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ELECTROSURGERY

A CLINICAL REPORT ON 118 OPERATIONS

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AFTER an experience in more than 118 operations performed in whole or in part with the aid of electrosurgery, it becomes my duty to make a report embodying my opinion as to the cases in which this method of operating is applicable. I shall present a few brief illustrative histories and some suggestions concerning technic.

Gottesman, Perla, and Ziegler, in a paper published nearly two years ago,* presented the results of a study based upon animal experimentation in which the opinion was given that surgery of this type should not be promiscuously employed. Since then and in spite of this article electrosurgery has been increasing and its results, both immediate and remote, have been not only encouraging but often brilliant.

There are two important points in which it seems to me that the reporters have drawn unwarranted conclusions: First, that primary union is less likely to occur in a wound made by the electric method than in one made with the ordinary scalpel; and, second, that foreign-body necrosis with giant-cell reaction appears and that this is harmful. Farther on I shall discuss these two aspects of electrosurgery.

There are various units on the market for the production of a suitable bipolar electric current. This is not the place to describe and explain the physics of electrosurgery but those who are interested in this phase of the subject are advised to consult the excellent chapter in the recent book by Howard A. Kelly and Grant E. Ward.†

While it is undoubtedly desirable that the surgeon should know everything about his instruments I feel that the knowledge of the application and proper use of a piece of apparatus is more important than the details of its construction and the theory of its function. For example, in the use of the cystoscope it is not essential that the operator should understand all the optical details of the telescope with which he is working, although its general principles must, of course, be known to him.

The Incision.—With the instrument at my disposal in which the oscillations are extremely frequent I have been able to divide the skin by a rapid

* Surg., Gynec., and Obst., vol. li, p. 667, 1930.

† Electrosurgery. Howard A. Kelly, M.D., and Grant E. Ward, M.D., Chap. II, W. B. Saunders Company, 1930.

stroke, the tissues falling apart with no visible evidence of cauterization. Dr. Beverly Chew Smith* in a comparison of the microscopical appearance of sections of healed wounds following incision by knife and by electricity finds that the union is no less firm in one than in the other. Clinically, this is confirmed by my own experience. Upon applying the recently divided tissues to each other after electric incision there is immediate adhesion, and, this being more nearly aseptic than any scalpel wound can be, it is not surprising that rapid linear cicatrization occurs, whether the skin union was secured by metal clips, adhesive plaster, or by sutures. I am assuming, of course, that we are dealing with so-called clean cases. If infection is present it would be unreasonable to expect primary union by any method.

If current-oscillations are slowed down the division of the tissues becomes more and more associated with wider spreading of the area of coagulation and destruction of cells; and if the incision, even with rapid electric oscillations, has been made slowly a similar widening of the area of necrosis will take place and primary union will be less likely to occur.

The question, then, resolves itself into one of technic. We may compare in a similar manner the healing of a slow incision with a blunt knife with the result after the quick stroke of a keen edge.

By the electric method there is, perhaps, a little less bleeding from tiny points than is seen when the steel scalpel is used, but actual spurters, both large and small, must be caught with clamps in the usual manner. The next step in hemostasis, however, is one in which electricity has a great advantage over the ligature. A touch of the slow coagulation-point to the clamp, carefully isolated from all other instruments and from the surrounding walls of the wound will, in a second or two, seal the crushed vascular mouth with a firm eschar. A single wiping after the clamps have been removed should not be followed by hæmorrhage. Any vessel which bleeds after such sponging should be ligated.

The danger of infection by catgut or other ligature material I consider to be greater than that of recurrent hæmorrhage after sterile electrocoagulation. Catgut may harbor organisms as it comes from the tube or spool and, besides, it must be handled in tying the knot—even though with gloved fingers—thus subjecting it to at least one more possibility of infection.

As to the appearance of foreign-body giant cells in the presence of necrotic material it should be noted that these same cells are to be found in the neighborhood of any foreign body such as a ligature. I cannot understand why the mere presence of these cells should be regarded as undesirable. On the contrary, they have to do with the destruction and disappearance of the foreign body, whether this be a tissue eschar or a true *corpus alienum*.

ABSTRACTS OF HISTORIES WITH REMARKS AND SUGGESTIONS

My first case was one of apiclyosis for the compression of a tuberculous cavity in the lung. In the method which I employ in this procedure the wound is temporarily

* Paper read at meeting of New York Physical Therapy Society at the New York Academy of Medicine and to be published in the Archives of Physical Therapy.

ELECTROSURGERY

closed and in a few days is reopened. Compression of the lung is accomplished by daily packing from the outside of the parietal pleura. I felt that here, even if an accident were to occur, the field would be easily accessible and any untoward situation could be remedied. In this instance the operation consisted in an incision beginning near the axilla and running downward and forward for about six inches. This opening was made with a quick long stroke, passing easily through the fatty layer down to the muscle. The pectoralis major was nicked at right angles for the sake of better exposure. The electric scalpel was abandoned on reaching the bony chest-wall, two ribs were resected subperiosteally in the ordinary manner and the intercostal vascular bundles were ligated with catgut. All other vessels were caught with clamps and when a dozen or more were in place each clamp was lifted and was touched with the coagulating current for about two seconds and then removed. There was no bleeding. Extrapleural packings were inserted and the skin was temporarily closed over these packings by heavy stitches to be removed in four days. At the end of this period I found, to my astonishment, the cutaneous wound healed not only primarily but so firmly that it required considerable effort to separate its edges. There was no bleeding when the packings were taken out and subsequent progress was satisfactory, the patient making an excellent recovery.

This first trial eliminated at once the fear that primary union would not take place in a wound correctly made by electrosurgery. Manifestly this was of no importance in the case in hand and it was for this very reason that I had selected it as a test. The fact that there was no bleeding, while very satisfactory, was not conclusive, for, after all, this was only one case, and to establish confidence in hemostasis in electrocoagulation there would have to be further observations.

Twice since then I have done this operation with perfect satisfaction so far as the electric scalpel was concerned.

In addition to the three cases of apiclysis I present a list of other operations:

Thoracoplasty for pulmonary tuberculosis, twenty-eight operations upon fourteen patients. Pulmonary suppuration, twenty-seven operations upon ten patients. Chronic empyæma, eleven operations upon seven patients. Operations upon the chest-wall, seven upon seven patients. Carcinoma of the breast, six operations upon six patients. Carcinoma of the lung, four operations upon four patients. Appendicitis, nine operations upon nine patients. Cholecystectomy, six operations upon six patients. Inguinal and femoral hernia, six operations upon five patients. Operations for ranula, thyroidectomy, sebaceous cyst of the scalp, orchidectomy, osteomyelitis, one case each, eleven in all. In addition to these there were an indefinite number of phrenic neurectomies in which electrosurgery was used for hemostasis only.

OPERATIONS UPON THE THORAX.—These may be divided into two classes: Those in which the chest-wall alone was attacked, and those in which the organs within the thorax were operated upon. I have found without exception that electrosurgery is of enormous value in operations upon the chest-wall only, or as a preliminary to intrathoracic procedures.

CHEST-WALL.—*Non-malignant Tumors of Breast.*—Three cases, all extirpation of localized tumors. In none was there any mishap because of electrosurgery. The usual clean healing of the skin was the rule.

Carcinoma of the Breast.—In six cases of this disease, two of them complicated because of the necessity for immediate plastic operation, I found no cause to complain of the electric scalpel. Hemostasis by coagulation especially proved to be a great time saver. Primary union occurred in all these cases except one and here, on account of the unavoidable tension of a plastic procedure, there was necrosis of the edges of the skin for about three inches. Healing was complete five weeks after the operation, however, without further procedure.

There was one hematoma. It formed very slowly—more than a week after operation. This eventually necessitated reopening part of the firmly healed wound, after which there was prompt recovery.

In these mammary carcinomas I did not employ the electric method in dissection near the axillary vessels, but coagulation was employed except when a vessel spurted on wiping it after the forceps had been removed.

In the thorax as well as in other parts of the body I have been led to the conclusion that in sloughing or merely suppurating wounds ligatures might better be used than electric hemostasis. It is worth remarking, however, that even in these cases the entrance wounds when made through healthy skin healed with unusual rapidity.

Chest-wall. Miscellaneous.—The chest-wall alone was operated upon seven times. There was one carbuncle and I excised it with the electric scalpel. Of course, primary union was impossible but healing was rapid and without complications. In another case I had to deal with an area of movable chest-wall, several ribs having been resected with their periosteum by another surgeon long before. There was a small bronchial fistula at the centre of a large area of epithelialized lung. The electric scalpel was used to form skin flaps to cover the lung after its epithelial coating had been dissected away with scissors. The wound was drained at each extremity, but union of the flaps was perfect and final and rapid healing followed.*

Apicolysis.—Three cases. One has already been discussed and the other two showed nothing remarkable.

Thoracoplasty.—In the twenty-eight thoracoplasties there was much less bleeding than I have encountered when the ordinary scalpel was used, and the number of ligatures employed in the checking of spurting vessels was greatly reduced. Indeed, in one case, a secondary thoracoplasty where ten ribs were resected at one sitting, the entire operation was completed without the use of a single ligature. There was primary union. In another instance ten ribs were resected in two different sésances without employing a single ligature, and there was perfect primary healing.

In none of the other twenty-six operations had I the slightest regret for having employed the electric method. Occasionally a particularly rebellious spurter had to be tied but, as stated before, the total number of ligatures was very small.

* Surgical Clinics of North America, vol. xii, No. 2.

ELECTROSURGERY

I have found that when the electrode passes through muscular tissue there is violent twitching, and that this occurs whether the patient is operated upon under local or general anæsthesia. Kelly and Ward (*loc. cit.*) state that this contraction depends upon the number of current-oscillations. I have not had an opportunity to verify this but it would be an important factor in the selection of an electrosurgical apparatus. Of course, the manipulations about the bony structures, including the actual resection of ribs, must be performed with the usual bone-cutting instruments.

I am certain that in a thoracoplastic operation the time is shortened by at least one-quarter, perhaps even more. Healing is fully as rapid as I have found it when using the steel scalpel and ligatures, and the surgeon has an agreeable sense of security from infection. I have lately omitted the individual suture of muscle and fascial layers in these thoracoplasties, contenting myself with a few double silkworm-gut strands which pass through skin, fascia, and muscle. The cutaneous edges are approximated more exactly with metal clips. After all there is little or no tension because a section of the framework of the chest having been removed, the soft parts are actually redundant over a thorax of diminished capacity.

Another advantage of this form of surgery is the greatly diminished or even total absence of post-operative pain in the wound itself, which I imagine depends upon the destruction of the terminal portions of the divided sensory nerves.

INTRATHORACIC PROCEDURES.—In this list there are twenty-seven operations which were performed for suppurative diseases. I have not cared to employ the electric method here except for entrance through the skin and muscles of the thoracic wall, for fear of conduction of the electric current to the cardiac muscles with danger of arrhythmia, or even death from spasm. I have never seen a fatal case of this kind but I have heard of the accident and can well understand its physiology.

In the twenty-seven cases referred to I have seen no untoward phenomenon which could have been produced by the electric technic. There were four cases of pulmonary bronchiectatic disease with resection of a lobe or a part of a lobe and among them there has been no fatality; this, of course, not being by virtue of electrosurgery alone. It is merely mentioned in passing. The current was not employed within the chest.

Empyæma.—The eleven operations for chronic empyæma were extremely complicated and difficult, all seven of the patients having been operated upon before I saw them, some of them many times. Here, too, the electric incision was of greater importance than the hemostasis, which was usually accomplished by ligation with electrocoagulation as an adjunct. None of the patients has died. Four are long since recovered. One has a tuberculous pleural fistula and was operated upon merely to reduce the size of his empyæma. Two are still under treatment but are rapidly convalescing. It was in one of these cases that I learned the lesson that electrocoagulation may be unsafe in securing hemostasis in suppurating fields. There was a

severe secondary bleeding which demanded reopening of the wound. The patient is now nearly ready to be discharged from the hospital.

Carcinoma of the Lung.—There were four cases. No patient recovered, and in none was life shortened by electrosurgery.

ABDOMEN.—Appendicitis.—The skin incisions were made with the electric instrument. The fascia was cut with the scalpel or scissors and the remainder of the operation was completed in the usual manner. All vessels of the abdominal wall except the epigastrics were coagulated instead of being ligated. In seven of these cases there was primary union; in one there was a little exudate which was treated by opening the wound at its extremities and which finally healed before the patient left the hospital three weeks after her operation. In another instance the electric apparatus was not in perfect condition and the incision had to be made slowly. It was necessary to draw the wound edges in contact with adhesive plaster for some days after the skin clips had been removed.

Gall-bladder Disorders.—In six cases the gall-bladder was removed and it was in one of these that I learned to fear electric section of the aponeurosis. There was a separation of the wound six days after operation necessitating complete resuturing. The patient was an emphysematous man with a wide costal arch. While I believe that this accident might have occurred under any technic, I am willing to acknowledge the probability of added danger when an avascular tissue like the aponeurosis has to be divided and sutured.

One of the patients upon whom I operated for appendicitis had to have her gall-bladder removed at the same sitting. Because of faulty functioning of the apparatus the incision had to be made slowly. Here, too, the skin separated over a distance of about one-half inch and the entire wound was treated by firm strapping. Subsequent union was excellent.

In operations within the abdomen I have occasionally made use of the electric scalpel in dividing adhesions or in ablating organs, but I fear the accidental contact of the electrode with a mobile viscus and, therefore, prefer not to employ it as a rule in operations upon the abdominal organs.

Hernia.—Six cases of hernia (one of the femoral variety, the others inguinal) two of which were recurrent, were successfully operated upon with good results. Three of these, however, developed exudates, one of them purulent, evidently due to an infected chromicized catgut ligature. All of the patients, however, recovered perfectly, and since the skin only was electrically divided (not the essential parts of the hernia) I do not feel that the slight accidents could have been ascribed to the electric technic. In no case was the patient kept longer in the hospital than the usual three weeks. I feel that in this region of the body absolute sterilization of the skin is difficult and that the employment of a truly antiseptic knife is a distinct advantage.

Miscellaneous.—Of the eleven cases of miscellaneous operations nothing remarkable is to be reported.

CONCLUDING OBSERVATIONS.—(1) The rapidity and perfection of heal-

ELECTROSURGERY

ing in cutaneous wounds depends upon the speed with which the incision is made.

(2) Only an instrument with extremely frequent oscillations is suitable for making the incision.

(3) The rate of healing of properly made wounds is equal to that of those made with the scalpel.

(4) The firmness of the immediate adhesion of the cutaneous edges compares well with that of ordinary incised wounds.

(5) Wounds made slowly or with an instrument whose electric oscillations are not sufficiently rapid do not heal as well as those made with the scalpel.

(6) The histological appearance of healed wounds electrically made differs from those in incised wounds but does not indicate tensile weakness, or any other undesirable quality. (Beverly Chew Smith, *loc. cit.*)

(7) An electrically made wound is more likely to be aseptic than one made with the knife.

(8) In checking hæmorrhage from the smaller vessels electric coagulation is much more speedy and quite as satisfactory as ligation. Large vessels should, however, be tied. There is to be found in the text of this paper a description of the application of the clamp and coagulation method applied to spurting vessels.

(9) In sloughing wounds there is danger of recurrent or secondary hæmorrhage no matter what method has been employed. Most surgeons will prefer the ligature in these conditions. Electrocoagulation is absolutely aseptic and no ligature can carry the same degree of certainty.

(10) When local anæsthesia is employed in the section of muscle there is a sensation of electric shock accompanied by contraction of the muscles as they are divided. Therefore, general anæsthesia is preferable in electro-surgery.

PRECAUTIONS.—In the immediate neighborhood of the heart it is believed that dangerous phenomena may occur because of muscular stimulation of this organ.

No metal instrument in contact with the skin or with other instruments should be touched with the electrode.

The electrode fastened to the patient's arm or leg must be firmly secured. It must not be in contact with wet drapings of any kind for fear of burning.

No electric spark should be employed near an explosive anæsthetic, nor near explosive cleaning fluids.

While working in the mouth electric contact with dental fillings and metal prosthetic appliances must be avoided.

It seems to be the impression among operators inexperienced in this kind of surgical procedure that its only important use is in the extirpation of malignant growths and that it should not be employed when first-intention healing is to be desired. As a matter of fact, electro-surgery as a routine is a distinct advance over the more usual methods.