

## EXPERIENCES WITH ULTRASONICS

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In the past 18 months I have personally administered over 3,000 ultrasonic treatments using one type of machine. During this period I have received an increasing number of inquiries on the subject.

The *symptoms* of patients referred to the Specialist in Physical Medicine fall mainly under a twofold classification, viz. *pain* and *disability*; usually both complaints are present but sometimes only one. Likewise the *pathology* is also twofold, viz. *traumatic* and *rheumatic*, often one feature occurring but sometimes both.

The Physical Medicine Specialist, having taken the history from the patient and made his examination and pertinent investigations, determines the diagnosis before proceeding to prescribe from the vast armamentarium at his disposal, which includes various forms of heat, high-frequency and low-frequency currents, actinotherapy, hydrotherapy, massage, kinesiatics, spinal traction, intermittent venous occlusion and occupational

therapy. To these forms of treatment is now added—ultrasonics.

*Historical.* During 1917 ultrasonics were used experimentally in Germany and were found to have biological effects.<sup>1</sup> Later, when the country was being ruled by megalomaniacs, it was hailed—as being a wonder cure for most conditions—from an ingrowing toenail to an exostosis of the skull. However most writers seemed to agree that it was of great value in the treatment of varicose and indolent ulcers.

It was then handled in the U.S.A.—probably in too big a way—for adverse reports were given stating that necrosis of tissue and irreversible changes in nerve tissue had been produced. Thereafter it was tried in Great Britain, where it was stated to be useful in the treatment of ankylosing spondylitis.

*Nature and Generation.* Ultrasound consists of mechanical vibrations beyond the range of human audition and therefore of a frequency of more than 20,000 per

second. The particular machine I used propagates 800,000 cycles per second of continuous unmodified oscillations. These are generated by passing a high frequency current onto a natural quartz crystal which consequently vibrates and produces ultrasound. The penetration varies according to the type of tissue it has to traverse but the intensity decreases to about  $\frac{1}{2}$  its value at a depth of 1—1 $\frac{1}{2}$  inches. It is completely absorbed in air or gas. The transducer applicator I use has an area of 7 sq. cm., all of which radiates ultrasound.

#### USE IN MEDICINE

The effects<sup>2</sup> of ultrasound are:

1. *Mechanical.* These include the disintegration of crystalline solids, and sometimes of colloidal particles, with their emulsification; the coagulation of fogs, smoke and some emulsions; and the degassing of liquids. Cavitation results when the disruptive forces engendered break through cohesive bands between molecules of a liquid, a gas, or even certain colloids or solids. The cavities are immediately collapsed by the succeeding compressive phase of the sound vibration plus atmospheric pressure.

2. *Thermal.* Heat is generated in any medium by ultrasound, the amount depending on the energy absorbed. The amount of heat produced and the region of maximum heating are influenced by the nature of the medium, the presence of dispersive elements, colloidal particles and precipitates, and reflection at interfaces of matter. Higher sound-frequencies generate more heat per unit of energy and time. If cavitation occurs it is accompanied by considerable heat production. The heat released in living tissues is localized and there is normally rapid removal by the circulation, conduction and radiation. Ample evidence of damage to tissues has been demonstrated when ultrasound in overdoses is applied to epiphyses, fascia and muscle.

3. *Chemical.* These are oxidation, luminescence, depolymerization, hydrolysis and inversion of sugar.

4. *Biological.* The following are some of the actions and theories regarding this aspect of ultrasound:

(a) It produces heat<sup>3</sup> (this I found to be very mild, rather a warmth).

(b) It acts as a micro-massage<sup>4</sup> (I believe this to be one of its functions).

(c) There is a subsequent hyperaemia and vasodilation.<sup>5</sup>

(d) It has a sedative action on neural tissues,<sup>6</sup> relieving pain either directly or *via* the sympathetic or parasympathetic systems (I found this to be so).

(e) An antispasmodic and muscle-relaxant effect is produced<sup>7</sup> (to a minor degree).

(f) It hastens regeneration of the dermis (definitely).

(g) It softens collagen tissue (this action is usually of a temporary nature).

(h) It has an iontophoretic action<sup>8</sup>—this I confirmed through the preliminary application of histamine before using the transducer. Local and general reactions followed. Such reactions may be the explanation of the sedative effect on nerve tissue, for when the galvanic current is used on pathological peripheral nerve tissue

it assists the positively-charged and negatively-charged ions on either side of the nerve sheath to return to normal.

Ultrasound has been used as a *diagnostic* medium.<sup>9</sup> Its radiation is transmitted through the parts of the body to be examined. The transmitted energy establishes oscillations on an ultrasonic receiver applied to the opposite surface of the body and the energy thus obtained is transformed into a picture by photo-electric procedures. This method, called 'sonography', has demonstrated the cerebral ventricles and may in future replace the present more dangerous ventriculography and encephalography.

#### AUTHOR'S EXPERIENCE

From my personal experience with the machine used I give the following particulars of treatment and dosage:

The *technique* employed was a direct labile application either with liquid paraffin as a lubricant or with the part of the body to be treated immersed in water.

*Intensity.* The best I found to be about 1 Watt/sq. cm. Not more than 3 Watts/sq. cm. were given. There must be no discomfort to the patient.

*Duration.* A period of 10 minutes seems to be about the optimum time. Not more than 15 minutes were allowed.

*Interval.* Daily treatments are advised.

*Number of Treatments.* As many as 15 to any part seems to be the limit of response. The maximum number used was 20. Should there be no satisfactory response by the 3rd application then there is little reason for persisting.

*Advantages.* The treatments are of short duration. The patient does not become overheated. No discomfort is produced.

*Overdosage.* With an overdose a sensation of pain develops comparable to that experienced when receiving a hammer blow upon a finger nail. There is thus the possibility of ultrasonia being used in the future for the estimation of pain thresholds.

*Contra-indications.* Certain of these are mentioned<sup>10</sup> in relation to:

1. The eye (I believe such contra-indications to be reliable).

2. Brain tissue (I found ultrasonia caused no ill effects).

3. Growing epiphyses (I treated adults only).

4. Gravid uterus (such cases did not come under my care).

5. Tumours (no tumours were treated by me).

6. Lower cervical sympathetic ganglia (there were no adverse reactions).

7. Precordium (patients took this well).

8. Acute infections. Considering the theories there would appear to be contra-indications, although I have not encountered any mention in the literature. However I tried ultrasonia in a case of cellulitis and in one of palmar-space infection, with poor results.

As two features of this treatment are generally accepted, viz. the remarkable response of skin ulcers and the anti-ankylosing effects, I thought ultrasonic therapy

would be ideal for trauma of soft tissue and I have found this to be the case.

The following list gives some idea of the various conditions treated and the responses:

1. Trauma of soft tissues. Sixty per cent of my cases were of this class and in these the best results were obtained. They included contusions, lacerations, haematomata, wounds, sprains, scar tissue and keloids.

2. Osteo-arthritis of hip, 2 patients, over 50 years old; both obtained relief from pain and increased function.

Osteo-arthritis of spine, 4 patients, middle aged: 2 obtained some relief and the others showed no improvement.

Osteo-arthritis of shoulder, 2 cases, over 50 years old; both showed definite improvement.

Osteo-arthritis of hands and wrists, 2 cases, aged 30—40 years; both obtained some relief.

3. Amputation stumps with neuromata and causalgia, 2 cases; both obtained amazing relief of pain. Since percussion is a recognized form of therapy it is not unnatural that I accepted the micro-massage theory of ultrasonic action.

4. Metatarsalgia, 3 cases, over 40 years of age; all very successful (2 responded only to this modality).

5. Fibrositis. These cases constituted 20% of the patients treated. About one-fifth of them felt that ultrasonia was superior to other physical measures.

6. Neuritis due to pressure syndrome. In 8 cases temporary relief of pain was obtained but other physical methods, e.g. traction, proved superior.

7. Supraspinatus syndrome. In 6 cases there was an excellent response.

8. Ankylosing spondylitis, 2 cases in an advanced

stage, with histories of 15—20 years; both showed immediate increased neck mobility and feeling of comfort.

9. Rheumatoid arthritis. In 1 case—very advanced—temporary relief was obtained.

10. Sinusitis. Ultrasonic therapy was tried in 2 cases, and was found to be of no value.

11. Asthma. In 1 patient ultrasonic therapy to dorsal spine was tried and was found not to be helpful.

As a result of this experience I have come to the following conclusions:

1. Ultrasonia has a place in physical medicine.
2. It is most effective in soft-tissue trauma, the supra-spinous syndrome, and ankylosing spondylitis.
3. Treatments should be in the hands of persons suitably qualified and acquainted with physical therapy.<sup>11</sup>
4. The use of ultrasound is in its infancy and is destined to be placed on a surer footing.

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