Are auricular maps reliable for chronic musculoskeletal pain disorders?  
A double-blind evaluation  

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Abstract
Aim To examine the proposed somatotopic relation between the regions in which patients report musculoskeletal pain and tender points located on the external ears according to a map based on commonly used auricular acupuncture maps.

Methods Twenty-five patients (16 women) from a chronic pain clinic were included. Patients were asked, before examination of the external ears, if they had past or present musculoskeletal pain in any of 11 body regions. An ear map, collapsed into 11 zones representing the musculoskeletal system, was used. The ear examiner was blinded to the patients' pain conditions, medical history and ongoing treatment. Patients communicated with the examiner only to express if tenderness was present in the external ear on palpation using a spring-loaded pressure stylus commonly used for auricular acupuncture. The degree of tenderness was registered on a 5-point scale and dichotomised (no tenderness or tenderness). Agreements between the patients' painful body regions and tenderness in the external ear zones were presented as percentage, kappa values, sensitivity and specificity.

Results The 25 patients reported 116 past or present musculoskeletal pain regions and had 110 tender ear zones. No statistically significant agreements were found between the painful body regions and the corresponding tender ear zones.

Conclusions Our results did not show agreements between patients' reported musculoskeletal pain regions and tender zones in the external ears assessed according to commonly used maps in auricular acupuncture using a pressure stylus. However, very tender points occur on the external ear in a population with chronic musculoskeletal pain.

Keywords
Auricular acupuncture, auriculotherapy, ear acupuncture, regional musculoskeletal pain.

Introduction
Auricular acupuncture, ear acupuncture, or auriculotherapy (here regarded as synonyms, and the term 'auricular acupuncture' will be used to include all) is frequently used as an adjuvant therapy in body acupuncture treatment for pain, but is sometimes used as a sole method. Auricular acupuncture is commonly used in substance abuse programmes to diminish craving, anxiety, and other withdrawal symptoms.  

The method is based on the idea that there is a reflex connection between the external ear and the rest of the human body, and that disorders in the body (the inner organs as well as the musculoskeletal system) are reflected in specific points on the external ear becoming distinctly tender or painful to palpation. These points are proposed to be well localised within a small area (ie within millimetres). The tenderness is expressed as a distinct pain, ie pressure allodynia that differs clearly from the perception expressed when the area close by is examined. A decreased electrical skin resistance has also been proposed for these points. In auricular acupuncture the assessed tender points are treated with small, thin acupuncture needles that can be stimulated both manually and electrically.
Historically, in China, auricular acupuncture has not been used for as long or to the same extent as body acupuncture, although some of its roots originate from there. In the 1950s Paul Nogier, a French doctor, studied and published literature on auricular acupuncture. When examining the external ear, he found that tender points occurred when the patients reported pain or other disorders in their body. He constructed an ear map where the body is represented as a foetus, the head located downwards. Oleson and co-workers have further studied and developed the method and the description of the 'body's representation in the ear' on auricular maps. These maps form the basis for auricular acupuncture.

In one study, Oleson and co-workers claim to find an agreement between musculoskeletal pain conditions and tender points in corresponding ear zones according to the auricular acupuncture maps in as many as 75.2% of the examined zones. In a paper published in 2002, the history and theories of auricular acupuncture, together with clinical trials and an assessment of its place in neuro-rehabilitation, are presented. Interestingly, the authors concluded that there was not enough evidence for accepting the neurological explanation models that have been presented regarding auricular acupuncture.

Recently the different methods used in acupuncture have been discussed, and one study has been carried out on soft tissue shoulder disorders using ear maps as the basis for the auricular acupuncture, but this was in combination with body acupuncture. In one study on low back pain, auricular acupuncture was used solely as an adjuvant therapy and could therefore not be properly evaluated. Usichenko et al., in a randomised controlled study, have evaluated auricular acupuncture and placebo in combination with patient controlled analgesia after total hip arthroplasty in 54 patients who completed the study. The specific auricular acupuncture points that were used were chosen after recommendations made by an expert's treatment protocol, and/or previously used groups of auricular acupuncture points frequently found to have lower skin resistance in patients during orthopaedic surgery. Their results demonstrated that auricular acupuncture could be used to reduce postoperative analgesic requirements.

Ceccherelli et al. have recently published a randomised controlled trial where body acupuncture in combination with auricular acupuncture was compared to body acupuncture alone in 62 patients with myofascial cervical pain. In both groups the reduced pain intensity level was statistically significant compared to before treatment, but no statistically significant inter-group difference was found. In spite of the lack of evidence, many clinicians have the opinion that tender points on the external ear are related to disorders in the musculoskeletal system and so use auricular acupuncture in their everyday practice.

We performed this clinical study to examine the proposed somatotopic relation between patients' reported musculoskeletal pain regions and assessed tender points on the external ears according to a map based on commonly used auricular acupuncture maps. To our knowledge no recent studies have been performed on the subject, therefore this new validation is proposed.

**Methods**

**Patients**

Twenty-five patients (16 women; 9 men) with chronic musculoskeletal pain were included in the study (median age 53 years; range 26 - 75). All patients had pain problems for at least six months, and no specific changes were seen before, during or after our investigation, implying a static clinical situation during the short study period. All patients were currently being treated for some regional pain condition during the period in which this study was implemented at our outpatient pain treatment clinic. They received body acupuncture, analgesics or analgesic blocks. Patients with headache, widespread chronic pain or other serious illness, or who were pregnant, were excluded. The patients did not have knowledge of the proposed auricular map. From inspection of their medical records, 17 of the 25 patients used medication. This was taken in low weekly doses only and consisted of: acetaminophen plus codeine (n=5); acetaminophen plus tramadol (n=3); tramadol alone (n=1); acetaminophen alone (n=1); acetaminophen plus non-steroidal anti-inflammatory (NSAID) (n=1); and NSAID alone (n=4). None of the patients used strong opioids or anticonvulsant drugs. Two patients used benzodiazepine, in low dosage, as night sedation (2mg or 5mg of diazepam). Four patients used antidepressants.
Procedure

The design was experimental but the assessment of tenderness of the external ears was the only procedure additional to their prescribed treatment. The patients filled out a form answering the question: ‘Do you have past or present pronounced musculoskeletal pain in any of the following regions: the cervical spine; the thoracic spine; the lumbar spine; the sacral region; the shoulder; the arm and elbow; the hand; the lower leg and foot; the muscles of the abdomen; the knee and the pelvic region; and the hip and the thigh?’

The ear examiner (EA) was blinded regarding the answers until the statistical analysis was completed and no information concerning the patients’ medical history and pain situation was given prior to assessment. The ear examiner has relevant education in acupuncture and long clinical experience of ear examinations using a pressure stylus.

For practical reasons the ear examination was performed when the patient came to the clinic for a scheduled consultation, but always before the treatment. The patient was placed supine on a treatment table. The whole body except the head was covered with a blanket, blinding the examiner from body inspection. The patient was instructed not to speak to the ear examiner, except to answer the questions concerning the degree of tenderness in each point during the external ear examination. A spring-loaded pressure stylus (Sedatelec, France), commonly used in auricular acupuncture, was used to search for tender points in the ears. The manufacturer guarantees a pressure force of 250g/mm². Both ears on each patient were examined, always beginning with the right-hand side. The ear was wiped dry with cotton to avoid the instrument sliding during the examination. The patient was asked to score the perceived pressure sensation on a 5-point Likert scale, ranging from 0 to 4, each time the ear was pressed with the stylus. Each zone was pressed with the stylus 4 to 6 times in order to cover the entire zone. The scores for the perceived sensation at pressure were: 0 = light touch, no tenderness; 1 = touch, no tenderness; 2 = slight tenderness; 3 = distinct tenderness; and 4 = severe tenderness. For an assessment to be scored as 3 or 4 we followed Nogier’s description of a pain reaction, the ‘wincing sign’, which he states is the characteristic way patients react when the palpation identifies an exact ear point. The wincing sign can be replaced by involuntary movement of the legs, arms or head. The tender locations and the scores were registered by EA on an ear drawing that did not show the zones.

The authors used Oleson’s 30 specific zones as a base and collapsed them into 11 ear zones representing the musculoskeletal system and corresponding with Nogier’s charts. Each zone in our chart thus represented a larger part of the body than in Oleson’s zones: the cervical spine; the thoracic spine; the lumbar spine; the sacral region; the shoulder; the arm and the elbow; the hand; the lower leg and foot; the muscles of the abdomen; the knee and the pelvis; and the hip and the thigh (see Figure 1).

All analyses were made after the assessments of all patients had been performed. To find out in which of the 11 ear zones the patient had reacted with distinct tenderness or severe tenderness (scores

![Figure 1 Line drawing showing the 11 ear zones, each representing different regions of the body with exception of the head.](https://www.acupunctureinmedicine.org.uk/volindex.php)
3 or 4), a transparent plastic template with a line drawing showing the ear zones (Figure 1) was placed on top of each ear drawing scored by EA. The results from the ear zone assessments for each patient were compared with the musculoskeletal pain regions that had been reported by that patient. The agreement between the tender ear zones and the body pain regions were analysed. Analyses were also made after combining the patients’ pain regions, and the proposed ear zones, into two larger body pain regions, the cervicobrachial region and the spinal region.

Statistical analysis
We chose to dichotomise the ear assessments and body regions into no tenderness (no) = scores 0-2 or tenderness (yes) = scores 3-4. Cross-tables were constructed for each of the 11 ear zones. Agreements between ear zones (yes/no) and painful body regions (yes/no) were calculated and presented as kappa values. Kappa values show the overall strength of an agreement between two variables after correcting for chance agreement, and a score of one is equal to total agreement. For an excellent agreement this value should be high, over 0.75. A fair to good agreement is represented by a value of 0.4-0.75, and agreement is regarded as poor if the value is under 0.4. In this study, we also calculated the sensitivity (the proportion of patients with pain in the specified body region who had a positive ear assessment) and specificity (the proportion of patients without pain in the specified body region who had a negative ear assessment). A positive answer was registered when tenderness was found in at least one ear for the respective ear zones. The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 11.5 Software for Windows (SPSS, Chicago, IL, USA).

Ethics
Verbal and written information about the purpose of the study and the procedure were given to all patients prior to and at the time of the assessment. They were also informed that choosing to participate or not would in no way influence their treatment in any other respect. All participants signed an informed consent. The study was approved by the Ethics Committee of Lund University (LU 358-03).

Results
All the patients’ number of body pain regions and number of assessed tender ear zones are presented in Table 1. Two of the patients did not have any tender ear zones. As can be seen, the number of painful body regions reported by our patients was 116, giving a mean of 4.6 regions in each patient. The total number of tender ear zones was 110, thus giving a mean of 4.4 zones in each patient.

Agreements
Table 2 shows an example of how the agreement calculations were performed between reported body pain regions and tender ear zones (here the cervical spine region). Agreement in percent (%), kappa

<table>
<thead>
<tr>
<th>Ear zones</th>
<th>Pain regions n</th>
<th>Tender ear zones n</th>
<th>Agreement %</th>
<th>K</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cervical spine</td>
<td>17</td>
<td>18</td>
<td>64</td>
<td>0.14</td>
<td>76</td>
<td>38</td>
</tr>
<tr>
<td>2 Thoracic spine</td>
<td>15</td>
<td>12</td>
<td>48</td>
<td>-0.03</td>
<td>50</td>
<td>57</td>
</tr>
<tr>
<td>3 Lumbar spine</td>
<td>10</td>
<td>7</td>
<td>48</td>
<td>-0.14</td>
<td>27</td>
<td>71</td>
</tr>
<tr>
<td>4 Sacral region</td>
<td>11</td>
<td>2</td>
<td>48</td>
<td>-0.16</td>
<td>0</td>
<td>85</td>
</tr>
<tr>
<td>5 Shoulder</td>
<td>14</td>
<td>15</td>
<td>48</td>
<td>-0.07</td>
<td>53</td>
<td>30</td>
</tr>
<tr>
<td>6 Arm and elbow</td>
<td>11</td>
<td>8</td>
<td>44</td>
<td>-0.11</td>
<td>27</td>
<td>62</td>
</tr>
<tr>
<td>7 Hand and fingers</td>
<td>8</td>
<td>8</td>
<td>52</td>
<td>-0.10</td>
<td>25</td>
<td>64</td>
</tr>
<tr>
<td>8 Lower leg, foot and toes</td>
<td>4</td>
<td>11</td>
<td>64</td>
<td>0.22</td>
<td>75</td>
<td>61</td>
</tr>
<tr>
<td>9 Abdomen</td>
<td>3</td>
<td>7</td>
<td>60</td>
<td>-0.02</td>
<td>0</td>
<td>64</td>
</tr>
<tr>
<td>10 Knee</td>
<td>7</td>
<td>6</td>
<td>56</td>
<td>-0.14</td>
<td>14</td>
<td>72</td>
</tr>
<tr>
<td>11 Pelvic region, hip and upper leg</td>
<td>11</td>
<td>16</td>
<td>48</td>
<td>-0.01</td>
<td>63</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>111</td>
<td>110</td>
<td></td>
<td></td>
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</tbody>
</table>

www.acupuncturemedicine.org.uk/volindex.php
Table 2 Example showing how agreements between reported body pain regions and assessed tender ear zones were calculated, here in the cervical spine region

<table>
<thead>
<tr>
<th>Pain region</th>
<th>Tender ear zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>13</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
</tr>
</tbody>
</table>

Agreement \((\frac{3+13}{25}) = 64\%\)

\(k = 0.14\)

Sensitivity = 0.76

Specificity = 0.38

Table 3 Agreement between the reported body pain regions and assessed tender ear zones for pain in a larger region, combining the neck-shoulder region and the upper extremity (ear zones 1+5+6+7; n=25)

<table>
<thead>
<tr>
<th>Pain region</th>
<th>Tender ear zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>18</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
</tr>
</tbody>
</table>

Agreement = 76 %

\(k = 0.11\)

Sensitivity = 0.86

Specificity = 0.25

Table 4 Agreements between the total number of reported body pain regions and ear zones assessed as tender out of the maximum possible in 25 patients (275)

<table>
<thead>
<tr>
<th>Tender ear zones</th>
<th>Pain regions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes n (%)</td>
</tr>
<tr>
<td>Yes</td>
<td>46 (16.7%)</td>
</tr>
<tr>
<td>No</td>
<td>65 (23.6%)</td>
</tr>
<tr>
<td>Total</td>
<td>111 (40.3%)</td>
</tr>
</tbody>
</table>

Agreement = 53.1 %

\(k = 0.02\)

Sensitivity = 0.41

Specificity = 0.61

values \((k)\), and sensitivity and specificity are presented in Table 1.

In Table 3, the analysis of a larger region, ie the whole neck/shoulder and upper extremity region and tender ear zones is presented. A similar analysis combining pain in the cervical spine, the thoracic spine, the lumbar spine and the sacral region (ear zones 1+2+3+4), gave agreement = 76\%, kappa value = 0.12, sensitivity = 0.81 and specificity = 0.33.

Twenty of the 25 patients (80\%) were tender in the ear zones 10 or 11 (knee or pelvic region, hip and upper leg); but only 14 of the 25 patients (56\%) reported pain in these body regions. Nineteen of the 25 patients (76\%) were tender in the ear zones 1 or 5 (cervical spine or shoulder) whether or not they had reported pain in these body regions.

Discussion

Our results do not support the hypothesis that, when using manual palpation with a spring-loaded pressure stylus, there is a significant agreement between the regions in which patients reported musculoskeletal pain regions and the tender ear zones according to the maps used in auricular acupuncture. However, we have found that very tender points occur on the external ear in a population with chronic musculoskeletal pain.

Double-blinding was carefully applied and we have not found anything that could have invalidated it. The patients had no problems with understanding instructions or cooperating at the clinical assessment, and showed no hesitation or difficulties in reporting if tenderness was present in the ear zones.

Most of our patients reported both past and present musculoskeletal pain in many body regions. All patients had had their pain problems more than six months, and no specific changes were seen before, during or after our investigation. Cutaneous sensitivity might change during the course of the disease, which could have an impact on the findings, especially the sensitivity and specificity, but this is not a problem here because the patients' conditions were static during the study period.

Our study is limited in not using a healthy control group. Although it may be difficult to find a group of people who have not experienced any musculoskeletal pain, in order to strengthen the design in future studies it is desirable to include healthy patients, or those who have only experienced pain from a few body regions or only have acute pain.

All patients were suffering from chronic musculoskeletal pain and their medication did not change during our short observation period. Most of the patients only used analgesic medication occasionally, since the drugs were not experienced as being effective. Because of their chronic pain conditions patients had tried many varying treatment modalities without effect before they were seen at...
the pain treatment clinic. Medication in the present study consisted of common analgesics, and was used in low weekly doses only. None of the patients used strong opioids or anticonvulsants. The two patients who took benzodiazepines used them as night sedation and not for the pain. (Benzodiazepines are not prescribed for chronic pain in Sweden). The four patients who used antidepressants had started doing so long before coming to the pain treatment clinic, and were still experiencing pain. If the analgesic medication had been more pronounced in our patients the number of tender locations on the outer ear might have been less numerous. On the other hand, it might be that the tender ear zones connected with the most painful body regions could be the ones least influenced by medication. However, the drugs ought to interact with the sensitivity of the whole ear, and not only the ear zone corresponding to a specific pain condition. Thus, it is not likely that patients on analgesic medication have other tender ear zones than those corresponding to their pain problem.

Since the basis for the present study was to examine the most commonly used clinical method for assessing tenderness of the external ear, ie point searching with a manual pressure stylus, we chose not to include electrical resistance assessment. Moreover, the precision of the apparatus available on the market has been considered imprecise. In view of the difficulty of accurately measuring electrical resistance at ear points Margolin et al did not recommend the use of electrical devices for point determination. They concluded that there seems to be little scientific basis for the preselection of specific points for needle insertion within auricular zones and recommend that needle placement should be based upon clinical judgement.

It might be argued that, for our small study group (n=25), gender difference might play a great role in pain threshold measurement. We could not however, detect any obvious differences between the males and females in our study. Moreover, our patients had multiple pain locations, and to study gender differences, with a tight topography of potentially ‘active’ auricular acupuncture points, one needs a homogenous group of patients with, if possible, a single source of musculoskeletal pain (eg arthritis of the knee or frozen shoulder) with comparable history of chronic pain (cause and duration), similar analgesic medication and a sample of at least 50. Other limitations of our study could be the method of collapsing Oleson’s areas into manageable zones, which was for purely pragmatic reasons, and the fact that we did not include the posterior auricle.

Our results differ from those of Oleson et al, presented in 1980. Whereas we found no agreements between ear zones and painful regions, they presented an agreement of 75.2% when analysing their results using the chi square test. Furthermore, they used the number of ear zones from all of the assessed patients as 480 independent observations, whereas it would perhaps have been more correct to use the 40 patients as independent observations. However, we did not plan to directly replicate Oleson’s study, but to develop this new method of validation by examining the relation between patients’ reported musculoskeletal pain regions and assessed tender points on the external ears.

For further discussion we made some additional exploratory analyses. The number of painful body regions reported in our study was 111 and the number of tender ear zones was 110. Thus we have 110 tender ear zones among 275 possible (25 patients and 11 possible ear zones) = 40%. We also have 111 painful body regions among 275 possible (40.4%). If the tender ear zones are distributed in a random manner, there would be a (40.4% x 40%) 16.2% chance that a given body pain region would have tenderness of the corresponding ear zone according to the auricular map. As can be seen from Table 4, the actual value was 16.7% in our study, strongly suggesting that the overall result is due to chance.

Clinical perspectives
In clinical practice, it is the question of the sensitivity of the manual palpation with a pressure stylus that is relevant, eg how great is the chance of detecting a tender ear zone when a region of the body is reported painful. As a diagnostic tool, this method is of course not sufficient when assessing pain patients in a clinical setting. The auricular maps are mostly used as an aid to find tender ear zones quickly for treatment with needling. If the maps are to have a clinical value they must be valid in almost all patients.

As can be seen from Table 1, the most common zones presenting tenderness, whether the patient had a pain problem in the proposed corresponding body region or not, were the ear zones 1, 2, 5, 8 and 11. It is worth noting that the ear zones 10 or 11 (knee or
pelvic region, hip and upper leg) were tender in 80% of the patients, although only 56% had pain in these regions (Table 1). Those familiar with auricular acupuncture can see that these zones are situated where point Shenmen is located, a point proposed to be used in cases of anxiety or tension. Future studies should consider including psychometric scales.

Perhaps the auricular map does not exist in any detail at all. One speculation could be that pain conditions in the body, through the process of central sensitisation and neural convergences, induce spots of pressure allodynia on the outer ear, and perhaps even on other places on the body, but without any somatotopic arrangement.

Can auricular acupuncture with needles inserted in the painful points of the external ear be used without considering the ear zones described on the maps? To be able to answer this question, further research on larger groups of patients is needed.

However, one clinical suggestion arising from this study might be: for any pain condition, if you find tender ear zones – use them for needling. Thus, in clinical practice, perhaps what is most important is just to insert the needles in the most tender points of the external ear and rely on general mechanisms for pain relief, the diffuse noxious inhibitory control (DNIC), and long term depression of neuronal activity, as a way to achieve rather short term clinical effects.

Conclusions
Our results did not show any agreement between the regions in which patients reported musculoskeletal pain and the tender ear zones located in the external ears according to commonly used maps in auricular acupuncture, when using a pressure stylus. However, very tender points occur on the external ear in a population with chronic musculoskeletal pain. We suggest that future studies are performed on a homogeneous group of patients with a single source of musculoskeletal pain, including a gender and age matched control group without pain, and that assessments are done using both a manual pressure stylus and by electrodermal measurements.

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Competing interests: None declared

Summary points

<table>
<thead>
<tr>
<th>It has been proposed that there is a somatotopic relation between the regions in which patients report musculoskeletal pain and tender points located on the external ears.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very tender points occur on the external ear in a population with chronic musculoskeletal pain</td>
</tr>
<tr>
<td>This study did not show any relationship between musculoskeletal pain regions and tender zones in the external ears assessed according to commonly used maps in auricular acupuncture using a pressure stylus</td>
</tr>
<tr>
<td>Further studies should include a more homogeneous group of patients and test both manual and electrodermal measurements</td>
</tr>
</tbody>
</table>

Reference list


