REMOVAL OF TONSILS BY ELECTRICAL CURRENTS OF HIGH FREQUENCY

BY

ALBERT EIDINOW, M.B., B.S.LOND.

PHYSICIAN, WITH CHARGE OF LIGHT DEPARTMENT, RADIUM INSTITUTE ;
PHYSICIAN, WITH CHARGE OF LIGHT DEPARTMENT AND DEPARTMENT OF BACTERIOLOGY, THE ST. JOHN CLINIC AND
INSTITUTE OF PHYSICAL MEDICINE, PIMLICO

The successful scientific research on high-frequency electrical currents during the past thirty years has helped to improve electro-medical apparatus. It is now possible to obtain diathermy machines which generate high-frequency currents which will cut through living tissue cleanly, subsequent healing being by first intention, or will cause coagulation and electrical destruction to any required degree. This is indeed a great advance since the pioneer work of d'Arsonval in 1895 and Boudier and Lecomte in 1900. It was then only possible to produce electrical currents of long wave-lengths, and these caused local heating or uncontrolled coagulation.

The modern high-frequency diathermy current is produced by connecting the main alternating supply current of 200 volts, 50 to 60 cycles, to a step-up transformer, which raises the supply voltage. A series of condensers is placed in the circuit; this high-voltage current is discharged across a single or a series of tungsten spark-gaps, and currents of very high frequency are produced. In place of a tungsten spark-gap a triode valve may be employed. The high-frequency current is stored and conveyed through subsidiary condensers to the exit terminals and to the electrodes connected to the patient.

Beyond a critical frequency of approximately 1,000,000 cycles per second, the wave-length of the electrical current has little influence on the resulting action on the tissue. The intensity of the current, as controlled by the amperage and voltage and the size and nature of the active electrode, determines the final effects. Within a certain range, as the voltage is increased and the amperage is reduced, the wave-length becomes lengthened and frequency diminishes.

Electro-coagulation is produced by long wave-lengths. Clean cutting is produced by currents of lower voltage, higher amperage, and higher frequency or short wave-lengths. The knowledge and correct control of electrical apparatus is of great importance in this technique. High-frequency currents are of great value in surgical operations, since it is now possible to obtain electrical currents of sufficient energy which, when correctly applied, will cleanly cut or will coagulate and destroy tissue *en masse*.

The removal or destruction of the tonsils by the application of high-frequency currents has certain advantages over other methods of tonsillectomy. Theoretically the active electrode produces the combined effect of cutting and coagulation; the operation should be bloodless, since the heat generated coagulates and seals off blood vessels. The lymphatic vessels are similarly closed and, since the local heating effect is great, infective organisms within the tonsils are destroyed; the risk of spread of infection, therefore, should be greatly lessened.

The tonsils may be removed by means of one of two methods: (1) the complete removal at one operation under a general anaesthetic, or (2) the progressive destruction of the tonsils by treatment once a week. Each tonsil receives treatment at intervals of twelve to fourteen days. Each method has its advantages, which will be discussed later on after the technique of each method has been described.

The Single Operation

Excision of the tonsils by means of high-frequency electrical current aims at complete removal in one operation. A general

anaesthetic is employed. The use of chloroform and oxygen by means of the intratracheal method is essential, since the danger of combustion of ether or nitrous oxide from electrical sparking prohibits their use. It is possible that the use of intravenous injection of evipan, or similar basal anaesthesia, will be of great help, and will overcome the difficulty of anaesthesia in surgical diathermy. The patient's head is tilted back by placing a sand-bag under the shoulders. A Davis gag is inserted; the mouth is opened, and the pharynx is plugged with a strip of gauze. A motor-driven air pump helps, and the flexible lead tube is introduced along the floor of the mouth.

An indifferent electrode is applied to the skin of the thigh or arm. A sheet of lead covered by a saline pad may be used, but I prefer a thin phosphor-bronze chain mesh, 9 by 9 inches in size, which is directly bandaged to the skin of the thigh or forearm. The mouth is illuminated by a head lamp. The active electrode which I employ has already been fully described (*British Medical Journal*, 1931, i, 892). It consists of a tapering quartz rod curved at its tip. The quartz tube is bored in the centre like a capillary tube, and through this a fine molybdenum wire about 0.2 mm. thick is threaded. The wire projects for 2 mm. beyond the tip of the quartz tube, but the length of the active electrode can be regulated and simply adjusted.

An incision is made through the mucous membrane covering the anterior pillar of the fauces of the right side, and the right tonsil is grasped gently by means of a small vulsellum forceps. The tonsil is dissected and removed. It is necessary to try to avoid pulling on the tonsil, since this may lead to tearing, and cause bleeding which obscures the field and interferes with the efficient working of the electrical current. The tonsil should be gently cut away from its bed. At times the heat generated causes a cloud of steam and smoke; this is overcome by inserting a soft lead tube connected to a suction air pump. After the right tonsil has been removed the tonsillar bed is cleaned by means of a small sponge. Small bleeding points are treated by sparking and fulguration; the tonsil bed may be dealt with similarly by light fulguration. The left tonsil is removed in the same way.

The operation can be carried out with ease and rapidity; in successfully treated cases it is, at times, almost bloodless. If the tonsil has been torn and inefficiently treated bleeding may occur. The use of a sponge, applied with pressure and immediately followed by the application of the active electrode to the bleeding point, will arrest haemorrhage successfully. During the operation of tonsillectomy it is most surprising to observe the rapid shrivelling and contraction of the tonsillar lymphoid tissue; this is due to heating and coagulation. Should the vulsellum forceps slip and become detached, some difficulty may be found in establishing the anatomical relations at the field of operation.

Following tonsillectomy by this method, oedema of the soft palate and uvula develops during the next forty-eight hours. Pain and discomfort is slight, as a rule, and swallowing is less troublesome. The oedema usually subsides after the second day, except in those cases which carry a heavy infection of streptococci and allied throat organisms; such cases show more oedema, cervical adenitis, or pyrexia. A greyish-yellow-white slough forms at the tonsillar bed, at the site of the application of the high-frequency current. When this is well established there is little pain and discomfort. The slough forms an efficient barrier against the spread of pathogenic organisms to the lymphatic and blood streams. It should be well conserved and allowed to separate slowly in its own natural course, which lasts ten to twelve days. The use of hydrogen peroxide and other chemical agents which attack this slough should be avoided.

Young children respond well to this technique of treatment. They are usually active and feel well within forty-eight hours. Pain is, on the whole, less than in the other methods of open dissection, since there is so little interference with the pillars of the fauces; the use of forceps and ligatures to tie off bleeding vessels is unnecessary. The operation should be of value in the

removal of chronically infected tonsils, in tuberculous disease, and also in the removal of doubtfully malignant tonsils, since the electrical coagulation necrosis is a firm barrier against spread of infection or metastasis.

Six months after a successful operation there remains a white scarred area, with the typical fibrosis following surgical diathermy. The scar is soft and pliable, with little contraction. If the operation has not been fully successful tags of tonsillar tissues or an irregular mass of granulation tissue may be removed by further treatment under a local anaesthetic. Haemorrhage following surgical diathermy of the tonsils is of no greater frequency than that caused by other surgical methods. It is very rare in young children. In adults haemorrhage may occur during the first forty-eight hours; it is usually due to failure to completely seal off bleeding points or to disorganization of the coagulated tissue by vomiting or retching after the anaesthetic. Such haemorrhage must be rapidly treated by sparking and coagulating an isolated bleeding point by means of the active electrode of the high-frequency current. If the haemorrhage is due to a general oozing of diffused areas it is necessary to suture the pillars of the fauces by the usual technique.

It is obvious that the operative technique of direct tonsillectomy can only be really successfully performed by the specialist surgeon who has practical knowledge of oral surgery, and has adequate training in, and equal experience of the working of, electro-medical apparatus and the nature of the high-frequency electrical currents which are needed. The technique is not necessarily advocated to replace completely the older established methods of tonsillectomy. There are definite indications for this technique in selected cases, provided that both surgical skill and adequate knowledge of the application of high-frequency electrical currents are available. Such specialized knowledge and training are essential.

Progressive Electro-Surgical Diathermy

The removal of tonsils by progressive electro-surgical coagulation has the advantage that tonsillectomy is slowly performed while the patient is active and continuing routine daily work. The necessity for general anaesthesia, rest in bed for ten to fourteen days, and subsequent convalescence is avoided. This appeals to patients who dread anaesthetics and surgical operation, but it follows that many in this group are highly nervous, and are not ideal patients for operative manipulation of the throat. It is not advisable to perform this operation on the young under 16 years of age, since they are naturally averse to such procedure.

Treatment is undertaken once a week, the right and left tonsils being dealt with alternately. Each tonsil therefore receives treatment at intervals of about fourteen days—on an average six to eight treatments; thus three to four treatments of each tonsil are necessary to complete tonsillectomy, the number varying with the size and nature of the tonsil. The procedure takes six to eight weeks. The improvement of electro-medical apparatus has greatly facilitated the success of this operation, for, by means of a suitable active electrode and electrical apparatus generating an adequate intensity and suitable current, satisfactory coagulation necrosis is obtained.

The patient is placed in an armchair which has an adjustable head rest. A projection inspection lamp is placed behind the patient, and a beam of light is projected into the mouth by means of a head mirror. It is advisable for the operator to wear a face mask. The mucous membrane of the roof of the mouth, the soft palate, and the pillar of the tonsil are anaesthetized by spraying them with a solution containing 10 per cent. cocaine, 1 per cent. diamorphine hydrochloride, and 0.1 per cent. menthol. This solution is placed into a two-ounce Devilbiss spraying bottle attached to an electric motor-driven air pump. The spray is forcibly ejected without fatigue to the operator, and by this means successful local anaesthesia is induced. I have found this method superior to swabbing with cotton-wool, and much less trouble than local injection of the pillars of the fauces.

The technique employed should always be as simple as possible, and involve the minimum of manipulation in the mouth. As an indifferent electrode a phosphor-bronze chain mesh about 9 by 9 inches in size is bandaged directly to the skin of the forearm. The room is semi-darkened, and light is subdued. The active electrode which I employ is the similar quartz-molybdenum-wire electrode which has already been described. The tongue is depressed by means of a tongue depressor with an electric torch attached. A head lamp or a head mirror may be used in conjunction with a glass or metal tongue depressor. The right tonsil is treated first.

A semilunar incision is made through the mucous membrane covering the anterior pillar of the fauces. This is of great advantage, since by this technique the tonsil is dislocated from its bed, and the removal of a hidden or buried tonsil is much facilitated. Further, the use of special retractors for pulling aside the anterior pillar of the fauces and exposing a hidden tonsil is quite unnecessary. Following this operation, the anterior portion of the tonsil is treated in three to four areas, and a yellowish-grey coagulum forms. The area treated is finally given surface fulguration. It is necessary that the correct type of high-frequency current should be employed during the operation, since coagulation at a depth is necessary. The electrode should be removed with ease, and should be perfectly cleaned when withdrawn from the tonsil. If the electrode sticks within the tonsil it becomes covered with adherent coagulum; this has to be pulled away, so that the tonsil is torn, and bleeding results. In the treatment of septic tonsils, when the electrode is inserted in the tonsil pus may be seen to exude from many crypts and follicles in several surrounding areas. This is due to the heat affecting the whole tonsil. The lymphoid tissue rapidly contracts and the tonsil shrivels up and becomes much smaller during treatment.

The first treatment of each tonsil is of much importance. It is usually followed by oedema and swelling, and gives the greatest reaction and pain. The patient is told to gargle well with a 5 per cent. solution of borax, 0.1 per cent. menthol, and 1 in 1,000 carbolic acid solution, using 1 drachm to 10 ounces of water. The oedema subsides after forty-eight hours, and a firm coagulum is formed. This should be allowed to separate slowly in its natural course, and not be irritated in any way. A severer reaction may ensue in cases in which the tonsils are infected with virulent haemolytic streptococci and allied bacteria. Treatment should not be applied during any stage of active inflammation, such as acute pharyngitis or subacute tonsillitis, since severe reaction may result and cause painful swelling of the cervical glands, pyrexia, and general malaise.

A week after the first treatment the left tonsil is dealt with in a similar manner. At this stage the right tonsil usually presents a firm slough at the site of application of the high-frequency current. This should now be painless, and begin to show separation. The first treatment to the right or left tonsil causes the most pain and severe reaction of the whole treatment. This is due to the reaction following the incision into the mucous membrane of the anterior pillar of the fauces, and to the coagulation and heat sterilization of the tonsil. General constitutional reaction may follow the absorption of killed bacteria and coagulated septic lymphoid tissue. The application of high-frequency electrical currents to granulation tissue and the lymphoid tissue of the tonsils causes very little pain or discomfort.

The second stage of treatment to the right and left tonsils is applied to the posterior portions which remain attached to the posterior pillars of the fauces; it is usually undertaken during the third and fourth weeks. The anterior portion of the tonsil has been removed; the coagulation and slough have separated, leaving a clean red granulating area, and showing a surface exudation of sero-pus, the remaining follicles or crypts being filled with caseating pus. Treatment should not be begun until the slough has completely separated and the acute inflammatory reaction resulting from previous treatment has subsided. If necessary, it should be delayed for a further week until this has occurred. The treatment of the posterior area of the tonsil may give rise to pain on swallowing, and may also cause earache. This is due to reaction at the posterior pillar of the fauces and referred pain from the posterior auricular nerve. These symptoms usually subside within forty-eight hours after treatment.

The third stage of treatment is applied to the base of the tonsil, the remnants of tonsillar tissue, and the lower pole towards the lingual portion of the tonsil. The right and left tonsils are usually treated alternately at the fifth and sixth weeks. However, if the tonsils originally were not very large in size, both can sometimes be treated at the same session. This causes very little pain or reaction, since the bulk of the tonsil has now been removed, and the infection is much reduced. The treatment may be continued at weekly intervals until the whole tonsillar tissue has been destroyed and removed. The patient reports for inspection at monthly intervals. As the healing progresses and fibrosis occurs, it is possible to determine the degree of success, and if necessary to advocate further treatment. A successful operation should show a clean granulating bed between the pillars of the fauces; this finally heals by forming a greyish-white area of scar tissue, with very little contraction or deformity.

The older methods of treatment, described by Dan McKenzie and Bulmer, advocated the use of specially designed electrodes of many varied sizes and patterns. These electrodes are too large, being about 3 mm. in diameter and 1 cm. long. The improvement in diathermy apparatus which now generates electric currents of higher frequency, and the use of a much smaller active electrode (0.2 mm. in diameter and 2 mm. long) results in a more defined and regular area of coagulation, diminishing the danger of tearing the tonsil and surrounding tissues. The older methods do not allow such high energy to be applied, and the coagulum sticks to the electrode, being partly detached and pulled away from the tonsil when the electrode is removed. The apparatus should be kept switched on during the whole process of treatment; it is not switched off until the electrode has been removed from the tonsil.

The number of treatments necessary depends upon the original size of the tonsil and to some extent upon the behaviour of the patient. With nervous patients and those who resist and are irritated by manipulation of the mouth and tongue it is necessary to proceed slowly, and to be satisfied with slow progress at each treatment. The small, hard, fibrotic and adherent tonsils seen in elderly people, and the remains of tonsillar tags following an incomplete tonsillectomy, respond well to this method of treatment.

The danger of haemorrhage is not great; it compares favourably with the incidence of haemorrhage following routine surgical tonsillectomy. Haemorrhage may occur within forty-eight hours after treatment; this is rare, and is due to straining of the throat and palate, causing detachment of the slough and damage of the blood vessels. It can usually be arrested by the application of the active electrode or fulguration to the bleeding point. Haemorrhage may also occur five to seven days after treatment, owing to premature separation of the slough and coagulum or to bleeding from granulation tissue. The application of electrical fulguration, or of the high-frequency current, to the area of haemorrhage is usually sufficient to arrest and control this. I have seen only three cases of haemorrhage during the progressive treatment of 250 patients.

Conclusion

The application of high-frequency electrical currents, commonly called surgical diathermy, may be employed successfully to remove and destroy the diseased tonsil. The technique of progressive destruction by coagulation has advantages, since this operation can be performed while the patient continues with routine duties. The procedure is slow, involving treatment at weekly sessions for six to eight weeks. The discomfort and disturbance incurred by the patient is not really great, especially in suitable types of cases, but in the highly strung and nervous patient it causes apprehension and fear. However, I have managed to complete treatment in all the cases I have attempted, and no patient has, as yet, failed to complete treatment once he has agreed to start.

OXYGEN ADMINISTRATION BY NASAL CATHETER

BY

H. L. MARRIOTT, M.D., M.R.C.P.LOND.

RESIDENT MEDICAL OFFICER, MIDDLESEX HOSPITAL, LONDON;
ASSISTANT PHYSICIAN, MILLER GENERAL HOSPITAL,
GREENWICH

AND

KENNETH ROBSON, M.B.CAMB., M.R.C.P.LOND.

MEDICAL REGISTRAR, MIDDLESEX HOSPITAL, LONDON

For prolonged administration of oxygen by any method it is now generally agreed that the proportion of oxygen in the inhaled air should be between 35 and 60 per cent. This means that the alveolar air should contain at least 30 to 55 per cent. of oxygen. Lower percentages have little therapeutic value; higher percentages are irritant, and may cause fatal inflammation of the lungs. The definition of the optimal range of oxygen concentration for prolonged administration has been the result of much

FIG. 1.—General disposition of apparatus.

experimental study by many investigators. This work has been reviewed by several authors.^{1 2 3}

There is a widespread impression that oxygen concentrations within this optimal range cannot be attained by nasal catheter administration. Recent work in America^{4 5} has challenged this view, and the claim has been made that the nasal catheter method can be completely effective, provided that adequate flows of oxygen are used—namely, 4 to 16 litres per minute. Such flows are far greater than those at present generally used. When released under water they cause a boiling turbulence, not the well-known little trickle of easily counted bubbles.

The importance of the subject and the American communications stimulated commencement of the work recorded in the present paper. Preliminary trials upon ourselves and upon patients seemed to confirm the general truth of the claim, but there appeared to be room for improvement of apparatus in several respects. The purposes of this article are: (1) to describe apparatus presenting certain new features; and (2) to record experimental data concerning alveolar oxygen concentrations obtained with the apparatus.