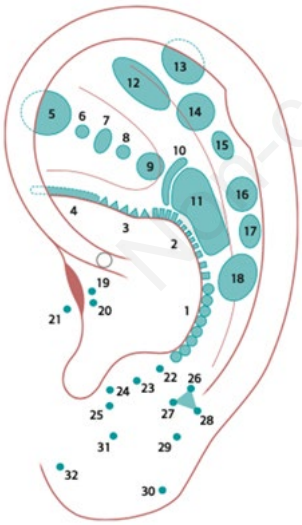

Fig 4. *Image taken from "Agopuntura Auricolare teoria e clinica", Antonello Lovato, NOI Edizioni, 2019, with the somatotopic representations of the body and of the upper limb, according to Nogier (i.e. "18" is Point Shoulder, "1" is Cervical Spine C1-C7, "2" is Thoracic Spine T1-T12).*

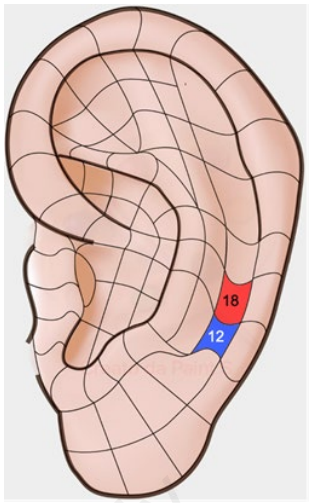

Fig 5. *Auricle areas sensitive to Pain Pressure Detection in the Scaphoid Fossa (or SF) called SF1 (in blue) and SF2 (in red). Number of subjects of NCT group were the acupoint was found active, that is 12 subjects in SF1 and 18 in SF2, respectively.*

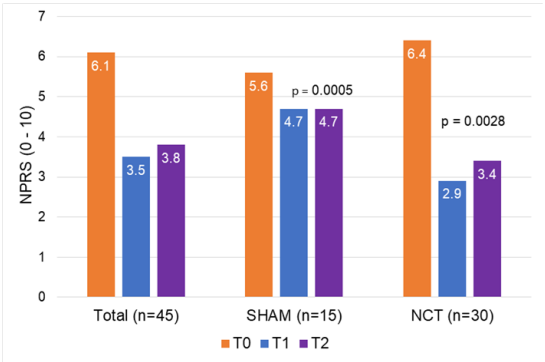

Fig 6. *Fig 6. NPRS assessment at T0, T1 and T2 for all subjects evaluated as a whole (or Total), for group SHAM and for group NCT, respectively. NPRS scores are shown as mean. NPRS, Numeric Pain Rating Scale (from 0 minimum to 10 maximum), NCT Needle Contact Test, T0 baseline assessment, T1 assessment at 1 minute after NCT, T2 assessment at 5 minutes after NCT.*

and the thoracic vertebra representation area on the antitragus (i.e., at the C7-D1 point) (Figure 4). Each detected acupoint must be tested to find the mo). Nevertheless, it has been frequently stated that AA treatment for any condition must be done using the most effective AA acupoints.[23]

It is the authors' opinion that the best point to treat in AA is the most active AA point found on the single patient that is treated for the reported symptom. st "active" one, thus to obtain the most effective AA treatment. Furthermore, the AA maps can give an indication to where the area that represents a certain anatomic part of the body may be, but it must be the practitioner who has to find where the active acupoint is on each single patient's auricle, since each patient may have an AA acupoint in a slightly different position if compared to the standardized position shown on an AA ear map.

Furthermore, it must be considered that no patient has exactly the same ear as the one drawn on AA maps. The AA points shown on AA maps are standardized to a position as found on the many subjects studied through PPT and ESRT detection, but can be not found in the expected standardized auricle position on the patient's ear as examined in that moment. Searching for the shoulder pain activated AA acupoint in SF1 or in SF2 in the subjects in group NCT leads to believe that an exact location on every single patient for this AA point as regards shoulder pain due to SST is not possible. Thus, it is reasonable to believe that most likely, due to the anatomical complexity of the shoulder joint, its representation is in a very large area of the SF (as originally described by Nogier and as currently shown by the Chinese Standardization (Figure 5). When these SF AA points were challenged with NCT an overall significant reduction of NPRS between T0 and T1, a slight reduction between T1 and T2 and a significant overall reduction between T0 and T2 was obtained in group NCT. NCT obtained a reduction of rated pain, when compared to baseline, of 55% at T1 and 47% at T2, respectively. On the other hand, the same evaluation done on the control group resulted in a mean reduction of only of 17% at T1 and T2, respectively. Nevertheless, as shown in Table 2, the modest reduction in mean NPRS scores measured in group SHAM revealed to be statistically significant ($p = 0.0008$). However, in group SHAM the NPRS assessed at T1 and T2 showed the same mean score, while in group NCT the NPRS mean scores increased between T1 and T2 assessments, as foreseen since pain reduction is expected to be limited in time. Furthermore, NPRS score reduction between T0 and T1 and between T0 and T2 was minimal in group SHAM when compared to group NCT.

Thus, it is reasonable to assume that the statistical significance of the modest reduction in mean NPRS scores measured in group SHAM could be associated to a placebo effect (i.e., the positive expectations from an AA shoulder pain treatment). NCT showed that the challenged acupoint had a therapeutic effect when stimulated, so much so subjects immediately reported the positive effect on the pain symptom. The reported symptom modification though was transient due to the mild and short-time limited stimulation. Furthermore, group NCT resulted in an overall significant increase in ROM between T0 and T1, a significant increase between T0 and T2 and slight increase overall between T1 and T2. The effect of the NCT challenge on active AA points, identified through PPT and/or ESRT and then selected, as regards the reported pain symptoms is clearly evident (Figure 6). Thus, AA therapy done with selected AA points that gave positive results at the NCT challenge will give the best results. It must be pointed out that time spent to do the NCT can significantly increase time dedicated to the choice of AA points to treat. Nevertheless, the time spent is frequently rewarded by the fact that the patient can immediately experience the change in the reported symptom (though limited in time) due to stimulation of the selected AA point, confirming the expectation of obtaining results from the AA therapy.

Limitations of the study can be identified as follows. A limited number of patients have been evaluated if compared to the number of patients suffering from shoulder pain in the population. A greater number of subjects to enroll would give a higher value to results obtained. Nevertheless, the study was carried out in a local family doctor practice where resources and patient numbers are already very limited. NPRS at T0 was seen to not be different between the two groups, though the statistical significance was close ($p = 0.0551$). Thus, group NCT could have had subjects with more pain than group SHAM. However, it must be noted that NCT was effective in obtaining a reported pain improvement that was statistically significant. The effect of NCT may be due to the therapeutic stimulation of the AA point even though it was stimulated for only 10 seconds since the shoulder pain was chronic, but no follow-up from the treatment was done to evaluate efficiency of treatment. No follow-up after the last AA treatment session was done to see if the AA points selected after NCT were still active. Lastly, the use of exclusion criteria to wean out subjects highly influenced by the placebo effect could better validate results obtained.

In conclusion, NCT is a viable tool to efficiently identify the best AA acupoints for treatment of patients with shoulder pain due to SST. Precise AA acupoint identification on the single patient is important for AA treatment to be efficient and reach the goal to eliminate or at least significantly reduce shoulder pain for improvement of patient's quality of life.

Further studies on NCT to identify active AA acupoints in subjects with pain in other regions would allow to further demonstrate the use of NCT to identify the most efficient AA point to use in AA therapy for pain.

List of acronyms

AA - Auricular Acupuncture
APT - Active Points Test
ASP - Semi-Permanent Needle ("A" is for "Aiguille" in French)
Electrical Skin Resistance Test (or ESRT)
MRI - Magnetic Resonance Imaging
NCT - Needle Contact Test
NPRS - Numeric Pain Rating Scale
PPT- Pressure Pain Test
ROM - range of Movements
SF1 and SF2 - Scaphoid Fossa 1 and 2
SST - SupraSpinatus Tendinopathy
VAS Visual Analogue Scale (or

Contributions of Authors

AL: Conceptualization; GG, FC: Methodology; MP, MB: Data curation and formal analysis; AL, MP: Writing; AL, MP, FC: Review and Editing; AL, FC: Supervision. All authors have read and approved the final edited typescript.

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Conflict of Interest

The authors declare no financial, personal, or other conflicts of interest.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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