STATED MEETING, HELD MAY 7, 1906.

The President, JOHN B. ROBERTS, M.D., in the Chair.

OSTEOTOMY FOR ADOLESCENT RACHITIS.

DR. JAMES K. YOUNG presented a lad, fifteen years of age, who was admitted to the Polyclinic Hospital June 10, 1905, with a well-marked genu varum of the left leg, which had developed during the preceding three months. The shortening was considerable, and he wore a high shoe until the time of the operation. He sought relief from the pain and disability caused by the deformity in the joint. The point of greatest deformity in the bone was just below the tuberosity of the tibia.

Osteotomy of the tibia and fibula was performed at the point of greatest deformity. He was dressed in a fracture-box with compresses, and the recovery was uneventful except for a consecutive hæmorrhage which occurred from the fibular wound. Dr. Young said that osteotomy at this point is exceedingly difficult, on account of the danger of wounding the anterior tibial artery, the peroneal nerve, and the posterior tibial artery, and also because the section has to be very freely made on account of being very near the joint, but the result of the osteotomy in this case is perfect.

ANASTOMOSIS OF THE EXTERNAL AND INTERNAL POPLITEAL NERVES FOR INFANTILE PARALYSIS.

DR. JAMES K. YOUNG reported the case of a girl seven years of age, who applied to the Polyclinic Hospital November 29, 1904, on account of infantile paralysis of the left leg.

When two years old a paralysis of the left leg developed, so that she could not walk for six weeks. Was taken to various hospitals and treated by electricity and massage, after which she was enabled to walk. Had had no treatment for several years. She was a well-nourished child, well developed for her years. Left leg showed shortening, and there was a limp present in left leg.

Measurements—

Right leg....Length, 23 in.	Calf....9½ in.	Thigh....12½ in.
Left leg.....Length, 22¼ in.	Calf....6½ in.	Thigh....11½ in.

The entire distribution of the motor-tract of the external popliteal was paralyzed except the extensor longus digitorum, which showed a very feeble power of extension, only to be detected by careful observation. Sensation was normal.

Operation of nerve anastomosis, suggested by Dr. Wm. G. Spiller, was performed December 8, 1904. The operation consisted in a total central peripheral transplantation of the external popliteal into the internal popliteal nerve.

The technique of this operation does not differ from that employed in nerve anastomoses of other parts. The object sought is to transplant the nerve in such a manner as to place the central nerve axis of the paralyzed nerve in the same direction as the central nerve axis of the sound nerve.

The region was exposed by an incision six inches long, beginning at the middle of the posterior aspect of the thigh and terminating at the inner side of the biceps tendon. The external popliteal was first exposed and then the internal popliteal. The external popliteal was divided and attached to an incision in the internal popliteal. It was held in place by three chromicized catgut sutures. The wound was closed with catgut sutures and dressed in a plaster-of-paris case.

Sensation in the toes over the distribution of the musculocutaneous nerves returned in twenty-four hours. For three months afterward there was no improvement in the motor power or in the growth of the limb. Growth was then resumed and has since continued uninterrupted and more rapid, and the circulation has improved. There has been no loss of power in the extensor longus digitorum, but a slight increase of function, and the limb is more useful than before the operation.

DR. WILLIAM G. SPILLER said that in this case in which only a little motion was preserved in the extensor longus digitorum before operation, the question arose as to whether the nerve in this muscle should be sacrificed. As only slight power persisted it seemed proper to sacrifice the nerve. It would not be destroyed by the operation, but its power would be distributed over the entire region of the popliteal.

DR. YOUNG, in closing, replied to a question as to whether

the operation of anastomosis was of value in cases in which distinct reactions of degeneration were present. Dr. Young was at one time extremely doubtful that benefit was derived from anastomosis in such cases. After hearing Hoffa's statements at Atlantic City a few years ago he is inclined to believe that restoration is possible even when the reactions of degeneration are present. The appearance of the muscles themselves is the best guide to prognosis in these cases. The color varies from a dark red to pink or to a yellow tinge. The last indicates that the muscle is fatty; in these the reactions of degeneration are most marked. The reactions are in all cases difficult to determine, as admitted by neurologists, and may in some instances not be obtained. One is not sure that degeneration is not present even when the reaction is lacking. As to the technic of anastomosis, some surgeons do not employ sutures in the sheaths of the nerves. Dr. Young prefers to pass the anastomosing nerve entirely through the opening in the other and then suture at three points. The nerve then falls back until the ends of the axis-cylinders are in direct apposition with the same structures in the sound nerve. The new nerve in this way grows directly into the central axis of the sound nerve. The placing of three sutures refers only to nerves large enough to accommodate so many; in small nerves two or even one will have to suffice.

THE RELATION OF THE TECHNIQUE OF NURSES AND OF HOSPITAL APPARATUS TO THE HEALING OF WOUNDS.

BY CHARLES P. NOBLE, M.D.,

OF PHILADELPHIA.

Surgeon-in-Chief to the Kensington Hospital for Women.

It is the general belief of surgeons that infection in wounds, almost without exception, occurs in the operating-room as a result of introducing pathogenic microörganisms into wounds upon the hands of the surgeon or his assistants, or by means of the instruments or suture material or dressings employed. This belief has become general since the older theory that germs usually come in contact with wounds by means of the air was disproved. This source of contagion is believed to be a possibility, but practically to play a very small rôle in infection. This belief was held by myself and served as the practical basis of my own work until from experience I became convinced that the theory was not sufficiently broad to cover all the facts in hospital practice.

Some time ago, having occasion to investigate a series of infections occurring in clean wounds, I was driven to the conclusion that the infections did not occur in the operating-room, and upon careful investigation was satisfied that they were due to errors in technique on the part of the nurses, either before or after the patients had been operated upon. This experience led me to study the question of the technique of nurses and of the apparatus supplied to nurses in hospitals with which to perform their duties. It also led me to consider the wisdom of the plan usually followed by surgeons, including myself, of giving verbal orders to the head nurse in charge, and depending upon her to maintain a proper technique on the part of the pupil nurses.

In this particular investigation I learned that the technique in use was quite different from what I believed it to be.

Verbal orders had been given for many years, modified by other verbal orders from time to time, so that it was not surprising that the result of such a method should be a lack of exactitude in detail in carrying out general principles.

As a result of this experience I determined to adopt a technique which should be printed, so that there could be no question upon the part of the head nurse as to what was required, and no possibility on the part of any pupil nurse of misunderstanding the instruction of the head nurse.

With the assistance of the hospital staff a technique was compiled which was submitted to various head nurses for suggestions, and was used for a year so that it might be corrected by practical experience before being printed and finally adopted.

The result of this experiment, which I believe is novel, has been most satisfactory to all concerned. The long-continued series of infections which led to the investigation was promptly cut short and for nearly a year primary union was obtained, without exception, in non-suppuration cases.

During this particular series of infections already referred to, the same operating-room technique was employed which had been in use for a long time, with the result of obtaining primary union without suppuration in 98 per cent. of cases. When the infections began to occur, it was naturally supposed that this was due to carelessness on the part of some one connected with the operating-room. The personnel was gone over, every one was stimulated to rigid care in every detail of asepsis, with no improvement in the results secured. The sterilizing apparatus connected with the operating-room was overhauled and put in perfect order, and the time devoted to the sterilization of instruments, dressings, etc., and the disinfection of the hands was doubled, without result. Also the preparation of the field of operation was made more rigidly. These facts led me to consider whether it was possible for the wounds to become infected elsewhere. A peculiarity of the series of infections was that as a rule they were mild. The mortality during the series, which extended over a number of months, was not increased. There were no cases of peritonitis

in a long series of abdominal sections, and the infections as a rule occurred late and were confined chiefly to the subcutaneous fat. Finally, not only celiotomy wounds, but those of Alexander operations, hernias and eventually plastic operations upon the uterovaginal canal likewise became infected.*

Upon investigating the technique in use in the wards of the hospital I found evidence that the hands of the nurses were not adequately disinfected, that the douche bags were not sterilized, sterilization being limited to the douche-nozzle; that the basins and trays employed were not systematically sterilized (dependence being placed upon the solutions they contained for their sterilization), and that the methods in use for sterilization were far from satisfactory; also that the bath-tubs, while clean in the domestic sense, were not disinfected. It seemed to me to be a rational conclusion that patients being admitted to the hospital and given two or three baths in a bath-tub presumably septic, before being operated upon, and being prepared for operation by the hands of nurses which were not sufficiently disinfected, enough pathogenic microörganisms became implanted upon the skin of the patients to explain the series of infections. In order that this theory should be tenable it was, of course, necessary that the bath-tubs and the apparatus used by the nurses should have been infected from some patient early in the series of infections. In order to test the matter, rigid regulations as to the sterilization of all the apparatus used by the nurses, the disinfection of the bath-tubs and of the nurses' hands, were at once instituted and the usual technique of sterilization formerly in use in the operating-room was reverted to; that is, the amount of sterilization in the operating-room was cut down one-half. The result was immediate. The infections disappeared and the series was at an end.

It seems to me that the demonstration was complete that

* During the time that the infections were occurring in the hospital, the same assistants, dressings and suture material were used repeatedly in operations elsewhere without infection occurring in wounds. It was this fact which finally induced me to look elsewhere than in the operating-room for the source of the difficulty.

this series of infections came about in the way suggested. It has long been known that it is impossible to sterilize a surgeon's hands infected with virulent microörganisms by any means at our command, without a period of two or three days having elapsed since the infection took place. As a concrete example of this fact, in the early days, probably every abdominal surgeon had the experience of performing a celiotomy within one or two days after having examined a woman suffering from puerperal septicæmia, or having operated upon an abscess containing streptococci and of having the unhappy experience of seeing his patient contract a virulent septic peritonitis, with a fatal termination. The conditions were entirely similar in principle. The skin of the patient was infected with pyogenic microörganisms from the bath-tub or the nurse's hands, and the subsequent efforts at disinfecting the field of operation within the next day or two days were insufficient to render the field entirely sterile. The number of germs introduced in any case was insufficient to cause a fatal peritonitis, but did bring about suppuration in the wounds.

It seems to me that this demonstration is of sufficient importance to bring it to the attention of surgeons who, in general, like myself, have been convinced that to prevent suppuration in wounds it is only necessary to maintain a rigid technique in the operating-room.

Being convinced of the facts in the case, I investigated the nature of the apparatus in use by the nurses and the facilities afforded them to sterilize the same efficiently, and also the facilities afforded them for disinfecting their hands, when it became evident that these facilities were by no means adequate to obtain the best results. I therefore determined to institute a radical change. The problem was to eliminate all apparatus which could not be sterilized by boiling, to provide proper sterilizers by means of which all apparatus could be sterilized, and to study the problem of how the hands of the nurses could be kept from contact with infected objects, and, in addition to this, to prescribe rigid regulations for the disinfection of the hands of the nurses. It required but little study to determine

that, as hospitals are usually conducted, the hands of the nurses are constantly coming in contact with infected objects; for example, bed-pans are constantly receiving infected dejecta from the bowels, douche-pans are constantly receiving infected discharges from the genitalia, pus-basins and vomit-trays likewise are constantly handled by nurses, and the provision for the systematic sterilization of these utensils is lamentably poor or entirely absent. It was at once clear that if the hands of the nurses are to be kept free from contact with septic objects all such apparatus must be systematically sterilized.

It was clear also that under the usual conditions obtaining in hospitals all the objects about the wards with which the hands of the nurses come in contact might prove sources of infection, and that all such objects must be systematically disinfected.

A sterilizing plant was installed in the bath-room upon each floor sufficiently large to contain a dozen bed-pans or douche-pans. By means of high-pressure steam these can readily be sterilized by boiling. A rule was adopted that all bed-pans and douche-pans should be sterilized once daily, and thereafter stored in a clean closet until used. After use they are washed out in the usual way and drained. This prevents the carrying over of infection from one day to another. It would, of course, be more ideal if they were sterilized each time after use, but this was deemed to be an unnecessary nicety in practice. The point was to prevent carrying over infection from time to time or from one case to another. In addition to this, the customary rule that the apparatus in use upon septic patients should be isolated, was, of course, continued. A sterilizer similar to that used in operating-rooms for the sterilization of instruments was installed in each diet-kitchen, so that all of the basins and trays, catheters and instruments used by nurses can be sterilized as efficiently as is done in the operating room.

A rule was adopted that all basins, pitchers and trays used by nurses shall be cleaned and boiled for ten minutes after use, and then stored in formaldehyde solution 1–4000; also

that this solution shall be changed daily. All bowls for solutions must be again boiled before using. A general rule was adopted that all apparatus used by nurses must be sterilized at least once daily.

A definite technique for the disinfection of the nurses' hands was adopted, as follows: The hands shall be scrubbed for three minutes with soap and water and a sterile nail-brush. The finger-nails shall then be cleaned with a sterile wooden nail-cleaner, and the hands shall be scrubbed again for three more minutes. The hands shall then be soaked in formaldehyde solution 1–500 or bichloride of mercury solution 1–1000, for two minutes.

As a further precaution against the possibility of infecting the skin of patients admitted to the hospital, in addition to preparing for the disinfection of the bath-tubs and the nurses' hands, a plan was adopted of having all patients prepared for operation during a certain period by a nurse assigned for that duty, called the preparing nurse, whose hands are thus kept from contact with septic material.

In applying the general principle of keeping the hands of the nurses free from septic material there were numerous details to be worked out, some of which have been met as follows: It is required that, after the usual daily cleaning by the ward maid, the door-knobs, window-sills, tables, chairs, bureaus, bedsteads, poles for douche-bags, and the tops of all furniture or objects in the wards or rooms, shall be wiped off with formaldehyde solution 1–500 by the nurse; also, that all shelving in the diet-kitchens and in the rooms in which the apparatus for nurses is kept, shall be washed daily; on alternate days with soap and water, and with formalydehyde solution 1–500.

Among other objects with which the hands of the nurses come in daily contact there are probably none which are more septic, if not absolutely dirty, as hospitals are usually conducted, than the rubber sheets which are used to protect mattresses. The usual method of caring for these is to wipe them off when the patient is discharged and then to put them on

another bed; and it is quite probable that even this wiping off process is often omitted. As these sheets necessarily receive discharges from the bowels, from the vagina, and from discharging wounds in many cases, from the necessities of the situation they must always be covered with pathogenic microorganisms and are, therefore, a fruitful source of infection of the hands of nurses.

Such rubber sheets are treated by washing them thoroughly after use, after which they are soaked in formalydehyde solution 1–500 for twelve hours, wiped dry and put away in a sterile cloth, rolled on a roller, until used again.

The vomit-trays and pus-basins were eliminated as sources of infection of the nurses' hands by classing them with the other basins and trays in use, and having them cleaned and sterilized and stored in formaldehyde solution each time after use.

Another source of infection of the nurses' hands are the cans which are used to receive the dressings and waste from the wards. Such cans are in constant use in all hospitals, and receiving, as they do, septic dressings, they are a prolific source of infection of the nurses' hands. This source of infection was eliminated by requiring that the lids of the cans should be permanently removed, so that it is unnecessary for the nurse to touch the cans. When the cans are taken to the engine-room in order that their contents may be burned, they are cleaned, and then boiled in apparatus installed for the purpose. This is done by the engineer force, and it requires but a few minutes when the apparatus is installed; and it eliminates one source of filth and infection with a minimum expenditure of time and effort.

In the operating-room some additional apparatus was installed to insure the absolute daily disinfection of every article in use in the operating-room. With the modern pressure-steam dressing-sterilizer and instrument-sterilizer there is no longer any difficulty in adequately sterilizing dressings, instruments, towels, gowns, etc., but for convenience a large instrument-sterilizer similar to the ones designed for the sterilization of bed-

pans, douche-pans, etc., was installed in the sterilizing-room, which will contain a sufficient number of basins, pitchers, etc., to furnish sterilized basins for a day's work.

A new apparatus was installed by means of which the hands of the surgeon and his assistants are washed in a spray of running water—the supply of water being controlled without using the hands. This apparatus eliminates the possibility of infecting the hands by washing them in septic basins.

In my judgment every hospital should install a plant which will sterilize its entire water-supply. Hospitals having a high-pressure steam plant can do this with very little expense by having the cold-water inlet-pipe pass through a cylinder sufficiently filled with copper tubes connected with the high-pressure steam plant to boil and sterilize the water on its way to the storage-tank. By regulating the size of this tank and the amount of heating surface in the copper coils to the daily amount of water used, it is a relatively simple mechanical problem to sterilize the entire supply of a hospital. An additional apparatus would be required to cool this water on its way to the storage-tank. Such an arrangement would not only assist in eliminating typhoid fever from hospitals, but would also be of material service in carrying out the principles of asepsis.

The plan so often followed in operating-rooms of using the same basins for several consecutive operations, merely washing them out between the operations, is reprehensible, and with the present facilities for sterilizing such apparatus there is no excuse for this bad custom.

The real difficulty in the sterilization of the apparatus in the operating-room was how to sterilize the irrigators, the slop-buckets, the Kelly rubber cushions, perineal pads, etc. This problem was satisfactorily solved with the assistance of a mechanical engineer. The largest slop-can, with the smaller put within it, is filled with water and by means of a metallic connection with a high-pressure steam-pipe, live steam is turned into the water and the entire apparatus is sterilized by boiling. The Kelly pads are sterilized by soaking them over-night in

formaldehyde solution 1–500; after thoroughly cleansing them. The problem of how to deal with irrigators was solved by using large rubber douche-bags, which are boiled each day before being used.

The points to which I would direct attention are:

1. Whether surgeons should be satisfied with the policy of giving verbal directions to head nurses about the disinfection of hospital apparatus and the technique of nurses as applied to the treatment of wounds; or, whether each hospital should adopt a routine technique which should prescribe the methods which are to be followed, thus avoiding any possibility of error on the part of the head nurse and pupil nurses.

2. The importance of preventing the infection of the hands of nurses by the elimination of all possible sources of contamination, through proper regulations as to the cleansing and disinfection of wards, rooms, furniture and apparatus employed by the nurses.

3. The adoption of a proper technique for the disinfection of nurses' hands.

4. The installation of proper sterilizers, which will enable nurses to sterilize the apparatus used by them as efficiently as is done in operating-rooms at the present time.

Dr. George Erety Shoemaker said there was possibly a needless elaboration in some of the points detailed by Dr. Noble, but at the same time there is no doubt that surgeons cannot be too careful in securing asepsis. Boiled rubber gloves for the nurse who is preparing the patient solve some of the problems. A source of infection in operative cases is the slipping of the dressing applied by the nurse after preparing the operation site. This is especially true in cases in which plastic precede abdominal operations. He believes the free use of formalin as recommended by Dr. Noble will be found to cause a dermatitis in some nurses. In the hospital where he does much of his work they put a formalin solution in the wash-basins of the operating-room one hour before using them, but the hands are washed in running water. The stationary wash-basin may be a prolific source of infection.

Dr. James K. Young remarked that nothing had been said

by Dr. Noble regarding the use of gloves. He always uses rubber gloves and thus eliminates one source of infection.

Dr. Gwilym G. Davis regards the boiling of basins as a perfectly satisfactory plan. At the Orthopedic Hospital they use a large, square, steam-heated box for this purpose. He prefers that the nurses in the operating room should wear gloves, just the same as do his assistants. As to the dirty basins for washing the hands, that feature can easily be avoided by the use of running water and the rose spray.

Dr. John B. Roberts said an important point in this question of asepsis seems to be that no one can do good surgery unless he is in absolute control of a hospital. The value of this feature is shown by the excellent suggestions of Dr. Noble. Such details as he enumerates cannot be carried out in a hospital where four or six surgeons change at intervals, as in one institution with which Dr. Roberts is connected. The preparation of the nurses is an important part of surgical technique. In this connection it may be said that practically all surgeons are guilty of hurrying the nurses and not giving them time properly to attend to aseptic technique when an operation is at hand. In addition to those already named, a source of infection is the exposure of wounds often seen during ward visits. This is particularly true of wounds about the groin or in other places difficult to bandage, the wound being uncovered by the slipping of the dressing improperly applied by the resident who dressed the case.

Dr. Noble, in closing, said he was not at first prepared to believe that infection of wounds came from infection of the skin before operation, but a series of infections had conclusively proved its possibility. As to Dr. Shoemaker's statements regarding the impracticability of formalin, all the nurses in his hospital have used it for some years. Two or three thought it caused dermatitis. They were permitted to substitute bichlorid for the formalin. There is no difficulty with its use except in cases of idiosyncrasy. Regarding sterilization of the waste-cans in the wards, if one sees how easy it is to do this he would no longer be willing to let them go without it. Dr. Noble has for years used rubber gloves. They are of great value in keeping the surgeon's skin from infection, and also for protecting the wound, thus working both ways. He wears them in all except trifling operations. The rose spray installed in the hospital as described by him is the

same type as mentioned by Dr. Davis. It can be manipulated by the feet or by the elbow of the surgeon. It works by an ordinary lever pressed in by the feet, the latter being aided by a catch which holds the lever open after it is pressed by the foot. To mix the water properly there is an ordinary valve shut-off on both hot and cold supply-pipes. In manipulating the flow of water in any way desired, the surgeon does not need to use his hands at any time.

DISLOCATION OF A VERTEBRA.

Dr. Edward Martin (and by invitation, Dr. William G. Spiller) reported the case of a boy, an athlete, who was wrestling. His opponent was holding him with his head on the ground and endeavoring to force down his shoulders. Suddenly the boy collapsed and became totally paralyzed. When he was examined there at once arose the question of operation. There was evidence of either a total transverse lesion or of a twist or stretch of the cord. It was decided to wait until this point was decided. The persistence of the paralysis for three days furnished proof of a total transverse lesion. Whether it was due to a dislocation of a vertebra or to a tear could not be determined. X-ray examination was unsatisfactory, but seemed to show a lesion of the sixth cervical vertebra. Laminectomy appeared to offer nothing, and hence it was not performed. In spite of all that is said to the contray, laminectomy is not a safe procedure. If, however, his neck was injured in this way, Dr. Martin would like the operation done. It gives a possible chance of replacing a bony fragment or of removing a clot, and at least would hasten death if it did not relieve. Dr. Martin's experience with laminectomy is that improvement after the operation is the same as occurs in cases treated without operation. The lesion in the case reported proved to be a luxation of the seventh cervical vertebra which had been spontaneously reduced, there being no fracture and yet a complete transverse lesion of the cord.

Dr. Spiller said that when he examined the young man, a few hours after the injury, there was complete paralysis of the lower extremities. Sensation was completely lost as high as the umbilicus, and there was a zone of disturbed sensation between the umbilicus and the nipple line, by the following day the area of anæsthesia had extended as high as the third rib. The reflexes were entirely absent in the lower extremities. There was volun-

tary movement of the shoulders, the elbows, and the wrists. There was no grasp in the right hand and but little in the left. The signs were those of complete transverse lesion of the cord, and the level of the lesion was easy to determine. The disturbances of sensation on the inner side of each upper limb and the loss of power in the muscles of the hands—*i.e.*, in the distribution of the first thoracic and eighth cervical roots, pointed to a lesion in the corresponding segments of the cord, and hence the case was perfectly clear. All who saw the patient agreed that operation was not advisable. The question of operating in these cases is now greatly in dispute. Dr. Spiller is conservative in this regard and doubts if laminectomy is of value in fracture of the vertebræ. Some surgeons say that the chief cause of the paralysis is pressure by displaced bone and that restoration of function will follow removal of the fragments. As a matter of fact there is not extramedullary hæmorrhage in most cases. Usually there is disturbance of the cord due to the injury that produced the fracture, and whatever damage may have been done by displaced bone has occurred at the moment the displacement occurred. When the cord is thus injured no removal of pressure, if this exists, can restore it. In most instances the cord is mashed, and often there is softening and even hæmorrhage within the cord when the cord externally appears normal. Autopsy in the case under discussion showed there was no hæmorrhage on any part of the cord, either external or internal to the dura. At the eighth cervical segment was marked compression of the cord, with swelling above and below. Microscopically marked degenerative changes are present in and above the compressed area, hæmorrhage within, and intense disintegration of the cord being shown. This same condition is found in many of the cases of similar injury to the cord. There is also some change in the sacral region in this case and Dr. Spiller is inclined to believe there was a temporary dislocation in the lumbar vertebræ, although this was not suspected before death or at the necropsy. The lower end of the cord is partly separated from the rest or reduplicated. This is possibly a congenital malformation.

Dr. William J. Taylor said that he had now under his care a man who eighteen months ago fell 42 feet, this rendering him unconscious for several hours. He was paralyzed for six weeks after the accident, when Dr. Taylor first saw him. By the X-rays

it was thought possible to detect a fracture-dislocation of the first lumbar vertebra. The patient was put on the table in preparation for laminectomy, but a careful examination before ether was given revealed slight motion in one leg. The operation was not done and a plaster jacket was applied. The patient has continued improving up to the present time. He was in the hospital from September to February. He now has perfect motion and has no difficulty in walking. The greatest trouble now is when he leans over with the knees fixed, as this gives him intense pain down both thighs. The pain is not noticed if the knees are bent at the time he stoops.

Dr. James K. Young said he had under his care for many years a girl who showed the happy results of laminectomy. She was an aeronaut who fell 100 feet and sustained a fracture in the lower dorsal region and was operated upon by laminectomy by the late Dr. Ashhurst. He took the chances of operating and removed a fragment of bone. The patient is now able to walk. There is of late years a tendency among surgeons not to operate upon cases of tuberculous paraplegia. Dr. Young does operate upon such cases. One patient referred to him by other surgeons now, as the result of operation, has the use of her limbs.

Dr. Charles H. Frazier said regarding the etiology of the injury in the case reported, Dr. McKenzie, the physical instructor, stated that at the time of the accident the boy was much fatigued from long-continued exercise and wrestling, and he believes the muscles failed to give proper support to the parts involved. Dr. McKenzie does not know of any other case of like injury.

Dr. Martin, in closing, said the possible lesion in the lumbar region would help explain one puzzling symptom. In the case of a lesion high in the cord there should be incontinence rather than retention of urine. Here there was retention, which was suggestive of a lesion in the lumbar region.

AN EXPERIMENTAL STUDY OF SUTURE OF ARTERIES WITH A DESCRIPTION OF A NEW SUTURE.

BY GEORGE MORRIS DORRANCE, M.D.,

OF PHILADELPHIA.

Assistant Instructor of Surgery in the University of Pennsylvania; Surgeon to the Out-patient Department of St. Agnes' Hospital.

THE methods of repair of arteries hitherto proposed are as follows:

I. MECHANICAL METHODS.—(*a*) Adhesive plaster methods, devised by Dr. G. E. Brewer. Advantage: The rapidity of application. Disadvantages: 1, A foreign substance is left in place; 2, secondary hæmorrhage occurs frequently; 3, obliteration of the vessel is common from too much pressure. (*b*) Abbe's method. The introduction of a glass tube in the lumen with suture of the artery. Advantage: Very slight chance of secondary hæmorrhage. Disadvantages: 1, The tube is a foreign body and by its presence causes irritation of the intima and produces thrombosis at the ends of the tube; 2, the tube may ulcerate its way out.

II. SUTURE METHODS.—(*a*) Invagination method devised by Dr. J. B. Murphy. Advantages: It gives a double thickness of the artery at the line of approximation. Disadvantages: 1, The artery is necessarily stretched; 2, the operative procedure difficult and long; 3, the lumen is narrowed; 4, the end of the artery allows fibrin ferment to enter the blood-stream; 5, fringes of intima hang in the blood current and assist in coagulation. (*b*) Suture of the outer two coats only. Advantages: None, over the through-and-through method. Disadvantages: 1, The blood can dissect its way between the coats of the artery and cause an aneurism; 2, fibrin ferment from the arterial walls has free access into the blood-stream; 3, fringes of intima hang in the blood-stream and assist in coagulation. (*c*) Through-and-through method. Advantage:

Easy to perform. Disadvantages: 1, The suture is exposed to the blood-stream; 2, fringes of intima hang in the lumen. In the method now to be described attention is called to advantages: 1, The suture does not protrude in the lumen of the artery; 2, fibrin ferment cannot get from the ends or cut surfaces of the artery into the blood-stream; 3, the liability to secondary hæmorrhage is lessened by the double line of suture. Disadvantages: We have not observed any.

Description of the Suture.—Pagenstecher's thread Number One is used in the finest sewing-needle the thread will pass through. The clamps used are very limber-bladed forceps, devised by us especially for this work in order to avoid crushing the intima. The blades are covered with rubber tubing. (Figure 1.) Dissecting forceps are used to hold the edges of the artery. The suture can be used for a longitudinal, oblique or transverse (complete or incomplete) cut in the artery.

Method of Suturing a Longitudinal Cut.—(Fig. 2.) The clamps are applied 2.5 cm. above and below the cut. The suture is started 1.5 mm. above the cut edge, the suture is passed through the outer two coats and tied, the end of the suture is grasped by a hæmostat, the needle is next passed through all the coats of the artery on both sides 1.5 mm. below the first suture and 1.5 mm. from the cut edge; the suture from now on is a continuous mattress with the dropping back one-half a suture length every third suture until the end of the incision is reached, then the suture is passed through the outer two coats 1.5 mm. below the lower end of the cut and a half-hitch made to tie the suture. The same suture is continued as a whip-stitch over the edges of the artery outside of the mattress suture until the starting-point is reached, when the two ends of the suture are tied. The artery is grasped in a gauze pad, the distal clamp removed, then the proximal clamp and the artery is dropped back in place and the deep fascia sutured around the line of approximation.

The method of suturing an oblique cut is practically the same as the longitudinal.

The Method of Suturing a Transverse Incision Half Way Through the Artery.—(Fig. 3.) The clamps are applied 2.5 cm. above and below the cut edges. The suture is started 1.5 mm. from the lateral end of the cut and passed through the outer two coats and tied; the end of the suture is grasped with a hæmostat. The suture is continued as a continuous-mattress suture, dropping back one-half a suture every third stitch until the opposite end of the cut is reached, then the suture is passed through the outer two coats and a half-stitch made to tie the suture; the same suture is continued back over the line of suture as an over-hand whip-stitch outside the mattress suture until the starting-point is reached, when the two ends are tied. The mattress suture should be 1.5 mm. from the cut edges at all times. The deep fascia should be sutured around the line of approximation.

The Method of Suturing a Complete Transverse Division of an Artery.—(Figs. 4, 5.) The clamps are applied as before. The cut edges of the artery are grasped with dissecting-forceps and the suture is passed through the upper edge of the artery from without in and through the lower end from within out; the needle is then reversed and brought back 1.5 mm. to one side of the former suture and tied. (This suture is really a single-mattress suture.) The suture is continued as a continuous-mattress suture, dropping back half a stitch every third suture until the starting-point is reached, then a half-stitch is made and the suture continued back as a whip-stitch until the starting-point is reached again; then the two ends are tied. The suture is started on the anterior surface near the handles of the clamps. When the suture reaches the farther side of the artery the handles of the clamps are taken from the lower portion of the wound and placed in the upper portion; in this way the surface of the artery which was anterior is now posterior, and the suture can always be kept in sight.

EXPERIMENTS.

Case I.—Black horse, aged 20. Condition was very poor. The anæsthetic was chloral internally and chloroform by inhalation. An incision 20 cm. long was made on the left side of the neck, the carotid artery was

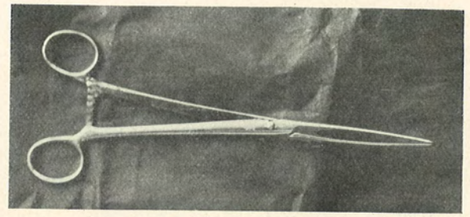


Fig. 1.—Special artery-clamp.

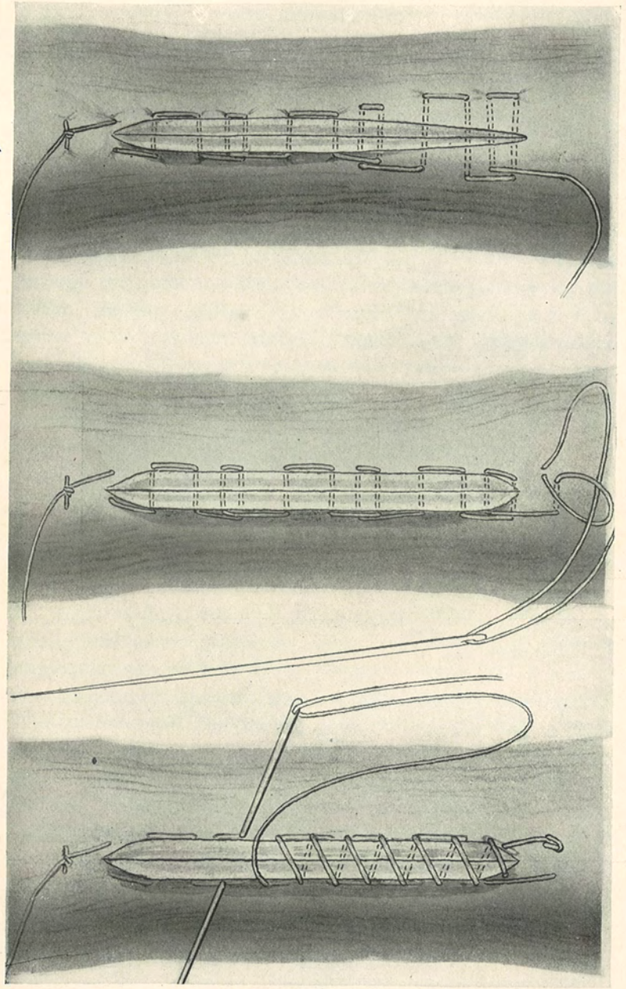


FIG. 2.—A, suture inserted and pulled tight in the lower half; B, suture inserted and pulled tight throughout; half-hitch made but not tightened; C, mattress suture pulled tight and half-hitch made, whip stitch partially inserted but not pulled tight.

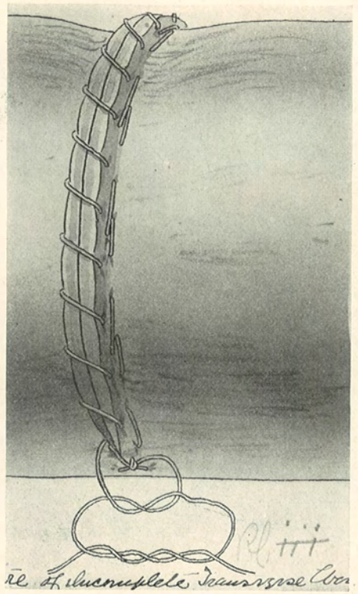


FIG. 3—Suture of incomplete transverse wound.

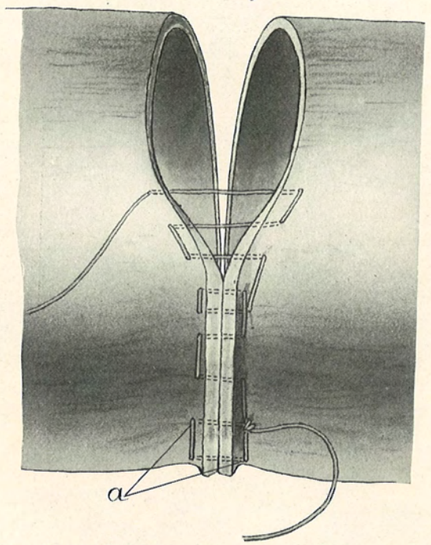


FIG. 4.—Suture of complete transverse wound ; A, mattress suture.

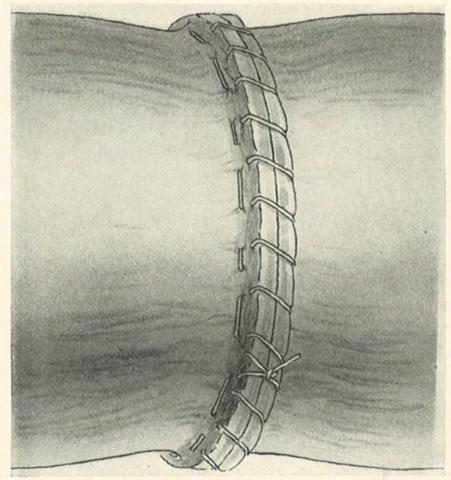


FIG. 5.—Suture of complete transverse wound, finished.

found and the clamps were applied. A small vessel arising from the under surface of the artery was clamped and ligated. A longitudinal incision 4.5 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation, the artery could be seen pulsating. The wound was sutured with through-and-through sutures of silkworm-gut. The horse died from the effects of the anæsthetic three hours after the operation. Through a mistake of the attendant, the specimen was not recovered.

Case II.—Black horse, aged 20. Condition was very poor; there were several sloughing wounds and sinuses over the body. The anæsthetic was chloral and chloroform. An incision 22.5 cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. The artery was divided transversely two-thirds the way through. The artery was sutured, the clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation, the artery could be seen pulsating. The superficial wound was closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the pulse was good and equal to that on the opposite side; the horse was unable to get up. Forty-six hours after the operation the pulse was equal on both sides; the horse was unable to get up and was killed by pithing. When the incision was opened up the wound was found to be infected; the artery was removed and examined; a very small lateral thrombus was present, but the lumen was not decreased. (Fig. 6.)

Pathological Report.—Gross specimen, preserved in a solution of formaldehyde, shows a portion of an artery dissected free from the periarterial tissues, the wall of practically normal thickness and without apparent gross trace of any marked hyperæmia. The vessel laid open shows the intima practically normal, save at site of the wound; the wound a partial transverse (slightly oblique) incision of the circumference, marked by a small clot extending in valvular fashion into the interior, and attached at the line of incision. This clot probably interfered but little, if any, with the flow of blood, and is apparently organized. The texture of the tissue of the wall shows no important gross changes.

Microscopic.—Section longitudinal, transverse to the line of operative wound. As seen in the section there extends from the line of closure of the incision a flap-like (valvular) thrombus into the lumen of the vessel, granular and fibrinous in structure, containing numerous scattered polynuclear leucocytes and a few eosinophilic cells. The wall of the artery is slightly thickened, its outer coat thickly infiltrated with polynuclear leucocytes, a smaller degree of the same type also existing in the other coats (prominent in part of the intima). The tissues in the line of enclosure (compressed by the sutures) are dense, more or less hyaline and staining without definition, and irregularly electing the hæmatoxylin and eosin tints. These tissues do not show any leucocytic infiltration. Especially in the outer coat the lymph-spaces are distended and contain a fibrinous coagulate, in which are seen scattered leucocytes. The

endothelium of these spaces is swollen and occasionally desquamated. Throughout the wall but little cellular proliferation is evident.

Case III.—Dog; Irish setter. Condition was good. The anæsthetic was morphine hypodermatically and ether by inhalation. The abdomen was opened and the abdominal aorta exposed 5 cm. above the common iliac artery; the clamps were applied and a longitudinal incision 2.5 cm. long was made in the artery. Bleeding occurred from the lumbar branches of the aorta, which were clamped and ligated. The artery was sutured with difficulty on account of the depth of the wound and the bleeding of the small veins. After the clamps were removed, the artery could be seen pulsating. Twenty-four hours after the operation the dog was in a weak condition, but the pulse was equal in both femoral arteries. Forty-eight hours after the operation the pulse could be felt in the femoral arteries, but was very rapid and weak; suppurative peritonitis was apparently present. Ninety-six hours after the operation the pulse could be felt in the femoral arteries; peritonitis was present, and as the dog was suffering acutely he was killed by chloroform. Post-mortem findings: Suppurative peritonitis was present; the artery was removed and opened up; a slight lateral thrombus caused by an infected suture was found. (Fig. 7.)

Pathological Report.—Gross specimen, a short length of abdominal aorta with its bifurcation, preserved in a solution of formaldehyde, shows the vascular wall with surrounding tissue closely adherent, and with discoloration from hyperæmia persisting. Laid open, the general intima shows no gross change. Over the line of longitudinal incision is a slight ridge of thrombosis apparently but little changed. The walls of the vessel, especially a little away from the line of closure (which is the thinnest part of the circumference), are thickened, hyperæmic and apparently the seat of inflammatory infiltration, but without gross appearance indicating suppuration.

Microscopic.—Section made transversely, at right angles with the line of operative wound. Over the incision in the lumen of the vessel lies a fibrinous thrombus, showing no organization as yet, with a rich polynuclear leucocytic infiltration along its base, and containing numerous hæmatoxylin-stained fragments (fragments of leucocytic nuclei). The line of incision shows a distinct mass of polynuclear leucocytes extending from the base of the clot to the exterior of the vessel. Tissue along the line of closure of the wound shows embedded suture, and it is densely hyaline in character, electing the eosin stain, being evidently necrotic. The general wall of the artery is deeply congested, at places infiltrated with blood; shows marked proliferation of the connective tissue, and contains numerous polynuclear leucocytes, the latter densely infiltrating portions of the adventitia.

Case IV.—Medium-sized dog. The anæsthetic was morphine and ether. The carotid artery was found on the right side of the neck, and the clamps were applied. A longitudinal incision 1.7 cm. long was made in the artery. The artery was sutured in the usual manner, the clamps were removed and no hæmorrhage occurred. The superficial fascia was sutured around the line of approximation, and the wound closed with

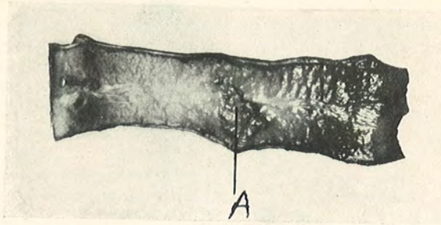
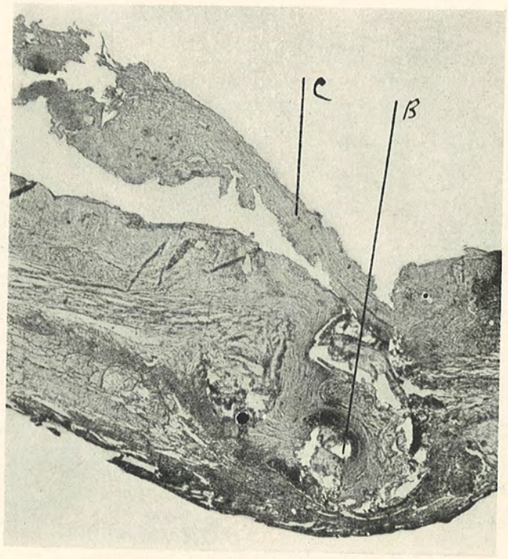


Fig. 6. Case 2.—A, line of incision.



Case 2.—B, remains of suture; C, small valvular thrombus.

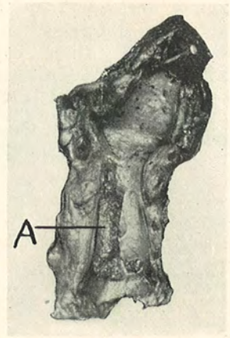
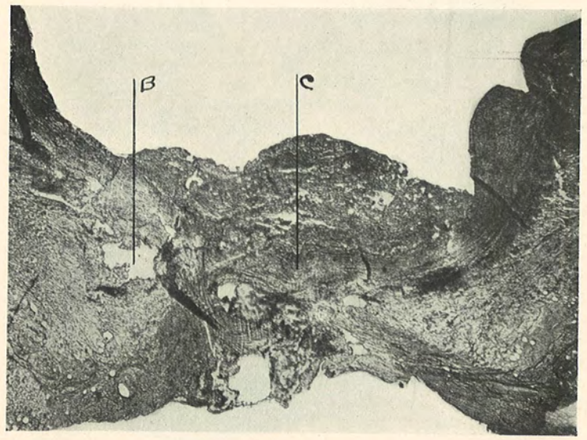


FIG. 7. CASE 3.—A, line of incision.



CASE 3.—B, remains of suture; C, line of healing.

through-and-through sutures. Twenty-four hours after the operation the dog was up and about, the pulsation was normal, but the wound was infected. Four days after the operation the pulsation in the carotid artery was normal; the wound suppurating. The dog was killed on the fourth day; the artery was removed and opened up and a lateral thrombus was found.

Pathological Report.—The section of this specimen unfortunately takes in only one margin of the injury, which is apparently not closely approximated. The whole vessel wall is diffusely involved in acute inflammatory changes, with fusion of the similarly-involved surrounding tissue to the adventitia, so that no sharp demarcation of the outer coat of the vessel exists. Inside the vessel a comparatively fresh thrombus exists, adhering along the line of the wound. These tissues close to the line of injury are necrosed, taking diffusely and with poor definition the eosin stain; they are more or less diffusely infiltrated with blood, and the seat of numerous hæmic granules. Throughout the thickness of the vessel along this line the tissues are the seat of considerable leucocytic infiltration, of infection of the vasa vasorum, and of numerous round and spindle-shaped embryonic connective-tissue cells. Examples of phagocytic leucocytes are not infrequent.

CASE V.—Black horse, aged 20. Condition was very poor. An incision 22 cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. The artery was cut completely across and end-to-end anastomosis was performed. Some difficulty was encountered in holding the edges together on account of having only one assistant and the horse shaking with a fine tremor. The clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation. Twenty-four hours after the operation the horse was up and about, the pulse was good, full and equal on both sides. Three days after the operation the pulse was equal and the wound suppurating. Five days after the operation the pulse was good, full and equal on both sides; the wound was suppurating profusely. The horse was killed and the wound opened up; the artery was removed and incised; the lumen was not decreased, and no thrombus was present. (Fig. 8.)

Pathological Report.—Gross specimen, preserved in a solution of formaldehyde, consists of a short segment of the artery freed from the surrounding tissues, with walls of apparently normal thickness and texture. Laid open, near the site of operation the intima is slightly nodular, apparently from slight focal swellings rather than from foci or thrombosis. The line of incision, a circular one, shows as a slight (circumferential) ridge a little less glistening than the adjacent intima, and presumably the seat of a small thrombus, which must, however, be partially organized. No distinct foci of softening from suppuration seen in gross inspection of the wall in section.

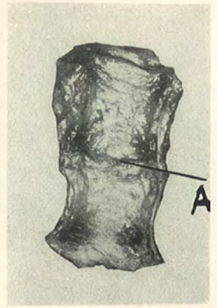
Microscopic.—Longitudinal section of artery (transverse to line of operative wound) shows a thin layer of granular clot over the site of wound; this clot is the seat of moderate leucocytic infiltration, especially

toward the base (in clot numerous nuclear fragments probably from leucocytic disintegration). In one part of the clot evidence of beginning vascularization. On the outside of the vessel are several tiny foci of suppuration shown in the section, and in the inner muscular layer and intima is a similar infiltration somewhat more diffused. Little reparative activity evident, and the general wall remains thin, showing microscopically but little embryonic cell formation present in the layers. The tissue does not show a clear line of incision; an irregular fragmented part of the wall evidently represents the wound; and in this part there is a special tendency on the part of the tissues of the muscular coat to select the hæmatoxylin.

Case VI.—Mouse-colored horse, aged 17. Condition was very poor. An incision 20. cm. long was made on the right side of the neck, the carotid artery was found and the clamps were applied. The artery was divided completely across and end-to-end anastomosis performed. The clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation. The pulse was equal in both submaxillary arteries. Twenty-four hours after the operation the horse was up and about, the pulse was good, full and equal on both sides. Three days after the operation the pulse was equal on both sides and the wound suppurating. Five days after the operation the pulse was equal on both sides. Seven days after the operation the pulse was good, full and equal on both sides, and the wound was still suppurating profusely. The horse was then killed and the wound opened up; the artery was removed and incised; the lumen was not decreased and no thrombosis present. (Fig. 9.)

Pathological Report.—The gross specimen, preserved in a solution of formaldehyde, shows an artery with the surrounding tissues at the site of operation intimately adherent to the external part of the wall, and with traces of discoloration and hyperæmia. Laid open, the intima shows a circular, slightly depressed line of operative union, without clear evidence of thrombosis, but somewhat roughened as if from a small deposit of this type. The gross section of the wall presents just beneath the line of closure, which is apparently firm, a small focus of pale opaque appearance, its substance somewhat softer than the general tissue, and suggesting a point of suppuration about a suture. The tissue of the deeper part of the wall and the adjoining tissue have a succulent appearance suggesting inflammatory infiltration rather than dense fibrosis from complete healing.

Microscopic.—Section made longitudinally, transversely to line of operation. There exists a small definite fibrous clot upon the intima just over the line of incision. The incision has been obliterated by partial healing, but the whole wall of the vessel is much thickened by an intense exudative inflammation. The outer wall is the seat of wide distension of its spaces which are filled by a fibrinous reticulum thickly beset with polynuclear and eosinophilic leucocytes, and at several points suppuration evidently is focalizing. The muscle-layers in both coats are separated and sharply outlined by a cellular infiltration particularly rich in eosinophilic cells, and the intima is much thickened, particularly by an embryonal



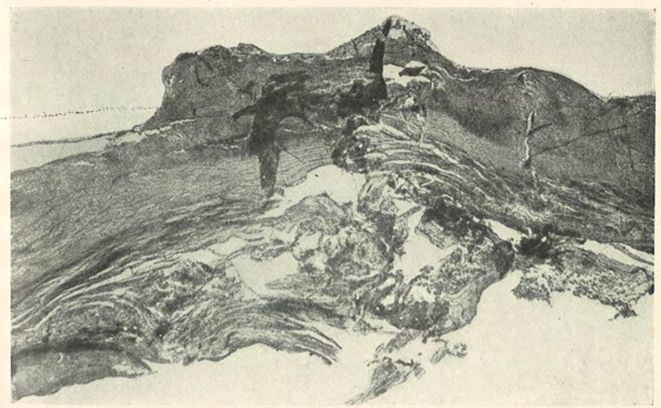


Fig. 8. Case 5.—A, line of incision.

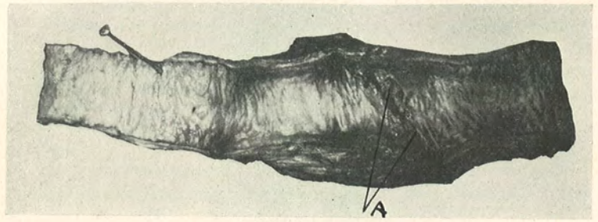
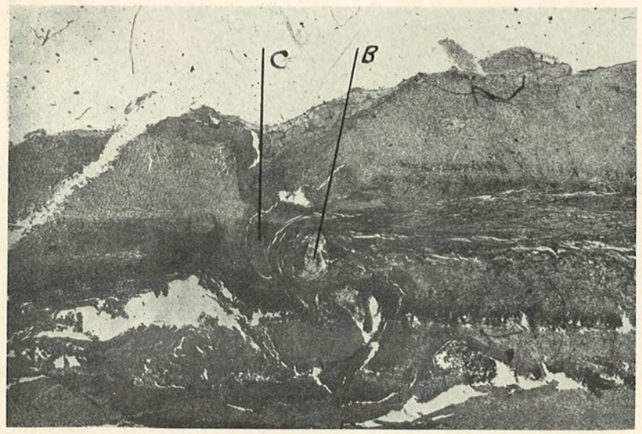


FIG. 9. CASE 6.—A, line of incision.



CASE 6.—B, remains of suture; C, line of healing.

cell infiltration, full of capillaries. Embedded in the tissue at the site of the wound is a suture about which is a marked suppurative infiltration, and in its vicinity there is more or less necrosis of the older tissue indicated by its hyaline appearance and strong election of the eosin stain. The suppuration only in a minor degree is invading the deeper part of the thickened intima, and is apparently a process implanted after healing had partially proceeded.

CASE VII.—Bay horse, aged 14. The diagnosis of thrombosis of the iliac arteries was made by Dr. John W. Adams. The horse was transferred to us through the kindness of Dr. Adams. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. An oblique incision with ragged edges 2.5 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation, the artery could be seen pulsating. The superficial wound was closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the pulse was good and equal on both sides; the horse was up and about. Three days after the operation the pulse was equal on both sides and the wound was suppurating. Five days after the operation the pulse was equal on both sides. Seven days after the operation the pulse was equal on both sides and the horse was in good condition. Nine days after the operation the pulse was good, full and equal on both sides; the wound was suppurating. The horse was killed and an autopsy was performed by Dr. C. Y. White. The thrombosis of the iliac arteries was found as diagnosed before operation. The incision in the neck was wide open and the artery could be felt in the bottom of the wound. The artery was removed, opened up and a slight lateral thrombus found, but the lumen was not decreased. (Fig. 10.)

Pathological Report.—Gross specimen, preserved in a solution of formaldehyde, consists of an artery with the surrounding tissue closely adhering to its outer part, and with traces of previous hyperæmia persisting. Laid open, a line of incision extending longitudinally is marked out by a thin, somewhat elevated and irregular thrombus, in places apparently partly organized, but at others still red and relatively unchanged. The general lumen of the vessel could not have been importantly impaired thereby. The intima in this part of the vessel is generally roughened, with nodules and slight ridges, which are apparently for the most part points of slight thrombus formation, and in part due to local thickenings of the intima. In cut section the thrombus is seen to be directly connected with the depression of linear closure of the arterial wound, and the intima generally seems redder than the deeper portions of the wall, the latter being, however, somewhat spongy and probably the seat of more or less inflammatory infiltration.

Microscopic.—Section made transversely to length of vessel, nearly transversely to the line of operative wound. Definite lateral thrombus overlying the line of wound shows no clear evidence of organization. Incision still to be traced through the whole thickness of the arterial wall;

the tissues included within the sutures largely necrosed, hyaline, stained diffusely with the eosin of the hæmatoxylin and eosin preparation. From the borders of this hyaline part of the wall, marking the line of the wound adaptation, there extends diffusely through all the coats of the vessel a thick polynuclear leucocytic infiltration, in places (mainly media) rich in eosinophilic cells, with numerous endothelioid and embryonic connective-tissue cells interspersed. There is but little leucocytic infiltration in the clot, which, however, contains considerable hæmatoxylin-stained detritus, probably fragments of leucocytic nuclei.

Case VIII.—Medium-sized dog. The anæsthetic was morphine hypodermatically and ether by inhalation. The carotid artery was found on the left side of the neck and the clamps were applied. An oblique incision 1.5 cm. long was made in the artery. The artery was sutured in the usual manner; the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation, and the wound closed with through-and-through sutures. Twenty-four hours after the operation the dog was up and about, and the artery was pulsating normally. Three days after the operation pulsation was apparently normal. His condition remained normal until he was killed, on the twelfth day. Post-mortem findings: The skin wound had united by first intention; the artery was removed and opened up; no thrombus was present, and the lumen was not decreased.

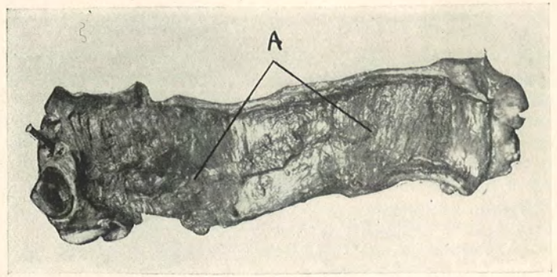
Pathological Report—Gross.—The artery is embedded in the surrounding tissues, which are closely adherent and are the seat of marked hyperæmia and inflammatory infiltration. Laid open, the vessel lumen is intact, the general intima smooth and glistening, and the line of incision marked by a small depressed linear scar.

Microscopically, there is marked hæmorrhagic infiltration in the surrounding tissues, together with numerous leucocytes and proliferated connective-tissue cells. No foci of suppuration. The whole wall of the vessel is the seat of numerous embryonic connective tissue cells, mainly as fibroblasts. The line of incision is obliterated by a young scar. No appearance of thrombosis overlies this upon the intima, which is somewhat thickened and puckered at the site of the wound, but otherwise practically normal.

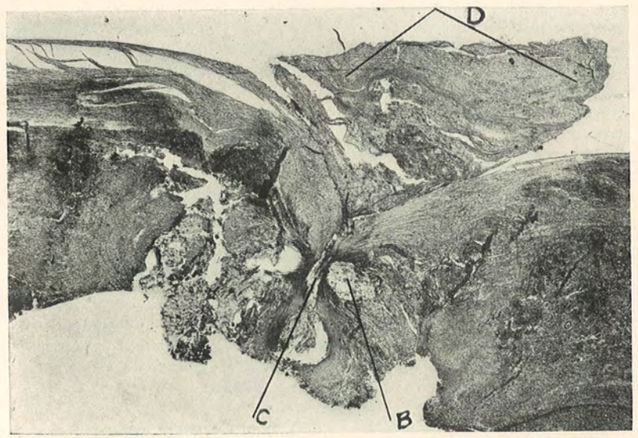
Case IX.—Mongrel dog. The anæsthetic was morphine and ether. The carotid artery was found on the left side of the neck, and the clamps were applied. A longitudinal incision 1.5 cm. long was made in the artery. The artery was sutured in the usual manner; the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation, and the wound closed with through-and-through sutures. Twenty-four hours after the operation the dog was up and about, the pulse being apparently normal. Three days after the operation the pulsation was normal, but the wound was infected. The animal was normal until he was killed, on the fourteenth day. Post-mortem report: The artery was immediately removed and opened up; a small lateral thrombus was present.

Pathological Report.—The artery contains a thrombus composed

Fig. 10.



Case 7.—A, line of incision.



Case 7.—B, remains of suture; C, line of healing; D, lateral thrombus.

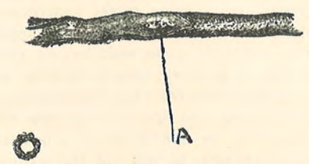
mainly of red cells and a granular fibrin, with at one place numerous polynuclear leucocytes penetrating the mass. No evidence of actual organization of thrombus; and no appearance, in sections examined, of endothelial or subendothelial proliferation in reaction to thrombus; the only changes of this type are along the line of wound of the artery-wall. In the latter line of incision, which is quite approximated and closed, the wall of the artery from without to the endothelial lining is the seat of a mass of well-formed fibroblasts, uniting the approximated surfaces; and close to the cut and over it the endothelium shows as a single (at few places double) line of pyriform cells projecting into the lumen of the vessel, but apparently quite free from the clot within. At one point, close to the cut in the adventitia, and upon the opposite side of the artery in the surrounding fat tissue, are minute foci of suppuration. Remnants of the sutures persist. Apparently in this case the healing of the wound and the thrombus are not synchronous processes; the latter is too fresh to date back to the origin of healing. Perhaps it is a thrombus occurring secondarily in connection with the suppuration which is evidently beginning in the arterial coat. The healing itself seems, even to the formation of an endothelial lining, to be progressing favorably.

Case X.—Bay horse, aged 18. His condition was very poor. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. One of the usual clamps was lost, and in its place a heavy hysterectomy forcep was used on the proximal end of the artery. The artery was divided completely across and circular end-to-end anastomosis performed. The clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation the artery could be seen pulsating. The wound was closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the horse was in good condition and the pulse equal on both sides. Three days after the operation the pulse was not as full or as strong on the operative side. The wound was suppurating. Four days after the operation the pulse was decidedly less on the operative side. Five days after the operation the pulse was very small on the operative side and the wound was still suppurating profusely. From the fifth to the fourteenth day the pulse gradually increased in volume and strength, but was not equal to the normal side at any time. The horse was killed on the fourteenth day by bleeding from the opposite side. The artery was removed and opened; a thrombus that almost filled the artery was found, extending from the position of the heavy clamp down to the line of suture. Through a mistake of the attendant the horse was injected with formalin before the artery was removed. The thrombus was not of recent origin, so could not have been caused by the formalin.

Pathological Report.—The specimen examined grossly after preservation in a solution of formaldehyde shows an artery embedded in the surrounding tissues, and poorly defined from those about the level of operation. There is no evidence in the preserved specimen of any intense hyperæmia or hæmorrhagic infiltration of the tissues. Laid open, the

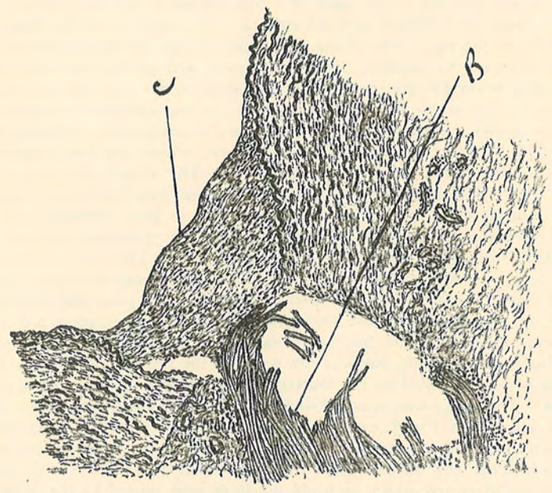
vessel shows a dark, obstructing clot, which was slightly adherent along the line of operation, and which shows a more or less lamination on cross section. The line of incision is a circular one; it is somewhat puckered and overlaid by remnants of the clot, where the latter is torn off in the

FIGS. II.



CASE II.—A, line of incision.

examination, and is superficially apparently firmly united. In section of the wall immediately beneath the slightly thickened intima at the site of closure are several points of softening apparently from suppuration and



CASE II.—B, remains of suture; C, line of wound completely healed.

seemingly about the sutures. The general tissue at this site is soft and spongy, suggesting decided inflammatory infiltration.

Microscopic.—Section at site of operative lesion shows a thin, parietal granular (plaque) thrombus almost limited to the line of incision. The

intima is thicker than normal near the lesion, but densely fibrous. Its endothelial coat is lost near the incision, and here its tissue stains with poor differentiation and strongly with the eosin of the hæmatoxylin-and-eosin preparation, giving the appearance of necrosis. Embedded beneath the intima is a loop of the suture used. This suture is surrounded by a dense infiltration of polynuclear leucocytes, and extending from this focus to the subendothelial portion of the intima on each side of the incision may be traced an infiltrating line of the same elements, along the border of the above necrosed part of the intima. The whole coat of the vessel is thickened, but definite suppuration is confined to the vicinity of the suture. The deeper coats are richly studded with round and spindle-shaped embryonic connective-tissue cells, with scattered leucocytes (numerous eosinophiles), and in the spaces of the adventitia the endothelium is swollen and often proliferated.

CASE XI.—Medium-sized dog. The anæsthetic was morphine hypodermatically and ether by inhalation. The carotid artery was found on the left side of the neck, and the clamps were applied. A longitudinal incision 1.5 cm. long was made in the artery. The artery was sutured in the usual manner; the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation and the wound closed with through-and-through sutures. Twenty-four hours after the operation the dog was up and about; the pulsation in the carotid artery was apparently normal. The animal remained normal until he was killed, on the twenty-first day after the operation. The artery was removed and opened up, no thrombus or narrowing of the lumen being present. (Fig. 11.)

Pathological Report.—Transverse section at site of injury shows complete healing of the intima, with perfect endothelial line. Intima at this point thickened, the thickening impinging upon the deeper tissues rather than protruding into the vascular lumen. Inner elastic lamina perfect beneath the subendothelial thickening. The thickened intima is for the most part fully fibrous, but strands of embryonic cells (fibroblasts) pass into the mass along with capillary vessels. No evidence of thrombus on the intima. In the media there persist strands of the sutures with considerable young connective tissue intervening among the muscle-bundles. Here the elastic layers are somewhat broken in their continuity, but are quite apparent and show no appreciable degenerative changes. About the sutures among the young connective-tissue cells a few foreign-body giant-cells are present. The adventitia presents practically the same features as just described in the media, and is slightly thickened from the fibrosis and young connective-tissue elements.

CASE XII.—Mouse-colored polo pony, aged 17. His condition was very poor. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was exposed and the clamps were applied. A longitudinal incision 3.5 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation, and the superficial wound closed with

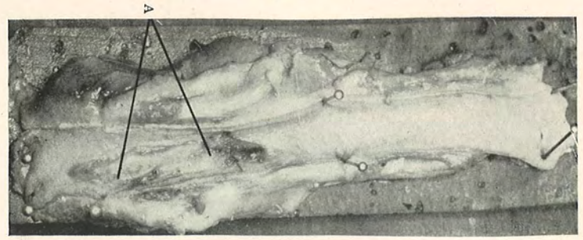
through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the horse was up and about, the pulse was equal on both sides. Three days after the operation the pulse was equal on both sides and the wound was suppurating. The pulse was equal on both sides until he was killed, on the twenty-first day. Post-mortem findings: The artery could be felt at the bottom of the wound. The artery was removed and opened up; the lumen was slightly decreased, but no thrombus was present. (Fig. 12.)

Pathological Report.—The gross specimen, preserved in a solution of formaldehyde, consists of an artery closely welded with the surrounding tissue, traces of well-marked hyperæmia being present in the latter in the neighborhood of the operative wound. Laid open, the lumen is seen to have been permeable; the intima is marked by a slightly-elevated longitudinal line of about 3.5 cm. in length, thus presenting the appearance of recent scar-tissue rather than of an unorganized clot. Its irregular outline suggests, however, that it represents an organized linear thrombus rather than a direct adhesion of the applied surfaces of the intima. Transverse section inspected grossly corresponds with the above idea, the linear scar above mentioned being distinctly elevated above the surrounding surface of the intima, and below it in the wall are seen tiny foci of a softer, opaque substance suggesting points of suppuration; the deeper parts of the vessel-wall and the immediately-surrounding structures have a somewhat spongy or succulent appearance, suggesting marked inflammatory infiltration.

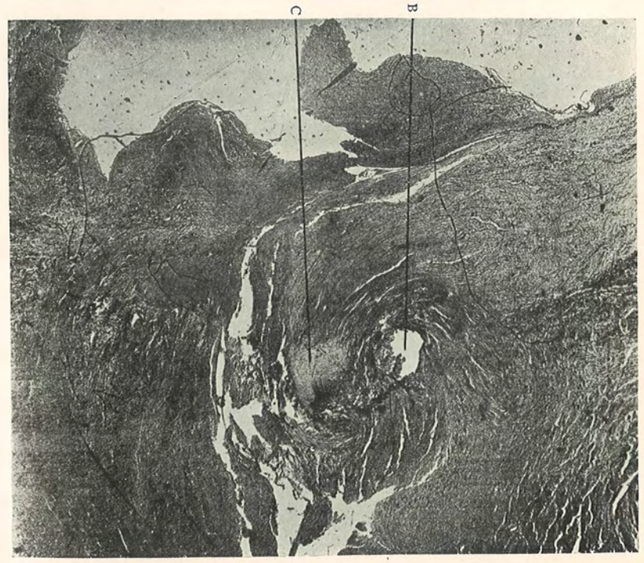
Microscopic.—Transverse section of artery, at right angles to the line of operative incision, shows over the site of operative line a small partly-organized thrombus. The organization is more perfect along the lateral borders of the clot. At its base, close to the line of the incision, there begins a polynuclear infiltration which continues outward through the intima to become especially marked about an embedded suture. The tissue between two strands of this suture (evidently section of the loop) is necrotic, almost hyaline, and poorly staining. All the coats are thickened and studded with embryonic elements, scattered leucocytes (many eosinophiles especially near the line of suppuration), and endothelioid cells (proliferated endothelium of lymph spaces). In several foci presumably near a suture giant cells are found in greater or smaller numbers. The general appearance here suggests that the clot was of earlier occurrence than the suppuration, and that the latter process is penetrating into the partly-healed wound.

Case XIII.—White horse, aged 20. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was exposed and the clamps were applied. A longitudinal incision 3.7 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation and the superficial wound closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the horse was up and in good condition, the pulse being equal on both sides. Three days after the operation the pulse was equal on both sides; the

Fig. 12.



Case 12.—A, line of incision.



Case 12.—B, remains of suture; C, line of healing.

wound was suppurating. The pulse was equal on both sides until the horse died, from a small secondary hæmorrhage, on the thirty-third day. The artery was removed from the wound and examined. It opened into a pus sac which completely surrounded the artery; the lumen was not decreased, and no thrombus was present. It did not seem possible the horse could have died from the small secondary hæmorrhage, but no other cause could be found. (Fig. 13.)

Pathological Report.—The artery contains a thrombus composed mainly of red cells and a granular fibrin, with at one place numerous polynuclear leucocytes penetrating the mass. No evidence of actual organization of thrombus; and no appearance in sections examined of endothelial or subendothelial proliferation in reaction to the thrombus; the only changes of this type are along the line of wound of the arterial wall. In the latter line of incision, which is quite approximated and closed, the wall of the artery from without to the endothelial lining is the seat of a mass of well-formed fibroblasts uniting the approximated surfaces, and close to the cut and over it the endothelium shows as a single line of pyriform cells projecting into the lumen of the vessel, but apparently quite free from the clot within. At one point, close to the cut in the adventitia and upon the opposite side of the artery in the surrounding fat-tissue, are minute foci of suppuration. Remnants of the sutures persist. Apparently in this case the thrombus is too fresh to date back to the origin of healing. Perhaps it is a thrombus occurring secondarily in connection with the suppuration which is evidently beginning in the arterial coat. The healing itself seems, even to the formation of an endothelial lining, to be progressing favorably.

Case XIV.—Sorrel horse, aged 18. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made in the right side of the neck; the carotid artery was exposed and the clamps were applied. The artery was divided transversely two-thirds the way through and then sutured, the clamps were removed and no hæmorrhage occurred. Some difficulty was encountered in suturing because of a very fine tremor. The deep fascia was sutured around the line of approximation, and the superficial wound closed with through-and-through sutures. The pulse was equal on both sides and the horse was in good condition. Twenty-four hours after the operation the pulse was equal on both sides. Three days after the operation the pulse was equal on both sides and the wound was infected. The pulse were equal until the tenth day, when the pulse on the operative side was slightly less. The wound was suppurating profusely. From the tenth until the eighteenth day the pulse was decidedly less on the operative side. From the eighteenth day until the forty-second day the pulse gradually increased in volume, but was not equal to the opposite artery at any time. The horse was killed on the forty-second day. The wound was suppurating profusely. The artery was removed and opened up. Complete thrombosis was found. In dissecting out the artery the vein was found very much thickened.

Pathological Report. Gross Specimen.—Two lengths of the vessel, preserved in a solution of formaldehyde, are presented for examination;

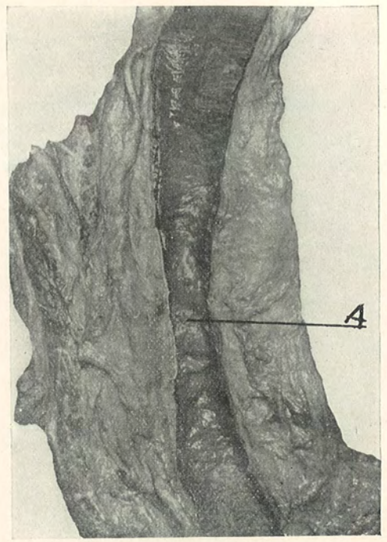
both are the seat of occluding thrombosis; the thrombi are dark in the central part and paler and more or less organized and adherent to the intima along the periphery. The general wall of the artery is thickened, pale and dense from sclerosis. No appearance of suppurative softening on gross inspection.

Microscopic.—A section made transversely to the length of the vessel contains a large thrombus with organization proceeding, the greater part of the clot being well cellularized. Phagocytic leucocytes are numerous in the interior of the clot. No evidence of suppuration present. Distinct extension of fibroblasts and young vessels from the intima. The general coat of the vessel shows no evidence of suppuration; the blood-vessels are slightly injected, their coats are unusually thick; but little embryonic cell-formation is evident; when seen it mainly exists about the vasa vasorum, in the adventitia, and between the muscle-bundles of the media.

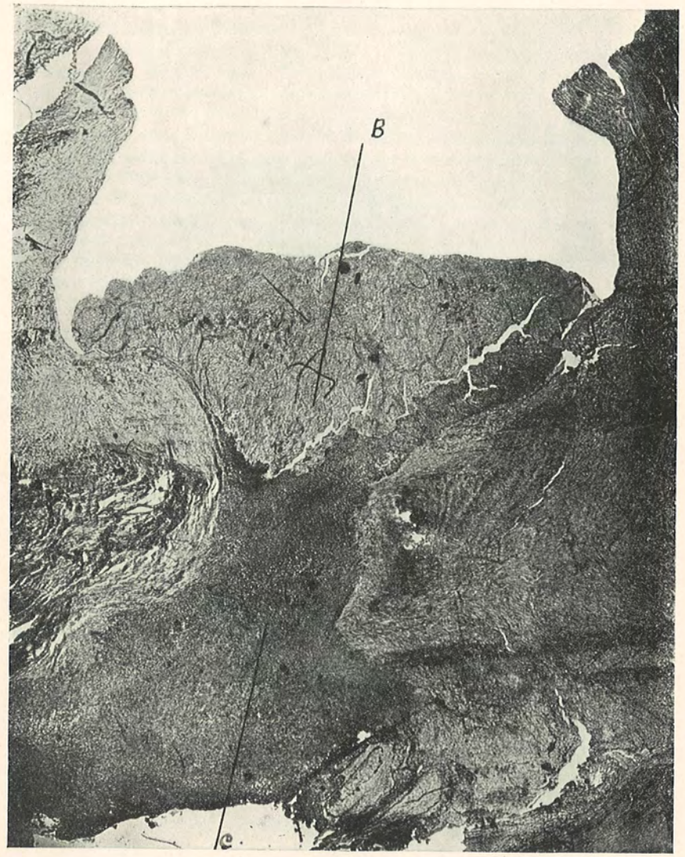
There were fourteen operations in all—nine on horses and five on dogs. The experiments on the nine horses and one dog were performed at the Veterinary Hospital of the University of Pennsylvania. The operations on the remaining four dogs were performed in the surgical operating-room of the medical laboratory. All the cases operated on at the Veterinary Hospital suppurated, and half of those at the laboratory. The operations on the horses were three complete circular, two transverse, three longitudinal and one oblique; on the dogs, four longitudinal and one oblique. When the arteries were opened up, in seven no thrombus was visible, in five a slight lateral thrombus was present; in one case we used a heavy hysterectomy forcep instead of our special clamp (clamp lost in transporting instruments), and almost complete thrombosis was present from the position of the clamp to the line of suture; in another case complete thrombosis occurred from infection around the artery. One ruptured on the thirty-third day into a pus-sac surrounding the artery, but no thrombus was present.

Conclusions.—1. Only one secondary hæmorrhage occurred, and that one was directly traceable by microscopical examination to infection from without; this alone is a distinct advantage over the older methods. 2, Under the aseptic conditions employed in human surgery the results ought to be perfect, as our thrombosis can almost always be traced to infection.

FIG. 13.



CASE 13.—A, line of incision.



B, lnteral thrombus; C, pus.

3, Whatever suture used, the principle of placing the intima to intima is absolutely essential. 4, The suture must be kept out of the blood-stream.

In closing I wish to acknowledge my indebtedness to Dr. De Forest Willard for his many valuable suggestions and for the financial aid which made it possible to perform these experiments, and to Dr. Allen J. Smith for the pathological reports. I also wish to thank the staff of the Veterinary Hospital for their many courtesies and Dr. Barnett, Resident Physician, in particular, for valuable assistance in many ways and for untiring efforts in my behalf; Mr. H. S. Hutchinson and Mr. F. Beekman, of the third-year medical class, for their assistance.

PERFORATION OF SKULL BY IRON ROD.

Dr. C. G. Ross reported the case of a man who was brought to the hospital March 20, with the history of having been struck over the leg center of the left side of the head by the end of a three-eighths-inch steel rod six-and-one-half feet long, which fell fifty feet. The pupils were dilated and did not react, and vomiting had occurred. There was doubt as to the advisability of immediate operation. The man did not develop convulsions. Operation was finally performed and showed that the iron had made a round hole in the skull as accurately as it could have been done by a trephine. The superior longitudinal sinus had been entered, but the button of bone prevented hæmorrhage. The inner table of the skull was compressing the leg center. When removal was accomplished, hæmorrhage was severe, and packing had to be kept in for seven days. When the packing was removed, motion in the leg was possible, and the man finally walked out of the hospital.

REPORT OF A CASE OF TUMOR OF THE CAROTID BODY.

BY JOHN CHALMERS DA COSTA, M.D.,

OF PHILADELPHIA.

Professor of Principles of Surgery and Professor of Clinical Surgery in the Jefferson Medical College; Surgeon to the Philadelphia Hospital.

THE first person to suspect the existence of the carotid body seems to have been the great Haller; and from his time on there has now and then been a suggestion by some anatomist of a knowledge of the presence of the structure. In 1833 Mayer gave a description of it and pointed out its common situation in the bifurcation-angle of the carotid artery. He described it as about the size of a grain of rice, and as attached to the carotid vessel; and mentioned some other facts in relation to it. Luschka, in the early 60's, made a microscopic study of the gland; and since that time, Arnold, Kölliker, and others have written about it.

One thing seems to be sure: that the carotid body is not invariably present. In fact, it is frequently absent. Funke [1] points out that it is enclosed in a fibrous capsule, and that a fibrous band comes from the capsule and divides the body into two parts, other bands from the capsule separating each half into lobules. This fibrous tissue contains a multitude of blood-vessels. Funke further points out that the lobules contain cell-collections without definite arrangement, that only rarely do they resemble the structure of a gland, and that in all parts of these lobules blood-vessels are demonstrable. The same observer believes that the lobules result from proliferation of the endothelial cells of the blood-vessels.

To-day, we should describe the carotid body as a structure placed in the bifurcation of the common carotid artery; to the inner side of this vessel, on a lower level than the bifurcation; or on the posterior surface of either the external or the internal

[1] Am. Med. July 16, 1904.

carotid. It probably always takes origin from the sheath of the internal carotid. In human beings, it is frequently absent. At least it is frequently absent in those beyond puberty. It is encapsuled in fibrous tissue, is fastened to the sheath of the internal carotid, and the gland with its capsule is embedded in a considerable amount of fat. In shape, it is oval; in color, reddish brown. Its size when not enlarged is about that of a grain of corn. The septa from the capsule divide the organ into folicles, or cell-balls; and these cell-balls are composed of numbers of endothelial cells and capillary blood-vessels. A small branch, several branches, or many branches from the carotid pass into the carotid body; and the carotid plexus of the sympathetic nerve is in very close relation with the body. This structure has been studied, of late, by John Funke, Paltauf, Reclus, Marchand, and others. Its function is unknown.

Occasionally tumors arise in this structure; and Dr. Funke, in the previously-quoted article, has collected fifteen cases. In his series, it is shown that the tumors may occur in adolescents or in adults, and in either sex. He quotes the observation of Heinleth that the carotid body undergoes development until puberty, when it ought to atrophy; but that if it fails to atrophy, but continues to grow, a tumor forms. Such a tumor grows very slowly, requiring years to reach any considerable size, and never becoming very large. Sooner or later, however, rapid growth is liable to begin; and it is usually only after years of growth, and when this sudden rapidity of growth has alarmed the patient, that a surgeon is called in.

Early in the case the growth is entirely free from pain, but in the later stages there may be pain in the tumor, pain radiating into the ear, dysphagia, and—as has been pointed out—perhaps pupillary contraction of the same side and facial vasomotor disturbance. In a large majority of the reported cases, there has been distinct transmitted pulsation in the tumor. The skin is movable over the growth; the tumor may be moved from side to side, but not up and down; and there is usually a systolic murmur over the tumor.

I have recently had, in the Jefferson College Hospital, a

case of this rare and interesting trouble, and a diagnosis was made before operation. The record of the case is as follows:

The man was 52 years of age. Over twenty years ago he noticed a very small lump on the right side of his neck. He said that when he first found it this lump was not larger than a grain of corn. During many years it slowly but certainly increased in size. A few months ago it began to grow rapidly, and within less than a year of rapid growth it attained the size of a small egg of a hen. He also began to have some difficulty in swallowing, had attacks of redness of that side of the face, and occasionally suffered from pricking pain in and around the tumor. The rapid growth alarmed him, and he decided to consult a surgeon.

An examination showed the tumor to be in the superior carotid triangle, having its lower border on a level with the upper margin of the thyroid cartilage, and its upper border passing to about the level of the angle of the jaw. The external jugular vein was distinctly visible passing over it. The skin was freely movable over the tumor; and the tumor itself was movable from side to side as though on a hinge, but was not movable from above downward or from below upward. The growth was not tender on handling, but was the seat of very marked pulsation, which investigation demonstrated not to be expansile pulsation, but a lifting of the growth by the pulse of the carotid. The tumor was hard, but somewhat elastic, being, however, softer at some points than at others. It was smooth, but apparently lobulated on the surface. On listening with the stethoscope, a systolic murmur could be made out when the stethoscope was pressed firmly upon it; but this was not more manifest than it was on the carotid artery itself, when the same maneuver was executed.

It was evident that this tumor was not an aneurysm, from its long history, from its hardness, from the absence of genuine bruit and expansile pulsation, and from the fact that pressure on the artery did not cause the mass to diminish in size. It was not a cyst, because it was evidently a solid body. The question of a misplaced fragment of thyroid tissue was considered; but the density, the history, and the vascular phenomena led to the rejection of this idea. It was too hard and too deep for a fatty tumor. Its movability, its long history, and the phenomena of pulsation were against sarcoma; and the long history, without

any change in consistency and without the involvement of the overlying parts, was considered to rule out lymphatic glandular trouble.

I advised operation, on account of the rapid growth then taking place and the apparently inevitable disaster, if this rapid growth were permitted to continue unchecked.

After having exposed the tumor by an incision at the anterior margin of the strenocleidomastoid, and while endeavoring to free it, I was greatly embarrassed by the profuse bleeding. The fatty tissue about the tumor and the capsule of the tumor oozed continuously from numberless places. The bleeding was both arterial and venus. Forty ligatures failed to arrest the bleeding.

After exposing the tumor thoroughly, the growth was found to be in and around the angle of bifurcation of the common carotid; and it embraced the vessels so completely that it was out of the question to free the growth from them as I had hoped to do and as was done in 3 reported cases. It was equally impossible to abandon the operation, because the persistent hæmorrhage barred such a road to retreat. Consequently, the operation was proceeded with.

The common carotid artery was tied with two ligatures below the growth, and was divided between the ligatures. The distal stump of the divided artery was grasped with forceps, and used as a handle in lifting the tumor while the growth was being separated. The tumor, with the beginnings of the internal and external carotid arteries, was freed from its attachments. During this separation the internal jugular vein was badly torn; and it was necessary to ligate it. When the portion of the external carotid artery above the tumor was reached this vessel was tied and divided. Between the upper border of the tumor and the base of the skull there was barely room to ligate the internal carotid; it was with great difficutly that it was ligated and divided, and I barely escaped the accident met with by Mikulicz, who found the tumor had entered the bony foramen and was obliged to cut away bone to stop bleeding. The wound was closed with drainage.

The man had lost much blood and was considerably shocked. He reacted but slowly from the anæsthetic. Eight hours after the operation he developed a weakness just short of complete paralysis of the left arm and leg, the face escaping. He was also found

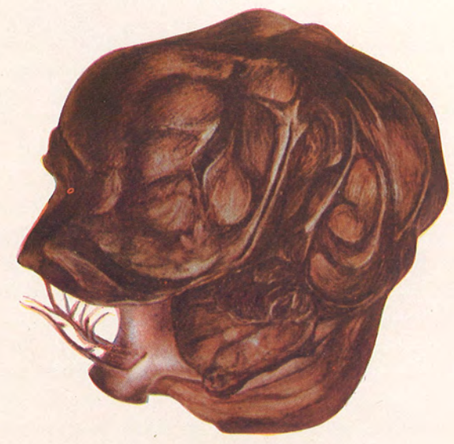
to have a very low and extremely hoarse voice. The day after the operation, the voice continuing low and hoarse, the throat was examined; and relaxation and œdema of the right vocal cord were observed by Dr. J. Leslie Davis to exist. These conditions were due to paralysis of the cricothyroid muscle from injury of the superior laryngeal nerve.

For many days there was a copious flow of mucus from the larynx and the bronchi; and, owing to the anæsthesia of the mucous membrane, the patient had great difficulty in expelling this mucus. For some time there was considerable difficulty in swallowing, probably also due to injury of the superior laryngeal nerve, which, it will be remembered, also goes to the inferior constrictor of the pharynx. For the first few days after the operation there was a copious flow of lymph from the wound, showing that large lymphatic vessels had been divided. This ceased about the end of the first week.

On the eighth day after operation complete hemiplegia suddenly developed. The left arm and leg were completely paralyzed; the face was much drawn; and the man was dull, drowsy, and sometimes stuporous, but never unconscious. It was the opinion of Dr. Alfred Gordon that this attack was due to embolism, in all probability in the internal capsule; and the first and milder attack was thought to have been due to thrombosis in the cortical vessels.

The day after the onset of the hemiplegia, the man was found to be suffering severely with dyspnœa and repeated choking fits, in some of which it seemed that he must strangle. Great quantities of mucus passed into the throat, and there was the greatest possible difficulty in ejecting it. Examination of the left lung, made by Dr. John C. DaCosta, Jr., developed the fact that at least half of the lung was in a state of complete collapse, containing no air whatever. The right lung was entirely normal. The patient stated that he had had an exactly similar pulmonary condition a number of months before. This had come on from an unknown cause, and had almost killed him. The atelectasis produced great discomfort for a number of days, but was gradually recovered from; and the lung is now normal, so far as physical signs indicate. It seems probable that the laryngeal anæsthesia was responsible for this condition, and that either plugs of mucus had passed into the lung and

FIG. 1.



CASE XXVI.

blocked the bronchi, or that some elements from the food had passed the larynx.

Present Condition (8 weeks after the operation).—A marked, but fading, left hemiplegia exists. The man can move the leg, and can stand upon his legs, if he supports himself with a cane or a crutch. He can move the elbow, the shoulder, and the wrist, and can flex the hand; but the extremity is still very weak. He has occasional paroxysms of violent shooting pain in the arm and in the leg. The wound is completely healed and not tender. The voice is hoarse and low, and the right vocal cord is œdematous and relaxed; and Dr. Davis is of the opinion that this is due to injury of the superior laryngeal nerve.

Conclusions.—It is thus seen that the operation of removing a tumor of the carotid body is a very formidable one. The surgeon may have to tie all the carotid arteries; and he may damage a nerve or nerves, with subsequent unfortunate results. The ligation of the common carotid artery is an extremely dangerous procedure; and it is one of the few operations in which the mortality does not seem to have been greatly diminished since the days of Sir Astley Cooper, who did the first successful ligation of the common carotid, in 1808. Mr. Richard Barwell, in his article on Aneurysm in "Ashhurst's International Encyclopedia of Surgery," published in 1889, gives the mortality of 107 cases of ligation of the common carotid for aneurysm as 25.23 per cent. Some more modern authors estimate the death-rate as in the neighborhood of, or over, 30 per cent.; and it is thus seen what a responsibility it is, even at the present time, to tie this vessel.

The danger of death is, however, not the only danger in ligating the common carotid. My case shows that hemiplegia may follow the operation. It has long been known that a considerable percentage of those on whom ligation has been performed suffer subsequently with cerebral symptoms. In some of the cases, these symptoms have been produced by thrombosis; in others, by embolism; and in still others, by cerebral softening. Pilz has pointed out that 32 per cent. of the cases in which the common carotid has been ligated exhibit brain

symptoms, and that 56 per cent. of the cases that show brain symptoms die. Zimmermann says that in 11 per cent. of the cases there is softening of the brain, and that 26 per cent. of the cases show brain symptoms. There is much greater danger of brain symptoms when the operation is performed on the elderly or middle-aged than when it is done on the young. In older subjects, arterial atheroma may interfere with the distension of certain vessels whose integrity is necessary to bring sufficient blood from the vertebrals, from the other internal carotid, and from the terminations of the external carotids. Failure in a satisfactory restoration of circulation is most liable to occur when profuse bleeding greatly lowers the blood-pressure, as it did in this case. When such cerebral change ensues, it does not necessarily mean death. In fact, it may be recovered from, partially or completely. Usually, however, the condition is permanent and progressive, and finally results in death. In Funke's series of 15 cases of tumor of the carotid body, there were but two deaths; one from bronchopneumonia, and one from secondary hæmorrhage. There may be added to this, Keen's unreported case, which makes three deaths in 16 cases. In Funke's series, there was but one case of hemiplegia. In Dr. Hearn's case, however, which is not recorded in the table as one of hemiplegia, the patient died two months later; and Dr. Hearn tells me that, although he did not see the case, he believes from what he has learned that the man died of cerebral softening. So, out of 13 recoveries in Funke's cases, to which my cases may be added, making 14 recoveries, there were two cases of hemiplegia and one of cerebral softening.

Owing to the great danger in ligating the common carotid, surgeons have sought to avoid it in removing carotid tumors. The reported cases show that almost always all the carotids must be ligated. Albert, in his case, was obliged to ligate only the external carotid, being able to remove the growth from the carotid sheath. In his case the growth recurred within one year. In Heinleth's case and in that of Cuneo, no ligations were necessary, owing to the free separability of the tumor. Out of Funke's 15 cases, only three are recorded as not requir-

FIG. 2.

CASE XXVI.—Section.

ing ligations of all the carotids; and when Keen's case and mine are added to this list, they make 17 cases, in 14 of which ligation of all the carotids was necessary.

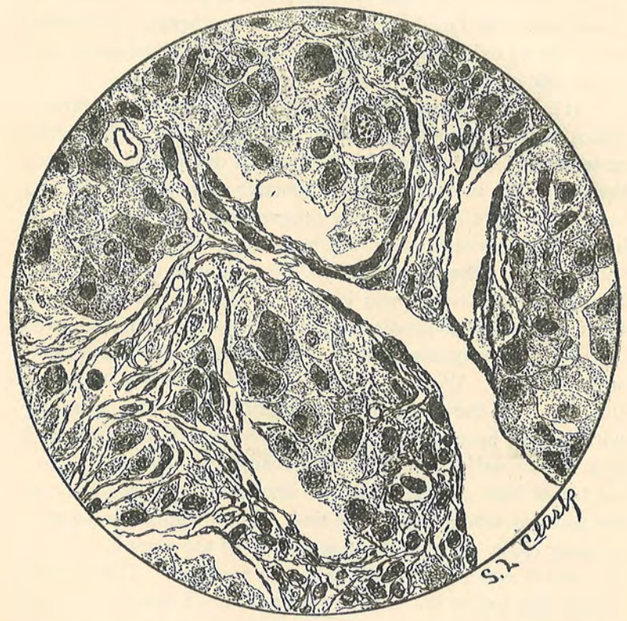
Another danger of the operation is nerve-injury. In my case, the superior laryngeal was injured. In all probability, it is a piece of this nerve that we find incorporated in the specimen. In Funke's 15 cases, there were six cases in which the nerves were injured—the sympathetic, the pneumogastric, the hypoglossal, the facial, or the recurrent laryngeal. Two cases out of the 15 exhibited postoperative paralysis of the vocal cord of the side operated upon.

It is thus evident that the operation of removing a carotid tumor is an extremely dangerous one, and is not to be lightly undertaken. We agree with Reclus that one should not touch these growths, unless they are productive of danger to life. So long as they are merely slowly progressing, they had better be let alone. It is only when they begin to grow rapidly that one should remove them, and then he must, in spite of the danger. In my case, the tumor was infiltrating the surrounding structures, and would unquestionably have killed the man, if allowed to remain. Surgeons must be wide awake to the existence of such growths. Without carefully examining every tumor in this region of the neck, one could easily be led into operating with a light heart for some supposedly trivial condition, and then find oneself suddenly so far advanced in attacking a carotid tumor that retreat would be impossible, and probably all the carotids would have to be tied. The diagnosis is possible in many cases. It was made in several of the cases in Funke's list, and it was made in the case now reported. The pictures exhibit the tumor that I removed, and Dr. Funke's report of the specimens follows:

Macroscopic Description.—The specimen is a lobulated mass, measuring 5 by 5 by 4 cm.; weight 104 gmm. It is dark red in color, encapsulated, distinctly elastic in consistency at some places and flabby at other places. The mass is irregular; it is composed of three large nodules, each being 2.5 cm. in one diameter and 2 cm. in the other. The smaller nodules present do not attain a diameter of 0.5 cm.; they are especially seen on the anterior surface. This surface contains many depressions

varying from 0.5 to 1 cm. in depth; these depressions are incident to the pulling of the capsule into the tumor substance. The lacerated tissue present adds to the irregularity of the anterior surface. The posterior surface is less irregular; it is lobulated, however, and the nodules are more conspicuous here than upon the anterior aspect. Laceration and fragmentation of the capsule is marked. Lying upon this surface, not more than 2 cm. from the margin, is a greyish-pink cord-like piece of tissue apparently made up of smaller cords; the consistency and the

FIG. 3.



architecture of this structure resemble a nerve. It is not firmly attached to the tumor-mass. Lying upon this surface, but only near one end, is a large vessel which from its general structure appears like the common carotid artery and which contains, 0.5 cm. from the free margin, a ligature. One centimeter above the ligature the vessel divides; one branch curves slightly toward what was described as the anterior surface and then tunnels the mass between two of the nodules described. Only 0.5 cm. of this branch is visible, but upon dissection it is found to traverse the mass

nearly parallel with the anterior surface and but 0.7 cm. from it. The other vessel curves slightly backward and then tunnels the mass near the opposite side of the specimen, but runs parallel and very close to the posterior surface. Both vessels are easily indentified at what is presumed to be the superior portion of the tumor, and both vessels as well as the common carotid artery are firmly attached to the tumor mass. The first vessel described in all probability was the external carotid, since it gave off a small branch near its point of severance.

FIG. 4.

Dissection showed that the three larger nodules mentioned are firmly united at a point posterior to the bifurcation of the vessel mentioned. The one nodule is united to the other two at this point and along the entire margin of but one nodule by means of a pedicle; the internal carotid passes between these nodules and is anterior to the pedicle. The other two nodules are for the most part situated in the fork formed by the branching vessel. Dissection also reveals that the smaller nodules are produced by the septa which penetrate from the capsule into the underlying tumor mass.

The cut surface has a lobulated appearance; it is granular, reddish-brown in color, but traversed by greyish bands; some of these bands are dense and comparatively broad. The cut surface as well as the capsule contains many small opened-mouthed blood-vessels; so numerous are they the surface has a porous appearance.

Portions of the tumor were fixed in Zenker's fluid and the remainder was preserved in Kaiserling's fluid. Sections were made and stained with hæmatoxylin and Van Gieson's method for connective tissue, by Mallory's reticulum stain and with polychrome-methylene blue.

Histology.—One margin of the sections is covered by a dense capsule composed by wavy fibrous connective tissue, in which are few lymphoid and spindle-shaped cells and few strands of elastica, together with many blood-vessels. From the capsule fibrous septa penetrate the underlying tumor-mass and divide it into lobules, which are again divided into alveoli. The fibrous septa are very broad and are found in cross and in longitudinal sections; they contain few lymphoid and spindle-shaped cells and large and small blood-vessels. Many of the last-named structures contain erythrocytes, and possess well-formed and thick walls.

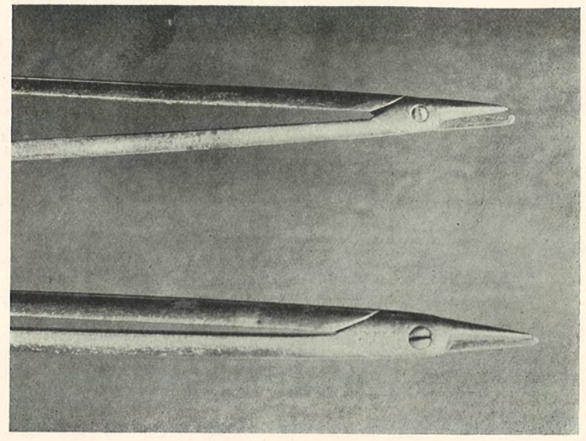
The walls of the alveoli are in some instances formed by delicate connective-tissue strands, evidently constituents of the septa already mentioned; the greater number, however, are formed by delicate capillaries, branches of the vessels found in the septa. Occasionally these capillaries are composed of a single layer of endothelial cells; in other instances the endothelial lining is supported by a few strands of fibrous connective tissue. The alveoli are fairly uniform in size and very difficult to outline in many places, owing to the number of contained cells. The cells in the alveoli vary somewhat in size, ranging from 15 to 25 microns in diameter; they are irregular in outline, many are polyhedral and few are oval. The protoplasm contains no cell membrane; it is finely granular and acidophylic. The nuclei are comparatively large and intensely basophilic. The nuclear membrane is conspicuous. Occasionally few red blood-cells are found among the tumor-cells. In not a few alveoli the tumor-cells show degenerative changes. Few chromaffine cells are present.

Diagnosis.—Endothelioma; this is the type of tumor to which most writers on the neoplasms of the carotid gland apply the term "perithelioma." From the fact that the growth has invaded the vessels and the surrounding tissues it should be looked upon as malignant.

SCISSORS FOR THE REMOVAL OF SUTURES.

Dr. George Erety Shoemaker exhibited scissors (Fig. 1) for the removal of deep-seated invisible sutures. He said that the suture or ligature which passes through dense structures in the lower part of its path is apt to bury its superficial portion with the knot, especially when tied upon mucous surfaces. There are certain localities, such as the rectum, the upper portion of the vagina, certain deeper parts of the wound in operations for gall-bladder drainage, and after vaginal hysterectomy, where ligatures or

Fig. 1.



Scissors with one blade blunt pointed and hooked for removal of invisible or deep sutures.

sutures may be almost or quite invisible and, because of distance from the operation, difficult to remove. The inside sutures of a properly-conducted Emmett operation for perineal repair are difficult to reach without such stretching of the parts as will imperil the recent union. For a number of years he had used scissors which safely remove such sutures, without laceration or over distention of the parts. These differ essentially from others having a hook on one or both blades, and may be described as follows: One blade has a blunt or probe point turned up not more than a twelfth of an inch, or to a point in a line with the back of the other blade when closed. The second blade is so much shorter than the first that there is just room for a silkwormgut suture to lie in the grasp of the hook, without being thrown out as the scissors are opened. The entire length of the instrument should be at least six-and-a-half inches. In order to use these scissors successfully, one end of the suture only should be left long after tying, the other being cut off close to the knot. For removal this long suture end is grasped and put upon the stretch, thereby furnishing a guide for the point of the scissors down to the loop to be cut in the depths of the part. The scissors, being slid along this guide, are introduced closed like a probe into the loop of suture, which is readily found when under the tension described. The suture is engaged in the hooked blade with the scissors still closed. The latter are then moved a little to one side to avoid cutting a knot. The tension is now removed from the long suture end previously held taut, and if the hook does not at once become disengaged it is evident that it is within the real loop of the suture. The scissors may now be confidently opened and shut, as the short blade does not throw out the suture, which will now slip between the blades and the entire suture may be drawn out by the long end above referred to.

The important points are, that the scissors should be introduced closed, that no part of the hook should be sharpened, and that all edges be somewhat dull, in order that the suture may not be prematurely cut while feeling for the proper adjustment of the loop.

These scissors were made for him by Mr. Gemrig about ten years ago and have been used with great satisfaction ever since, particularly after vaginal hysterectomy and perineal operations.