THE PRESENT STATUS OF THE TREATMENT OF MÉNIÈRE’S DISEASE WITH ULTRASOUND

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In the course of Ménière’s disease, the vertiginous attacks become very severe and disabling for a long period of time and if they are not at all controlled by medical treatment, surgery should be contemplated.

Until recently the only reliable surgical methods consisted either of destructive labyrinthotomy or of intracranial section of the entire eighth nerve. The hearing is completely lost in both procedures while a high pitched, and occasionally very bothersome, ringing often persists.

Intracranial differential section of the vestibular portion of the eighth nerve (Dandy) preserves hearing at least for pure tones but is technically difficult. It is pointed out by Schuknecht that “preservation of pure auditory thresholds may not represent the preservation of usable hearing, for 75 per cent of the cochlear nerve fibers can be cut without creating a pure tone threshold loss. There is good evidence for suspecting that ears with a loss of neurone population suffer from a severe loss of auditory discrimination.”

In view of the much greater dangers inherent in intracranial procedures, complete or partial section of the eighth nerve has been practically given up in favor of the destructive labyrinthine operations.

All attempts at preserving the cochlear function in direct interventions on the labyrinth have been unsuccessful (Altmann and Montreuil) and they are, therefore, only feasible in the relatively limited number of cases in which only one labyrinth is affected and in which the hearing on the diseased side has fallen permanently below the serviceable level. However, in view of the fact that involvement of the second labyrinth might occur three, four and more years after the first one,
destruction of a hearing ear is always a somewhat risky procedure.

Chemical destruction of the vestibular endorgans by parenteral application of streptomycin has been shown to be possible (Fowler, Rüedi, Schuknecht and others) but has the disadvantage that the function of the healthy labyrinth is affected together with that of the diseased labyrinth.

Cervical sympathectomy has been recommended under the assumption that an autonomic imbalance resulting in paroxysmal labyrinthine vascular insufficiency is the cause of Ménière’s disease; an attempt is made at eliminating or preventing the underlying vasomotor disorder (Passe, Seymour, Lewis, Wilmot and others).

Cervical sympathectomy seems to have a beneficial but often transitory effect upon the vertigo in about two-thirds of the cases and to a much lesser extent upon the tinnitus; the effect upon the hearing is variable. There are the usual unilateral nasal and Horner’s syndrome complications.

Within the last few years a far more promising method has been developed by Arslan for selective destruction of the diseased vestibular portion of the labyrinth by means of radiation with ultrasonic waves.

Although attempts at treatment of the ear with ultrasonic waves date back for more than 30 years, the apparatus used at that time produced waves of such low intensity that they could not reach the inner ear at all. Later, machines capable of producing ultrasonic waves of higher frequency and of much higher intensity were used. It was shown in animal experiments that ultrasound produces first a stimulation of the vestibular apparatus but that application of larger doses, or of repeated stimuli, is followed by a complete loss of vestibular responses. Furthermore, it was demonstrated that in man even ultrasound of higher intensity, when applied to the outer surface of the mastoid, practically does not reach the inner ear because it is almost completely absorbed by air, and to a considerable extent by bone.

Histological studies on experimental animals showed that if the ultrasound actually reaches the entire inner ear not only the vestibular but also the cochlear portion is damaged.

Krejci, in other experiments, succeeded in selectively irradiating the vestibular portion of the inner ear by using a narrow beam of ultrasonic waves after operative exposure of the bony labyrinth; he actually eliminated the vestibular function but preserved the cochlear function.
He then successfully used the same procedure in a patient suffering from Ménière’s disease. Arslan perfected Krejci’s method by constructing, together with Federici, a thin and narrow sound wave transducer which produces a narrow beam of waves with a frequency of 800,000 to 1,000,000 c.p.s. and an intensity sufficient to produce a relatively rapid destruction of the vestibular portion of the inner ear on application to the bony wall of the lateral semicircular canal. Practically no ultrasound waves seem to reach the medial wall of the petrous bone and the posterior cranial fossa. Lateral transmission of ultrasound is prevented by special shielding and overheating is prevented by a cooling system.

Arslan reported excellent results in a large number of cases with disappearance of the vertiginous attacks in 95 per cent of his patients, with marked improvement in hearing in the lower and middle tonal range. The tinnitus improved in the majority of cases; in many it was completely eliminated.

The results reported by Arslan seemed so impressive that, after a visit to Arslan’s department by one of us (J.G.W.), it was decided to try this treatment in the Ear, Nose and Throat Department of Presbyterian Hospital in New York.

The technique used by us in the series of cases to be reported in this paper followed the original technique employed by Arslan and was outlined by us in previous publications (Altmann and Waltner). The one major modification introduced by us is a thinning out of the prominence of the lateral semicircular canal with a polishing burr.

Premedication consists of secobarbital 100 mg. by mouth, two hours before operation and 100 mg. meperidine with 0.3 mg. atropin, subcutaneously one hour before operation.

The operation is carried out under local anesthesia with xylocaine 2 per cent with epinephrine 1:100,000. The mastoid is exposed through a retroauricular incision and entered. Enough cells are removed to get a good exposure of the antrum and of the prominence of the lateral semicircular canal; the incus remains undisturbed. In order to achieve a close contact between the tip of the soundhead and the lateral canal, the prominence of the latter is flattened out with a polishing burr under the operating microscope.

The tip of the soundhead is then applied to the lateral canal in such a way that the facial nerve and the cochlea are not included in the direct
path of the beam of ultrasonic waves.

Nystagmus starts, as a rule, one-half to one minute after the onset of the irradiation. The nystagmus must be constantly watched by an assistant, preferably with the help of Frenzel's glasses. At the same time the assistant looks for signs of irritation or paralysis of the facial nerve. If they should appear, the irradiation must be stopped immediately.

The initial nystagmus is "irritative" in type, with the quick component directed toward the treated side as with hot caloric stimulation. It lasts from 20-40 minutes, sometimes even longer. The homolateral nystagmus is followed by a short period without nystagmus and then frequently by a "paralytic" nystagmus directed to the not operated side. This nystagmus is most probably the result of severe damage to the sensory neuroepithelium of the crista and maculae by the ultrasonic waves. The irradiation is then continued for another five minutes.

In order to get as complete a destruction as possible of the vestibular endorgans, the direction of the beam of the ultrasonic waves should also be directed to the other semicircular canals until no more "irritative" nystagmus can be produced in any position of the applicator.

In some patients, especially those with markedly reduced vestibular responses, the usual sequence of nystagmus is often absent; particularly, the contralateral "paralytic" nystagmus may not appear. The radiation is then continued for at least five minutes after disappearance of the homolateral nystagmus. If the homolateral nystagmus does not disappear, the radiation is continued for 55 to 60 minutes.

The intensity of the radiation depends on the intensity of the induced nystagmus. If the latter is marked with an intensity of 7 to 8 w/cm² on the dial of the machine, no further increase is necessary. If the nystagmus fails to appear at this intensity, it should be increased to 9 to 10 w/cm².

Higher intensities are rarely necessary and should be given with great caution. At the termination of the irradiation the wound is closed with mattress sutures.

The postoperative course is much less stormy than after surgical destruction of the labyrinth. There is little or no nausea or vomiting; the nystagmus disappears after 24 to 48 hours. Some but usually not very severe attacks of vertigo may occur during the first postoperative weeks; the unsteadiness after sudden movements of the head disappears completely after three to four months.
Table I—Vertigo

<table>
<thead>
<tr>
<th>AFTER THE FIRST RADIATION</th>
<th>AFTER A SECOND RADIATION IN 6 OF THE RECURRENT CASES</th>
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<tr>
<td>Complete disappearance</td>
<td>30</td>
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<tr>
<td>Marked improvement</td>
<td>10</td>
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<td>(resumed normal work)</td>
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<td>Recurrence</td>
<td>13</td>
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Analysis of the 9 Failures

Persistence of attacks after one radiation 3
Persistence of attacks after two radiations 2
Third radiation performed recently 1
Labyrinthectomy 1
Labyrinthectomy after first irradiation 1
Bilateral hydrops with activity from the untreated labyrinth 3

Hearing

Improved 9 17%
Unchanged 35 71%
Worse 3 6%
Lost 3 6%

Tinnitus

Disappeared 3 8%
Improved 11 29%
Unchanged 21 55%
Worse 3 8%

Among the patients operated between the beginning of June 1957 and the end of July 1960, there were 53 with a well established diagnosis of true Ménière’s disease (endolymphatic hydrops) and a sufficient follow-up; 36 were males and 17 females. The results of the irradiation with regard to vertigo, hearing and tinnitus are shown in Table I.

The rate of completely successful primary operations is encouraging but not completely satisfactory. The main problem is the delivery of a
sufficient amount of ultrasound to the inner ear to bring about a complete and permanent elimination of the vestibular function. In a number of seemingly properly treated cases a return of the function was noted after several months and the return was often, but not always, accompanied by a return of the vertiginous attacks, while in others the labyrinthine responses had never been completely lost.

Analysis of the ultrasonic irradiation failures shows that at least three of them, and possibly four, still have a very good chance to be cured by a second or third irradiation. The same could have been the case with the patient who refused to undergo a second irradiation and chose surgical destruction of the labyrinth. Two of the three cases with bilateral labyrinthine involvement show markedly reduced hearing in both ears. In these cases we would rather consider treatment with streptomycin than radiation of the other ear because of the possible further hearing loss after radiation of the already severely damaged inner ear; in the third patient with relatively good hearing irradiation of the other labyrinth could be considered. In some cases of bilateral hydrops, for reasons not yet clearly understood, irradiation of one labyrinth seems sufficient.

In our patients we could not find any definite beneficial effect of the irradiation upon the hearing, as noted by Arslan, de Stefani and Bosotra in about one-fourth of their patients. We rather think that neither the improvement nor the deterioration noted in some of them exceeds the fluctuations frequently noted in Ménière's disease. Of the three cases with complete postoperative hearing loss, two had very little hearing left before the irradiation and in one the prominence of the lateral semicircular canal was thinned out until a "blue line" appeared; evidently too much ultrasound was delivered to the inner ear.

The results with regard to the ringing (cure or considerable improvement in 37 per cent of the patients), while not impressive, are better than those achieved with medical treatment and are not worse than the results from the methods of destructive surgical treatment. Among the three cases in whom the ringing became worse, one was a man of 71 years with marked cerebral arteriosclerosis and the deterioration was not necessarily the effect of the irradiation.

The only complication encountered was facial paralysis. It occurred in two cases in the course of the irradiation; a surgical decompression was performed a few days after the irradiation and the paralysis has Bull. N. Y. Acad. Med.
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almost completely disappeared in one case after nine months, while in the other case it was still incomplete after ten months. In a third patient a facial paralysis developed seven days after the operation but disappeared completely after six weeks. In a recently operated patient, not included in this report, an incomplete paralysis developed after seven days and cleared up completely after three weeks under treatment with corticosteroids.

The facial paralysis occurring during operation is caused either by misdirecting the beam of ultrasound towards the facial nerve or, more frequently, by excessive heat developed in the tip of the applicator. The facial paralyses developing seven days after the operation are difficult to explain. Most probably they are caused by edema within the nerve in cases with dehiscences in the bony facial canal.

The results reported in this paper are not as good as those reported by Arslan but are similar to those of Dubs, Lumsden, Ironside and Lindsay, and Ariagno.

It is evident from an analysis of our own cases and of those reported by the other authors that undertreatment is practically the only cause for failure.

Remarkable progress in overcoming this difficulty has been made by Angell James and collaborators. They suggest certain technical improvements for the soundhead and stress the fact that the bony wall of the lateral semicircular canal must be thinned out as much as possible, at any rate to below a thickness of 1 mm., because a thickness of 1 mm. is "critical" and would permit only very little ultrasonic energy to enter the labyrinth. Angell James smoothes the prominence of the lateral semicircular canal with a diamond paste burr to a flat area through which the "blue" line can be seen very clearly. However, in view of the fact that in one case, where we thinned the bone over the prominence of the lateral semicircular canal that far down, the hearing was completely lost, we are somewhat hesitant to do it routinely. The soundhead is then applied under continuous irrigation of the operative cavity with physiological saline solution of body temperature. This ensures that the temperature does not rise above 44° C. during the operation and also provides complete transmission of the ultrasonic energy to the vestibular endorgans.

The last six patients, treated by Angell James after the efficiency of the apparatus had been improved, all obtained complete relief from

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vertigo; the hearing was markedly improved in one case and slightly improved in two others.

Encouraged by these reports, we have used the irrigation method for the last three months and, judging from the results, we are quite satisfied with it. For continuous irrigation we use the attachment to the self-retaining retractor employed by Shambaugh in the fenestration operation. In an attempt to reduce the possibility of a facial paralysis developing several days after the operation, we now introduce a Penrose drain through the lower angle of the wound into the cavity and leave it there for two days.

It is to be hoped that with an improved soundhead and radiation under continuous irrigation the number of undertreated cases will decrease. Even at the present time radiation with ultrasound seems far superior to all other methods of surgical treatment and can be considered at a much earlier date than destructive labyrinthotomy. It can also be used in many patients in whom medical treatment seems the only possibility at present. The only group of patients in whom irradiation with ultrasound seems somewhat risky are those with bilateral hydrops and markedly depressed cochlear function. Here there is the possibility of a further hearing loss, a point also stressed by Angell James. In this group of patients treatment with streptomycin could be considered, provided they are below the age of 50 years.

Summary and Conclusions

The first therapeutic effort in Ménière’s disease should always be medical.

A certain percentage of patients continue to suffer from crippling attacks of vertigo in spite of all kinds of medical treatment.

This latter group of patients can best be helped by selective ultrasonic destruction of the vestibular endorgans. This can be achieved by surgical exposure of the semicircular canals and by application of a narrow beam of high frequency and high intensity ultrasonic waves to the bony canal walls.

Ultrasonic surgery offers definite advantages over all other surgical treatments of Ménière’s disease because the cochlear function is not destroyed. Irreversible, complete hearing loss is the rule in destructive labyrinthotomy. The results of cervical sympathectomy are far less satisfactory and often only transitory. Intracranial section of the eighth
nerve is technically difficult and not without danger to the patient’s life.

Follow-up of 53 patients who underwent ultrasonic surgery revealed good results in 83 per cent of the cases. These patients resumed normal activities. With improved ultrasonic apparatus still better results are to be expected.

Ultrasonic surgery seems to have no definite beneficial effect upon the hearing. Thirty-seven per cent of the patients, however, reported complete cessation or definite improvement of tinnitus.

**BIBLIOGRAPHY**


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