RUPTURE OF THE DRUMHEAD AS A WARTIME INJURY

BY

ALFRED B. ALEXANDER, M.D., L.R.C.S.

Rupture of the drumhead is a common peacetime injury; and when the present emergency has become a matter for clinical-statistical investigation rather than for clinical action, and more complete statistical figures are available, it might well prove the most common of all types of injury due to aerial bombardment. The frequency of rupture of the tympanic membrane under air-raid conditions is no surprise. Reports from Barcelona had suggested it, and in a recent discussion Miss J. Collier (1940) quoted R. Trueta's Barcelona figures, indicating that from 30 to 60% of the Barcelona air-raid casualties had sustained damage to the drumhead.

Rupture of the tympanic membrane in peacetime is a slight injury. But it only remains a slight injury when it is followed by an uncomplicated course, free from infection of the tympanic cavity; and there is evidence to believe that this uncomplicated course, which is the rule in peacetime injuries, is less frequent when the injury is due to the blast of high-explosive bombs. Once infection establishes itself inside the tympanic cavity the whole chain of aural afflictions and otogenic complications, ranging from slight persistent deafness to death from meningitis, is a possible outcome of the injury.

Apart from those ruptures of the tympanic membrane which are caused by the extension of a fracture of the cranial bones to the membrane, it is customary to differentiate between direct and indirect traumatic ruptures. The direct ruptures are caused by a great variety of foreign bodies and by over-powerful syringing of the meatus for the removal of wax. The indirect ruptures are due to sudden changes in the density of the air in the meatus, aided by complete blockage of the air in the meatus at the moment of the influence of the force. The most common causes of such indirect ruptures are blows on the ear, particularly the slap with the open palm occluding the meatus, and inadequate head-first dives into the water. Most textbooks include the rupture of the membrane due to explosions among the indirect ruptures, but this is wrong. The rupture is a direct one caused by the extremely powerful concussion of the air by the explosive—the "wave of pressure" (Zuckerman, 1941). All these differentiations, however, are only of theoretical interest.

From the practical point of view it is best to distinguish between ruptures which leave the tympanic cavity most probably sterile (slap on the ear), and ruptures in which the sterility of the tympanic cavity has been interfered with (syringing, diving). These two clinical types of rupture are often followed by a different clinical course. Ruptures of the drumhead caused by blast must be regarded as belonging to the second group, as it is always likely that foreign matter, carried by the blast, has entered and possibly infected the tympanic cavity.

Symptoms

Indirect ruptures of the drumhead can remain symptom-free, particularly in cases of previously reduced hearing or diminished resistance of the membrane. In air-raid casualties the symptoms are often masked by the presence of more severe injuries and, lacking routine otoscopy, such cases are in danger of being overlooked until suppuration occurs.

In most cases, however, at the moment of the rupture a short stabbing pain is felt, frequently accompanied by

tinnitus or the hearing of a high-pitched sound. Initial vertigo is very common. Some pain persists for a few hours or even days. Hearing is moderately reduced. In many cases a trying feeling of fullness in the ear, occasional giddiness and sickness, headaches, and a certain amount of deafness persist for considerable periods. The vertigo, particularly that immediately following the injury, deserves a few words of explanation. It is not, as commonly suggested, caused by some "concussion of the labyrinth," but is simply explained as being the effect of cold caloric irritation, caused by cold air. The air normally contained in the tympanic cavity is warmed by its passage through the nose and Eustachian tube. Following the injury, cold air suddenly gains access to the middle ear and irritates the labyrinth. I have found in such cases that vertigo and nystagmus can be re-elicited, and the direction of the latter characteristically changed, by alternately placing a bottle filled with ice and a hot-water bottle in front of the external canal. The irritation of the labyrinth by cool air is one of the reasons for keeping the meatus closed following such an injury.

Signs

In fresh cases the most common finding on the drumhead is that of a roundish, irregular, or slit-shaped perforation, the latter usually in a radial position. The margin of the perforation is often frayed and irregular, and sometimes a flap, exposing an angular-shaped perforation, is folded towards the skin of the meatus. These "everted edges" of the perforation are not, as recently suggested, due to the "wave of suction" that follows the pressure-wave of the blast, but are quite common peacetime findings, and are described in old textbooks. A small zone around the margin of the perforation is discoloured and stained by the extravasation of blood. The remaining part of the drumhead is unchanged, but may show small interstitial haemorrhages; the latter findings are particularly common in blast injuries, in which also minute blackish spots sometimes occur, due to the impregnation into the membrane of small solid matter contained in the blast. A certain amount of blood, or coagula, in the meatus is a very common picture; and in air-raid casualties the whole of the meatus may be blackened by soot. In fresh cases the yellow colour of the normal mucous membrane of the medial tympanic wall is easily distinguished through the perforation, its yellow ("bone-yellow") colour forming a distinct contrast to the blood-stained margin of the perforation.

The perforation is more often situated in the anterior than in the posterior quadrants. Any anatomical detail of the contents of the middle-ear cavity, such as stapes, chorda tympani, or round window, can on occasion be seen through the perforation, should it happen to lie within the line of sight; and such structures will show a typical parallax phenomenon on movements of the observer's head. In cases in which there is no suspicion of a fracture to the base of the skull it might be permissible to remove carefully blood crusts, coagula, or wax by means of a sterile probe or aural forceps, should such structures render inspection of the drumhead impossible. The use of the syringe, however, is always and most strictly contraindicated.

It is usually easy, but quite unnecessary, to demonstrate the presence of the perforation by certain tests such as the Valsalva experiment, Kugel's test, or "reversed politzerization." The hearing is moderately reduced, the tuning-forks revealing a deafness of the conductive (middle-ear) type. It is advisable to test for a reduction in the perception of high sounds, and for nystagmus (other than that produced by cold caloric influence from the air), which in complicated cases reveal damage to the labyrinth.

The diagnosis presents no difficulties in a fresh case. The blood-tinged irregular margin of the perforation is quite characteristic. In cases of longer standing, however, the shape of the perforation might have already become round and regular, and the extravasated blood be resorbed. In such cases diagnosis from a pathological perforation might become exceedingly difficult unless the history helps to clear the case.

Clinical Course

Traumatic rupture of the drumhead will lead to one of the following three types of clinical course.

1. *Uncomplicated Cases.*—The perforation gradually diminishes in size, while normal drumhead tissue regenerates. Complete healing ensues, and after the regeneration of the drumhead is complete it is quite impossible to recognize any trace of the site of the previous perforation. Drumhead and hearing regain perfect normality. The average duration of the healing process of such cases is twenty-five days.

2. *Infection of the Tympanic Cavity of Low Virulence.*—Minor inflammatory reactions appear within one to three days after the trauma. There is sero-purulent discharge, lasting from a few days to several weeks. Such cases often heal with the formation of atrophic scars followed by chalk deposits in the membrane, with chronic adhesive changes (synechia) in the middle ear, or with a persistent perforation. According to these changes, the hearing capacity is permanently somewhat reduced (middle-ear deafness).

3. *Infection of the Tympanic Cavity of High Virulence.*—Major inflammatory reactions, constituting the suppurative otitis media of post-traumatic origin, appear usually not later than twelve to twenty-four hours after the injury.

There are few indications in the literature regarding the relative frequency of these different types. It is obvious that ruptures which leave the tympanic cavity sterile stand a far better chance of an uncomplicated course than those in which the sterility has been interfered with. Water is the most common source of infection in peacetime, and therefore rupture due to diving or syringing is often followed by inflammatory reactions. It is a complete fallacy to think that the routine use of sterilized water for syringing could prevent infection in cases of accidental rupture, since the meatus, with which the water has always been in contact, is never sterile. However, taking into consideration both the uninfected and the possibly infected type of rupture, a survey of a large number of cases at the Neumann Clinic several years ago left me with the impression that at least some 80% of all peacetime ruptures follow an uncomplicated course to normality of drumhead and hearing. This proportion seems to be quite different in blast injuries, as over 50% of the cases caused by air raids which I have seen showed some infection of the tympanic cavity. Admittedly I am judging from a small number of cases, but the experience of a few colleagues with whom I have discussed the matter points in the same direction. It is therefore of great importance that in all cases of rupture of the drumhead caused by blast the tympanic cavity should be regarded as presumably infected, and treated accordingly.

Treatment

The object of treatment is best expressed in T. B. Layton's words—"to get well every single case under one's care. And by 'well' I mean a dry ear, a normal drumhead, and perfect hearing." This is achieved simply enough when the tympanic cavity has remained free from infection. In such cases the treatment should be restricted to the protection of the tympanic cavity from external influences that may cause further damage. No unnecessary manipulations in the meatus should be undertaken. Syringing as well as all types of ear-drops, whether contain-

ing water, peroxide, spirit, glycerin, or any other fluid, are strictly contraindicated. It is sufficient to plug the meatus lightly with sterile ribbon gauze or cotton-wool, and to inspect once or twice a week. The patient must be advised to take great care while washing his face or taking a bath—or, in the case of a woman patient, while having her hair washed or "set"—lest water should enter the meatus. The taking of violent forms of exercise should be avoided, as sweat might accumulate in the meatus and infect the middle ear.

It is the other type of rupture, in which foreign matter has entered the tympanic cavity, that presents the problem, and, as stated above, all ruptures of the drumhead caused by blast belong to this group. Complete healing and perfect hearing are guaranteed only when the tympanic cavity remains free from inflammatory reaction. Even minor inflammatory reactions might lead to some degree of permanent deafness with all its implications, and poor results obtained during the present emergency might increase the rate of deafness among the post-war population to a very considerable degree owing to the frequency of this injury. Perfect results depend on the prevention of the trauma leading to infection. But how can a tympanic cavity contaminated by blast be protected against the occurrence of such infection?

Insufflation of Sulphanilamide.—Impressed by the frequency with which suppuration follows rupture caused by air raids, I have recently started to treat all such cases as early as possible with a preventive insufflation of powdered sulphanilamide into the tympanic cavity. My results have so far been highly satisfactory, and although fully realizing that the results of all preventive methods are particularly liable to misinterpretation, and that the experimental data at present available on the topical use of sulphonamides are not convincing, I feel satisfied that early insufflation of sulphanilamide powder into a possibly or presumably infected tympanic cavity will reduce to a minimum the number of cases of subsequent suppuration in the middle ear.

I have also tried the insufflation in cases already infected, but have failed to observe any benefit, the powder just being swept away by the discharge. And cases of acute otitis of traumatic origin should be treated by the oral administration of a sulphonamide in the same way as it is used in otitis not of traumatic origin.

Technique of Insufflation.—This is very simple so long as the ordinary forehead-mirror and not an electric auroscope is employed. The site of the perforation is focused, and a few puffs from a straight powder-insufflator, administered through the speculum under guidance of the otoscopying eye, are quite sufficient. It is necessary to look into the ear in order to make sure that the powder not only coats the walls of the meatus but actually reaches the tympanic cavity through the perforation. Afterwards the meatus is lightly plugged and the patient advised as to the protection of his external canal.

The insufflation of powder into the middle ear is so simple, the results are so promising, and the aim of preventing infection is so important that I have no hesitation in recommending it as a routine treatment for rupture of the drumhead in the present emergency. It can cause no harm whatsoever, and if tried on a large scale and found successful it will also serve as a further argument in the demand for the routine otoscopy of all air-raid casualties.

REFERENCES

- Collier, J. (1940). *Proc. roy. Soc. Med.*, **34**, 10.
Zuckerman, S. (1941). *Ibid.*, **34**, 173.