The Clinical and Physiological Foundation of Auricular Acupuncture Therapy in Patients with Hypertensive Disease

P J Gaponjuk, T Ju Sherkovina

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Summary
The haemodynamic influence of each of 16 pairs of auricular acupuncture points was studied in 104 hypertensive patients who were classed according to circulation type. Changes in heart rate, stroke output and peripheral vascular resistance were measured, so that the degree of change could be charted for each acupuncture point. It became clear that certain groups of ear points induced a fall in blood pressure by influencing change in one or more of these cardiac parameters.

The ear has a particularly rich nerve supply derived from several cranial and upper cervical nerves and it is possible to explain the hypotensive action of specific groups of acupuncture points by reference to their innervation. The most effective auricular acupuncture points for hypertensive patients of each circulation type can thus be accurately predicted.

Key words
Acupuncture, Auricular acupuncture, Hypertensive disease.

Introduction
The literature provides evidence for the therapeutic effect of acupuncture in treating patients with hypertensive disease (1-12). At the same time the choice of reflex zone for the acupuncture stimulation has not been finally established.

The aim of this study was to evaluate the haemodynamic response of hypertensive patients with different types of blood circulation, to acupuncture stimulation at specific auricular points.

The types of blood circulation were determined in accordance with haemodynamic normal values worked out at the AUCSC of the USSR Academy of Medical Sciences, taking into account the patient's age and sex. They were divided into Hyperkinetic, Hypokinetie and Eukinetie circulation, characterised as follows:

Hyperkinetic
Increased cardiac output (stroke and minute volumes), tachycardia
Normal to low peripheral vascular resistance
High systolic blood pressure

ECC: raised ST segment and flattened T wave, arrhythmias
Asthenic type of body constitution
Normal diet or undernourished
Intensive headaches, heartache
Emotionally labile, sleep disturbance
Marked dermographia
Finger tremor of outstretched hands
Hypertensive crises develop without warning but are readily controlled by drugs or subside with a return to normal sleep pattern, rest and daily routine.

Hypokinetic
Decreased cardiac output (stroke and minute volumes), bradycardia
Increased general peripheral resistance
High diastolic arterial pressure, reduced pulse pressure
ECC: lowered ST segment and bifid or inverted T wave
Hypersthenic type of body constitution, obesity
Dull headaches lasting all day
Giddiness with a systemic character
Shortness of breath with normal exercise
Oedema of face and extremities
Hypertensive crises develop slowly, accompanied by sharp headache, nausea and vomiting, apathy, sleepiness, disorders of vision and hearing, sometimes bradycardia.

Eukinetie
It is difficult to describe this type clinically.
Normal cardiac output
General peripheral vascular resistance slightly increased
High systolic and diastolic blood pressures
Normal type of body constitution
Hypertensive crises develop quickly, with initial high arterial pressure accompanied by disturbances of a regional-cerebral character.

Using the hypertension classification of the World Medical Organisation, hypertensive disease is separated into stages I, II and III. Stage I is uncomplicated hypertension. Stage II shows evidence of left ventricular hypertrophy on X-ray and ECG, and
hypertensive ophthalmic fundal changes. Stage III shows symptoms of organic cardiovascular disease such as arteriosclerosis of the kidneys, heart and brain, and hypertensive damage to other organs. The hyperkinetic blood circulation type generally occurs in stages I and II. Hypokinetic and euokinetic types are usually found in stages II and III. None the less, this division into circulation types is clinically relative and a more precise definition can be obtained by the use of tetrapolar chest rheography.

Chest rheography (impedance cardiography) is a non-invasive method of investigating the cardiovascular system, in which the electrical resistance of tissue (impedance) is measured in vivo (13). The chest impedance changes according to the blood flow during the cardiac cycle, thus measurement of stroke volume and general peripheral vascular resistance is possible. The use of four electrodes in tetrapolar rheography, as described by Kubichek et al. (14) and modified by Pushkar et al. (15), makes measurement of cardiac indices more accurate. This was the method we adopted.

Method
We studied 104 patients with hypertensive disease Stage I-II with different types of blood circulation and investigated the effects of 16 pairs of auricular points: Brain, Subcortex, Sympathetic, Diaphragm, Point of relaxation, Ren, Shenmen, Hypotensive, Cor, Hypertension, Subren, Brain stem, Ear apex, Lesser occipital nerve, Groove for lowering blood pressure, Cardiac rhythm and Contractility zone.

Steel acupuncture needles were introduced to a depth of 2-5mm. The duration of stimulation was 15min. The effectiveness of acupuncture at various points was evaluated by comparing the data from tetrapolar chest rheography, using the Japanese polygraph PM-6000, before and after needling.

Results
For patients with a hyperkinetic type of blood circulation the following response was noted:

Acupuncture stimulation of the Apex point of the ear reduced systolic pressure by an average 20mm Hg. Stimulation of points Subcortex, Ren, Hypertension, Brain stem, and Groove for lowering blood pressure reduced it by an average 13mm Hg, and stimulation of other points by 10mm Hg. The diastolic pressure decreased with stimulation of points Ren, Point of relaxation, Cor, Hypertension, and Ear apex by an average 8mm Hg, and all other points tested by less than 7mm Hg.

In order to single out the most effective acupuncture points for a particular haemodynamic type, we carried out an analysis of the correlation between cardiac output and the general peripheral vascular resistance. We determined average changes in blood pressure, cardiac output and peripheral vascular resistance after stimulation, and the numbers of patients that showed these changes (Tables 1 and 2). Changes shown by less than three patients are discounted and are not recorded in the tables. The results of the studies showed that all points when stimulated decrease to some extent the cardiac output of patients with the hyperkinetic type of blood circulation. Thus, the blood minute volume decreases by 22% in 80-100% of patients after stimulating the Apex point of the ear; by 19% with the subcortex point; by 17% with the Ren point etc. (Table 1).

Further, we examined the change in parameters determining the cardiac minute volume, namely the heart rate and stroke output. With acupuncture stimulation of the Brain stem, Ear apex, and Cardiac rhythm and Contractility zone points, the heart rate decreased by an average 6-7 strokes per minute. In other cases the changes were less impressive. The stroke output decreased in practically all cases by 16% or more. Thus, the change in blood minute volume was explained both by the decrease in heart rate and the drop in stroke output. The general peripheral vascular resistance is another important factor determining blood pressure. In most cases in response to a sharp drop in cardiac output, a compensatory rise in vascular resistance was noted.

For hypertensive patients with the hyperkinetic type of haemodynamics, the optimum response is when the fall in blood pressure results from a drop in cardiac output with a relatively small increase in the peripheral vascular resistance. Stimulation of the following points provide these conditions most

| Table 1 | EFFECT OF EAR ACUPUNCTURE ON THE CARDIO-VASCULAR SYSTEM IN HYPERTENSIVE PATIENTS WITH A HYPERKINETIC CIRCULATION TYPE. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Ear Points**  | **Percentage change after treatment** | **Percentage change after treatment** | **Percentage change after treatment** | **Percentage change after treatment** |
|                 | Decrease in systolic blood pressure | Decrease in diastolic blood pressure | Decrease in cardiac output | Increase in peripheral vascular resistance |
| Ear apex        | 14% (90)         | 12% (60)         | 22% (100)        | 14% (70)         | 7% (30)         |
| Subcortex       | 13% (80)         | 10% (67)         | 19% (100)        | 14% (66)         | -              |
| Ren             | 10% (90)         | 10% (64)         | 17% (90)         | 10% (64)         | 16% (27)       |
| Point of relaxation | 10% (60)       | 13% (70)         | 13% (90)         | 11% (60)         | -              |
| Brain stem      | 11% (80)         | 13% (60)         | 16% (80)         | 13% (50)         | 13% (30)       |
| Hypertension    | 9% (90)          | 11% (44)         | 11% (90)         | 7% (55)          | 6% (33)        |
| Cor             | 10% (60)         | 12% (90)         | 13% (80)         | -                | -              |
| Groove for lowering blood pressure | 8% (90) | 11% (62) | 11% (92) | 8% (55) | 12% (33) |
| Lesser occipital nerve | 9% (60) | 11% (60) | 15% (80) | 18% (50) | 10% (40) |
| Hypotensive     | 8% (80)          | 8% (55)          | 10% (90)         | 6% (66)          | -              |
| Shenmen         | 8% (90)          | -                | 18% (80)         | 13% (67)         | -              |
| Sympathetic     | 10% (55)         | -                | 14% (100)        | 9% (90)          | -              |
| Cardiac rhythm and contractility zone | 8% (60) | 9% (30) | 20% (100) | 17% (80) | - |
| Subren          | 3% (55)          | 4% (55)          | 17% (64)         | 17% (36)         | 9% (27)        |
| Brain           | 6% (70)          | -                | 13% (80)         | 9% (70)          | -              |
| Diaphragm       | 7% (55)          | -                | 15% (100)        | 15% (90)         | -              |

* = p<0.05
- = Group of less than 3 patients
Brackets = Number of patients with the effect as a percent of the total group.
EFFECT OF EAR ACUPUNCTURE ON THE CARDIOVASCULAR SYSTEM IN HYPERTENSIVE PATIENTS WITH A HYPOKINETIC CIRCULATION TYPE.

<table>
<thead>
<tr>
<th>Ear Points</th>
<th>Decrease in systolic blood pressure</th>
<th>Decrease in diastolic blood pressure</th>
<th>Decrease in cardiac output</th>
<th>Increase in cardiac output</th>
<th>Decrease in peripheral vascular resistance</th>
<th>Increase in peripheral vascular resistance</th>
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<tr>
<td>Groove for lowering blood pressure</td>
<td>12*(75)</td>
<td>11*(82)</td>
<td>13 (38)</td>
<td>12*(63)</td>
<td>16*(81)</td>
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<td>9*(42)</td>
<td>12*(42)</td>
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<td>Lesser occipital nerve</td>
<td>9*(73)</td>
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<td>6*(46)</td>
<td>7*(46)</td>
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<td>12*(41)</td>
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<td>18*(50)</td>
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<td>13*(86)</td>
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<td>Diaphragm</td>
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<td>10*(36)</td>
<td>12*(64)</td>
<td>6*(29)</td>
<td>9 (36)</td>
<td>16 *(50)</td>
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</tbody>
</table>

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- = Group of less than 3 patients
Bracket = Number of patients with the effect as a percent of the total group.

EFFECTIVELY: Subcortex, Brain stem, Ren, Cor, Point of relaxation, Hypertension, Ear apex and Groove for lowering blood pressure. The additional acupuncture points for this type of blood circulation might be the following: Hypotensive, Shenmen, Sympathetic and Cardiac rhythm and Contractility zone.

The hypokinetic group showed a quite different picture of haemodynamic changes:

The decrease in their systolic blood pressure after stimulation of the Groove for lowering blood pressure point averaged 21mm Hg; Ren, Cor, Cardiac rhythm and Contractility zone points averaged a fall of 16-18mm Hg; Lesser occipital nerve, Ear apex, Hypertension, Brain stem and Brain 13-14mm Hg; and the other points 11mm Hg or less. The diastolic pressure decreased with stimulation of the Groove for lowering blood pressure, Cardiac rhythm and Contractility zone, Ear apex and Lesser occipital nerve points by 10-11mm Hg; in other cases it fell by 9mm Hg or less. Blood pressure falls, mainly due to a decrease in vascular resistance, were noted in 60-80% of patients after stimulation of the Groove for lowering blood pressure, Lesser occipital nerve, Ear apex, Cor, Ren and Cardiac rhythm and Contractility zone points. The ratio of the vascular resistance pre and post-treatment came to 11-16% (Table 2).

At the same time, stimulation of certain points (Diaphragm, Shenmen, Subcortex, Point of relaxation and Hypotensive) induces a fall in blood pressure in over half the patients by decreasing cardiac output through raising the peripheral vascular resistance. However, such a decrease in blood pressure cannot be called adequate or functional for this category of patients.

The group of patients with a eukinetic type of haemodynamics showed similar changes of their parameters.

For patients with the hypokinetic or eukinetic types of haemodynamics, the optimum points are those that cause a blood pressure fall through decreasing the peripheral vascular resistance. The following points meet these requirements: Groove for lowering blood pressure, Lesser occipital nerve, Ear apex, Cor, Ren and Cardiac rhythm and Contractility zone. Stimulation of the Brain point can be recommended additionally.

Discussion

Our results show that acupuncture stimulation of different points on the ear in hypertensive patients induce specific haemodynamic changes related to the area of the ear stimulated. This in turn is related to the ear innervation. Branches of the trigeminal, facial, glossopharyngeal, vagus and cervical nerves are all present on the ear surface, which makes the ear a neurologically unique area of the human body.

Bearing in mind the neurophysiology of reflex reactions to the stimulation of peripheral afferents of the vagus, glossopharyngeal, trigeminal and superior cervical nerves, it is possible to suggest some general principles. The group of points that reduce blood pressure through lowering of the vascular tone in patients with the hypokinetic type of blood circulation is located: a) in the area innervated by the superior cervical nerves - points: Ear apex, Lesser occipital nerve, Groove for lowering blood pressure; b) in the area of afferentation of the vagus and glossopharyngeal nerves - Cor point; and c) in the area of mixed innervation of the above nerves - points: Ren and Cardiac rhythm and Contractility zone.

There are anatomical and functional relations between the vagus, glossopharyngeal and superior cervical nerves. So the vasodilation effect in response to acupuncture stimulation could well be acting via the spinal and bulbar tracts.

Neurophysiological research (16-19) has shown that baroreflex sympathetic inhibition causing systemic vasodilation acts mainly at an interneuron level at the preganglionic sympathetic neurons in the lateral horn of the spinal cord. So one can suppose that vasodilation seen after stimulation of ear points located within the area of cervical nerve innervation is occurring by the same route of sympathetic innervation in the spinal cord.

When analysing the active mechanism of points located within the innervation zones of vagal and glossopharyngeal peripheral afferents, bear in mind...
that they share the same central neuron representation at a bulbar level as the carotid and aortic sinus baroreceptors. This is why stimulation of these receptor fields can lead to a single, directed, effector reaction. Thus the hypertensive mechanism of acupuncture at this group of points should be similar to the baroreceptor response to an increase in arterial pressure.

Hypertensive patients with the hyperkinetic type of blood circulation respond to acupuncture at any ear point by reducing cardiac rate and stroke output. The most effective were the following points: Ear apex, Subcortex, Ren, Point of relaxation, Brain stem, Hypertension, Cor and Groove for lowering blood pressure. In patients with the hyperkinetic type of haemodynamics, increased cardiac activity is caused by an increase in sympathetic tone or, as some authors think, by a decrease in parasympathetic influence (20). It is possible that stimulation of peripheral afferent fibres of cranial nerves X, IX and V and superior cervical nerves (by which the above mentioned points are innervated) leads to restoration of normal cardiac control mechanisms with resultant decrease in minute volume.

There is a group of ear points that, irrespective of the patient’s haemodynamic type, reduce blood pressure by primarily decreasing cardiac output. Most of them (Shenmen, Hypotensive, Subren, Diahphragm, Point of relaxation, Hypertension and Sympathetic) are located within the area innervated by the trigeminal nerve. The trigeminal is a powerful afferent nerve that produces a parasympathomimic reaction directly or indirectly affecting cardiac activity. Stimulation of these points is not recommended for patients with eukinetic and hypokineti types of blood circulation, the cardiac output of these patients being initially normal or decreased.

Thus, as a result of our work, we have managed to determine the most effective acupuncture points for each clinical haemodynamic variant of hypertensive disease and can recommend therapy with specific auricular acupuncture points for hypertensive patients of each initial type.

We have shown elsewhere (21) that this type-specific auricular acupuncture treatment is clinically effective in hypertensive disease, decreasing both systolic and diastolic blood pressure, increasing physical working capacity and allowing a reduction in drug consumption.

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References
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