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TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING, JANUARY 4, 1915

The President, DR. JOHN H. GIBBON, in the Chair

CARCINOMA OF FLOOR OF MOUTH

DR. ASTLEY P. C. ASHHURST presented a man, aged fifty years, who over a year ago began to have trouble in the floor of the mouth, between the frænum and the symphysis. When first seen by Dr. Ashhurst in August last, there was present a foul odor, and the man was dizzy from weakness on standing. It seemed to be an inoperable case. On August 4, he injected eucaïne into the lingual nerves and tried to divide them. Ten days later he gave him ether by the intrapharyngeal method and cauterized the mouth. Then the man gained seven pounds in two weeks. He was able to eat and sleep well, and went home for a holiday. Two weeks afterward, under intratracheal insufflation anæsthesia, he removed the glands on the left side of the neck, including the sternomastoid muscle, but leaving important nerves that could be saved. This shocked him very much and he lost ten pounds. Four weeks later he operated on the right side of the neck, in a similar manner. In the second operation he had to sacrifice the spinal accessory and hypoglossal nerves. At both operations on the neck the floor of the mouth was thoroughly cauterized from the neck wounds. There are now, more than three months after the last operation, no signs of carcinoma in the floor of the mouth. He has good use of the neck and head and eats and sleeps very well and can make himself understood in conversation, though the tongue is almost immovable. He has gained thirty-one pounds in weight.

The pathological report showed involvement of the glands of the upper part of the neck but not of the lower.

The interesting point in this case is the value of the cauterization of the floor of the mouth, with the cautery almost at a black heat, first from within the mouth, and subsequently from the neck wounds. The disease certainly has been arrested.

RECOVERED EMPYEMA

DR. NATHANIEL GINSBURG presented a man upon whom a partial rib resection for empyema of the thorax had been done at the Philadelphia Hospital, in February, 1914, the incision being located in the midaxillary line, removing a portion of the rib. When first observed by Dr. Ginsburg, there was a foul profuse discharge from the drainage tract, with temperature, loss of weight and great prostration.

He injected bismuth paste into the sinus, and for a time marked cessation of the discharge resulted, but later the man grew rapidly worse and impending death seemed certain. A skiagraph showed what was interpreted by the radiologist as a large subphrenic collection of pus in the right pararenal area. After a careful exploration of the kidney area through a loin incision, no subphrenic collection of fluid was discovered. At a second operation, a week later, Dr. Ginsburg removed the ninth rib from the post-axillary line to the costochondral junction, and found that the picture of a subphrenic abscess proved to be a collection of decomposed bismuth paste which filled a long, isolated tract, extending anteriorly to the cartilage of the sternum. The reporter stated that he wished to emphasize, in reporting this case, that it is one of empyema in which the so-called posterior drainage to which Dr. Thomas has recently called attention, and which at an earlier date had been discussed by some of the French School of Surgeons, and also recommended by Kocher in selected cases, was not feasible. He believed this patient gives reason for believing that many cases of pyothorax cannot be so reached, but must be drained at the point of aspiration. From the beginning this man apparently had a pus cavity which never would have been touched by posterior incision. Free exposure of the whole cavity and healing from the bottom removed the trouble. The case is the only one of four old cases of empyema recently seen which finally recovered.

RUPTURE OF THE BICEPS FLEXOR CUBITI *

WITH A REPORT OF EIGHT CASES

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RUPTURE of the biceps muscle or its tendon is a rather rare accident. It may be of interest to the Academy, therefore, to present eight of these cases, especially as five were operated upon and the exact location of the rupture was determined. Literature reviewed on the subject cites only 74 cases, 5 of which were operated upon.

CASE I.—M. C., aged twenty-six years, white, male, laborer. Admitted to the Episcopal Hospital January 9, 1914.

History.—On the day of admission, while at work cleaning out an endless chain elevator shaft, the elevator suddenly started and one of the buckets caught his right arm, crushing it against the side of the shaft. He was held in this position for forty-five minutes before being liberated. The shock following the accident was so great that it was necessary to remove him to the hospital in the ambulance. On admission to the hospital the patient was in a state of severe shock. He was unable to raise the right arm or flex the forearm.

Examination.—Showed a contused wound of the right chest wall and right arm. No bones were broken. The right arm anteriorly from the shoulder to the elbow was markedly swollen and ecchymosed. On deep palpation over the upper part of the biceps, where the swelling was greatest, a distinct furrow could be felt. This furrow was about the width of the index finger. The width of the furrow could be increased by extending the forearm. On account of the great swelling of the arm no bulging appeared at any point over the biceps on extending or flexing the forearm. A diagnosis of rupture of the belly of the biceps was made and an operation advised. On account of the bruised condition of the tissues the operation was postponed for several days.

On January 11, 1914, under ether anaesthesia, the patient was operated upon and a rupture of the belly of the short head and a partial rupture of the belly of the long head of the biceps were found. The ends of the muscles were properly approximated

* Read before the Philadelphia Academy of Surgery, January 4, 1915.

and sutured with twenty-day chromic catgut. The arm was dressed with the forearm in flexion, so as to relieve any strain on the sutured muscle. Primary union followed. Firm union took place between the ruptured ends. This could readily be determined by grasping the biceps over the seat of rupture and flexing and extending the forearm. On account of the marked atrophy of the humeral group of muscles which followed the accident, the return of power in the patient's arm was very slow, and massage and electrical treatment were given. At the time of his discharge from the hospital the biceps still showed marked atrophy, but the patient had good use of the arm and forearm. The usefulness of the arm has steadily improved and the patient is now able to follow his usual occupation.

CASE II.—F. L., aged fifty-three years, white, male, cloth finisher. Admitted to the Episcopal Hospital on January 16, 1914.

History.—In 1910, while putting a large belt on a fly-wheel, he lost his balance and fell, striking his right shoulder and arm against a machine. When he struck the machine he felt something give way in his arm, experienced a sharp pain at this point, and heard "a sound like the report of a revolver." Immediately his arm became swollen, "black and blue," and a "lump" appeared at the lower part of the arm over the belly of the biceps. For a short time following the accident he was unable to use the arm. He consulted a physician for the injury, who prescribed a liniment. No fixation apparatus was applied. The ecchymosis and swelling disappeared in one or two weeks, but the "lump" remained. He continued working at his trade but his arm was so weak that he finally gave up his position and sought an easier one. Since the accident he has been able to do only light work, as his forearm under muscular effort will often give way. The weakened condition of the arm and forearm has persisted, although he has been treated with electricity, massage, etc. He has never had rheumatism, gout, typhoid fever nor lues.

Examination.—His right arm, when either the forearm was flexed or extended, showed a marked bulging of the belly of the biceps. The bulging was greatest when the forearm was forcibly flexed to a right angle and the flexion strongly resisted. The entire biceps muscle was soft and flabby. Above the belly of the biceps, which terminated very abruptly, it was impossible to feel the tendon of the long head. There was no difference in the power of flexion of the forearm, whether it were supinated or pronated. A diagnosis of rupture of the tendon of the long head of the biceps was made. As four years had elapsed since the accident it was with some hesitancy that an operation was advised, but as



FIG. 1.—Case I. Five weeks after operation.

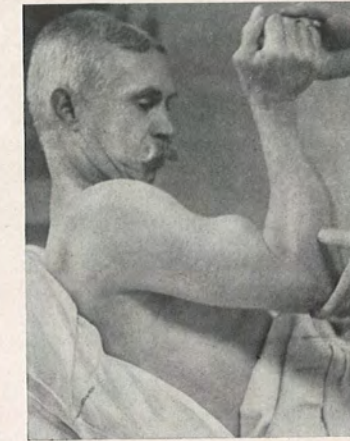


FIG. 2.—Case II. Before operation.



FIG. 3.—Case II. End result.

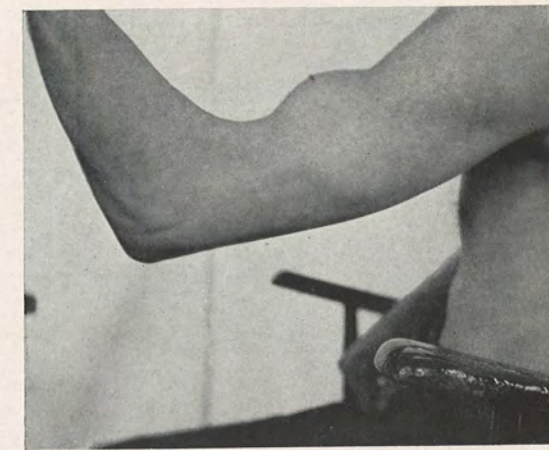


FIG. 4.—Case V. Before operation.

the patient was practically incapacitated it was hoped that an operation might better his condition.

On January 19, 1914, under ether anæsthesia, he was operated upon. An old rupture of the tendon of the long head at its junction with the belly was found and fibrous union had taken place between the tendon and the muscle. This cicatricial tissue, about one and one-half inches, was excised. The end of the tendon was split for about three-quarters of an inch and the muscle brought in between the two ends of the split tendon and sutured with twenty-day chromic gut. The arm and forearm were dressed as in Case I. Primary union followed.

The case progressed most favorably and the patient now states that he has been much benefited by the operation. A slight bulging still persists at the site of the old rupture.

CASE III.—P. McC., aged sixty-one years, white, male, punch helper. Admitted to the Episcopal Hospital on March 21, 1914.

History.—The patient came to the Medical Dispensary of the hospital on account of pain (rheumatism) in his right shoulder and weakness of his arm. In examining him the physicians found that he had, besides a chronic articular rheumatism, a rupture of the biceps muscle. Although the bulging was very great the patient had never noticed it. The patient stated that about six weeks before he came to the dispensary for treatment, while at work in a punch shed, he tripped and fell, striking his right shoulder. The injury caused him some pain and was followed by some stiffness of the shoulder. Since the accident he has noticed that his arm and forearm are weaker and that the weakness is increasing.

Examination.—Symptoms similar to Case II, the only difference was that in this case the bulging was greater and the muscle more flabby. Hüter's sign was not present.

On March 26, 1914, the patient was operated upon and a rupture of the tendon of the long head at its junction with the belly found. I was unable to find the tendon of the long head although I searched for it up to the bicipital groove. I did find a fibrous sheath, which I took to be the sheath of the tendon; there was, however, no tendon within it. As the sheath was not strong enough to suture the muscle to, the stump of the belly of the long head was sutured to the tendon of the short head.

The patient's arm was treated as in Case II. Primary union followed. Anatomically, the patient does not appear to be very much benefited, as he still has quite a bulging of the muscle. Functionally, he has been greatly improved and now says he is sure he is able to return to his former work, which he had had to give up on account of the weakness of his arm.

This patient, I feel sure, ruptured his biceps muscle much longer ago than six weeks before the operation. The interesting point is that although he had quite a bulging of the muscle he had never suspected any trouble.

CASE IV.—G. C., aged fifty-three years, white, male, machinist. Admitted to the Episcopal Hospital April 27, 1914.

History.—Six months before admission, while working on a lace curtain machine, he attempted to stop the wheel by catching it as it revolved. He succeeded in stopping the wheel, but it gave his shoulder quite a "wrench" and he felt something "give way" in his arm and heard "something snap." On flexing the arm he noticed a bulging over the biceps. Although he noticed that his arm was much weaker the accident did not completely disable him. The weakness was progressive and for this reason he came to the hospital. There was no history of gout, rheumatism, typhoid fever or lues.

Examination.—Symptoms similar to Cases II and III. Hüter's sign was present. (Hüter calls attention to the fact that flexion of the forearm in pronation when the biceps is tense is more forcible than when the forearm is supinated and the biceps is relaxed.) On April 20, 1914, under ether anæsthesia, the patient was operated upon and a rupture of the tendon of the long head at its junction with the belly found. The tendon was readily found, but it appeared more as a small fibrous cord than as a tendon. On account of the weakened condition of the tendon, I did not think it advisable to suture it to the muscle, but instead, sutured the belly of the long head to the tendon of the short head. The case was treated as the preceding. Primary union followed. The patient has a very satisfactory result. There is very little bulging of the muscle on forced flexion of the forearm and the arm and forearm are much stronger than before the operation.

CASE V.—W. S., aged forty-one, white, male, laborer. Admitted to the Episcopal Hospital on December 9, 1914.

History.—On the morning of admission to the hospital, while lifting a bag of coffee, he was suddenly seized with pain and heard something snap in his left arm. He said it felt as if "somebody had hit him with a club." As he was unable to use his right arm after the accident, he came immediately to the hospital. There was no history of typhoid fever, gout or lues, but an indefinite history of a mild attack of rheumatism in the left shoulder.

Symptoms were those of a rupture of the long head of the biceps. No hæmatoma or other signs of recent injury were present. Hüter's sign was not present.

The patient refused to be operated upon and left the hospital the same day that he applied for treatment.

This patient was operated upon one week after the accident by Dr. G. G. Davis at the University Hospital. The operation disclosed the tendon of the long head relaxed. A rupture had taken place at some point between its origin and the bicipital groove. The tendon was not pulled out of the groove, but the slack portion was taken up and the tendon sutured to the tendon of the short head.

CASE VI.—R. McF., aged sixty years, white, male, fish dealer. Admitted to the Episcopal Hospital on December 15, 1914.

History.—Three months before admission, while attempting to lift a barrel of fish, he was suddenly seized with a severe pain in his left arm. He dropped the barrel and rested the arm for a few minutes until the pain subsided. The night following the injury he suffered greatly with pain in his arm, forearm and fingers. Since the accident, on account of the weakness of his arm, he has been unable to do heavy work. He says that his left arm frequently "goes to sleep." No history of typhoid fever, rheumatism, gout or lues, but is a heavy whiskey drinker.

Examination.—Symptoms similar to Cases II to V inclusive. Hüter's sign not present. The muscle showed quite a bulging and was very flabby. Blood-pressure 180 systolic. No symptoms of nerve involvement.

Diagnosis.—Rupture of the long head of the biceps, probably at the junction of the tendon and muscle. As the patient was in very poor physical condition no operation was advised.

Besides the six cases reported above, two other cases have been treated this year in the Medical Dispensary of the Episcopal Hospital.

CASE VII.—Wm. M., aged eighty-four years, white, male, insurance agent. This case came to the Dispensary on account of a traumatic arthritis of the left knee. In the examination of the patient it was discovered that he had a rupture of the long head of the biceps muscle of the left arm. The probable seat of rupture was at the junction of the muscle and tendon. The Dispensary notes state: "No symptoms at time of rupture or afterwards; no history of rheumatism, typhoid fever or lues."

CASE VIII.—Wm. L., aged fifty years, white, carpenter. The patient was admitted to the Dispensary for treatment for chronic endocarditis and myocarditis. He was treated six years ago in the Episcopal Hospital for a severe attack of acute articular rheumatism. The lesion in this case was of the long head of the biceps of the left arm. The rupture, as in Case VII, was probably at the transition point between tendon and muscle. This case, as the preceding, had "no symptoms at time of rupture or afterwards."

Unfortunately, in the above two cases, no note was made as to whether the patients were right- or left-handed.

Loos¹ reports 66 cases of rupture of the biceps, 44 of which were of the muscle, and 18 of the tendon. Four of these were his own.

Petit,² according to Loos, collected 83 cases. In this series the point of rupture was as follows: Muscle 21; belly of the long head 9; tendon of the long head 43; at junction of belly of the long head and tendon 7; the tendon of insertion 3. I failed to find an article on the subject by Petit, so was unable to verify the statistics as given by Loos.

Wiesmann³ reviews the literature on this subject and reports a case of rupture of the tendon of insertion caused by the lifting of a table. He operated upon the case and obtained a successful result.

Davis⁴ reports 4 cases, as follows: Rupture of the tendon of the long head 3; rupture of the tendon of insertion 1.

Castret⁵ reports a case of rupture of the belly of the biceps due to slight muscular contraction. The case was treated by electricity.

Hollos⁶ reports "two cases of biceps rupture by paralysis." I have been unable to find his article.

Keen⁷ reports a case of rupture of the tendon of the long head and also one of DaCosta's, of a tearing off of the long head from the margin of the glenoid cavity. Both of these cases were successfully operated upon.

Gerster⁸ reports a case of laceration of the long head of the biceps due to a fall down stairs. The case was successfully treated with a sling.

In 64 of the cases reported, in which the histories were given in sufficient detail to locate the lesion, 16 occurred in the tendon, 44 in the muscle, and 6 at the junction of the tendon and the muscle. As only 5 of the cases reported were operated upon the exact site of the rupture in the others could not be ascertained.

Davis⁴ believes that true rupture of the tendon is rare and "when a tendon does rupture it is very likely to have been diseased." In Case IV of this series it appeared as if the tendon was either diseased or malformed.

From the cases reported it appears that rupture may take place through the belly of the long or short head, through the belly of the muscle proper, at the transition point of the belly and tendon, through the tendon of the long head or the tendon of insertion, and even as in DaCosta's case, at the origin of the tendon of the long head.

Of the cases reported, 4 have been the result of muscular effort alone. Only 2 cases are reported in which the accident occurred in women. Only 2 cases are reported of rupture of the belly of the short head; one of these was due to direct injury, a threshing machine accident, in which the belly of the short head and the tendon of the long head were both injured, an accident very similar to Case I of

this series. The other case occurred in an attempt to reduce a dislocated shoulder.

The causes of the rupture may be either direct force, muscular contraction, or possibly an indirect force, such as a fall on the shoulder, that would throw a great strain on the long tendon; also disease or malformation might be an underlying cause.

Since the great majority of the cases occur among working men, and since the right biceps is the one usually affected, it seems that muscular contraction is the most potent etiological factor.

In Cases II, III and IV of this series the rupture occurred at the transitional point between tendon and muscle. As tendon is stronger than muscle it is natural to believe that the rupture occurred on the muscle side of the tendon and that the underlying cause might possibly have been a myositis. This cause is suggested in Case III, where the entire muscle was markedly relaxed and very flabby, although only the tendon and belly of the long head were implicated in the accident. The cases reported show that rupture is most apt to occur after forty years of age. As this is the period that degenerative tissue changes are most apt to make their appearance it is very probable that disease of muscle or tendon plays a very important causative part in the rupture.

That rupture of the tendon or belly of the long head is more frequent than at any other site, I believe to be due to the fact that the tendon, by its position in re-inforcing the shoulder-joint, is subjected to all strains that may be thrown upon the head of the humerus. Cases II and III may have occurred in this manner.

The symptoms at the time of injury may be trivial, the patient noticing nothing wrong, or they may be quite severe and immediately incapacitate. Swelling and ecchymosis do not always accompany the rupture.

The physical findings will differ somewhat, depending on the site of the rupture. If the rupture is through the belly of the muscle a furrow can be felt between the two ends, this can be widened by extending the forearm. In rupture of the tendon of insertion, flexion and supination of the forearm may be interfered with and the belly of the muscle would be drawn up nearer the shoulder.

In rupture of the long head, whether it be a tearing away at its point of origin, in the continuity of the tendon, at the transition point between tendon and muscle or through the belly of the long head, the symptoms are almost identical. A bulging of the biceps at a point nearer the elbow than normal, a flabby condition of part or all of the muscle, an abrupt termination of the bulging above and an inability

to feel the tendon above that point, all point to rupture of the muscle or tendon. In rupture of the tendon or muscle of the long head the short head stands out prominently, and to its outer side, where the long head and tendon should be, a sulcus running upward and slightly inward is found.

Hüter's symptom was present in only one of this series. It was not tried for in Case I.

The treatment in the great majority of cases has been either none at all, or bandage, sling, electricity, etc. No doubt many cases have been operated upon. I have only been able to find, however, 5 cases treated in this manner.

VON HOCHSTETTER⁸ reports a case of a man forty-six years of age, who ruptured the tendon of the long head at its junction with the belly. This case was operated upon two months after the injury. The tendon was sutured to the belly with silk. Result successful.

BAZY⁹ reports a man, aged forty years, who ruptured the tendon of the long head at its point of origin. He operated upon this case, resected the tendon, and sutured the stump to the tendon of the short head. Result successful.

KEEN⁶ reports a case of a man, aged fifty-four years, who ruptured the tendon of the long head. The tendon was sutured with twenty-day chromic gut. Result successful.

DACOSTA,⁵ reported by Keen, operated upon a man, aged fifty-two years, who in lifting a bucket tore the tendon of the long head away from its point of origin. In this case the upper portion of the tendon was resected and the stump was attached to the short head by splitting the latter and suturing. Result successful.

WIESMANN² reports a case of rupture of the tendon of insertion, caused by lifting a table. The case was successfully operated upon.

Conservative methods of treatment have given satisfactory results in a few isolated cases only. Since successful results have been gained by operation in cited cases, it is evident that the operative treatment is to be recommended.

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⁴ Castret: Toulouse Med., 1911, 2 S., xiii, p. 347.
⁵ Hollos: Elme es ideg Kart, Budapest, 1907, p. 125.
⁶ Keen: ANNALS OF SURGERY, 1905, vol. xli, p. 756.
⁷ Gerster: N. Y. Med. Journal, 1878, vol. xxvii, p. 487.
⁸ Von Hochstetter: Wien. Med. Woch., 1890, p. 399.
⁹ Bazy: Bull. Soc. de Chir., 1895, p. 156.

DR. JOHN H. JOPSON exhibited a patient showing the results of an operation for rupture of the long head of the biceps muscle, who was one of two upon whom he had operated for rupture of the long tendon.

This patient was injured a year ago in an accident on a schooner. He was raising a sail and was caught by a rope, which wound around his arms in such a manner that the left arm was practically torn off and was later amputated a few inches below the shoulder. The right shoulder and upper arm were also injured. When Dr. Jopson saw him some months later, he exhibited the usual symptoms of rupture of the biceps muscle and, in addition to this, there was marked limitation of abduction and forward extension of the arm. He was operated on at this time and it was found that the long tendon had been torn about 3 cm. above the belly of the muscle and the two fragments were connected by a thin, flaccid strand of connective tissue. The tendon was plicated and sutured to the short head of the biceps. The result was satisfactory as regards the power of flexion of the arm, although there is still some depression above the belly of the muscle. The limitation of abduction and forward movement of the arm caused the patient to return for further treatment. The head of the humerus was then exposed through an anterior incision between the deltoid and pectoralis major muscles and the lesser tuberosity was found to have been fractured and was attached at a lower level than normal, while the head of the bone was above and in front of the glenoid cavity. The lesser tuberosity was chiselled off subperiosteally, which permitted the head of the bone to be brought down nearer its normal location, and the arm was dressed at a right angle to the body and kept in this position for several weeks. The patient now shows marked improvement in the movements which were formerly almost abolished, viz.: abduction and forward extension, although the head of the bone is still above its normal location. With treatment by massage and passive motions further improvement is probable.

The other patient was a man, aged sixty-eight, who, while attempting to catch a heavy bunch of bananas, was struck by it, the weight falling on his arm. In this case, operation showed that the tendon had been torn from the edge of the glenoid cavity. It was sutured to the common tendon of origin of the short head of the biceps and the coracobrachialis muscles through a second incision just below the coracoid process, the tendon being made taut before it was attached. He had not been able to trace this patient.

PROLIFERATING EPITHELIOMA OF THE SIGMOID

DR. GEORGE G. ROSS reported the history of a man aged seventy, who suffered some 20 years ago from various digestive disturbances and some nervous symptoms which he thinks were due to his habits

of life. Under treatment he improved and remained fairly well until two or three years ago when he began to fail. About the same time his wife's serious illness caused considerable anxiety and stress. After the result in her case became apparently hopeless, he himself ran down rapidly and has continued so until now. Has lost about 70 pounds in the last year or year and a half. His color, however, remained fairly natural. He has lately had some intestinal symptoms which seemed to point to the sigmoid region or perhaps lower. He is habitually constipated and constantly takes laxatives. He has discharged blood from time to time; sometimes several times a day. No particular local pain or soreness. On examination there is some hardness of the sigmoid region but no very definite indications of a mass. He is decidedly emaciated but not cachectic. Constant starvation diet may account for some of this. No renal symptoms of a definite kind. Urine shows as follows: Negative except for a heavy indican reaction; specific gravity 1022; a few casts. X-ray shows an incomplete obstruction of the sigmoid about the middle. This was best shown by X-ray of the bismuth injections from below. Blood count: Red blood-cells 4,520,000; white blood-cells 7,000; 79 per cent. polynuclears; 66 neutrophils; 27 lymphocytes; 3 large mononuclears; 0 transitionals; 4 eosinophiles.

Operation (December 3, 1913): Left rectus incision. Hard mass in middle portion of sigmoid demonstrated. Outer layer of meso-sigmoid incised to mobilize the sigmoid. Bowel clamped to either side of tumor. Sigmoid cut through with actual cautery between clamps, proximal and distal to tumor, and five inches of sigmoid, containing the tumor (Fig. 1) removed. End-to-end anastomosis, proximal and distal end of sigmoid, using chromic gut for mucosa and muscular layer reinforced by linen suture for serosa. Anastomosis reinforced by epiploic appendages which were sewn over side of anastomosis with linen suture. Colon tube passed to point above anastomosis. Colon tube sewn to anus with one silkworm-gut suture. Wound closed in layers. Dry dressing.

The day following operation the patient developed a bronchitis without temperature. The rectal tube was removed on the third day and the patient had a formed stool. He subsequently showed abdominal distention, diminished urinary output, and finally died seven days after operation from uræmia.

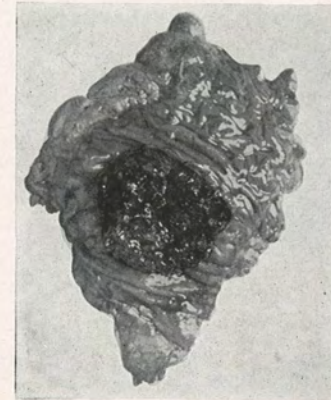


FIG. 1.—Proliferating epithelioma of the sigmoid.

THE OPERATIVE TREATMENT OF ARTERIAL THROMBOSIS AND EMBOLISM*

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OUR interest in the subject which forms the title of this paper has been aroused principally by the study of three cases in which efforts have been made to relieve arterial obstruction by surgical means. Two of these cases, in which the femoral artery was concerned, were reported in full to the Philadelphia Academy of Surgery in May, 1907, and are here reproduced in abstract. The third case, one of embolism of the abdominal aorta, is now published for the first time.

The operative methods that have been proposed for dealing with thrombosis and embolism of the arteries are (1) ligation, (2) arterio-venous anastomosis, (3) arteriotomy, (4) arterial resection, (5) arterial catheterization.

1. *Ligation* of the affected artery, distal to the point of obstruction, has been suggested in order to prevent the detachment of emboli. Whether this suggestion should be adopted or not depends, to a large extent, upon the frequency with which emboli are liberated from the point of obstruction, upon the damage that such emboli may produce after they are set free, and upon the possibility of recognizing an intra-arterial clot when it is most likely to launch particles into the blood stream.

The constant attrition of a strong current of blood on a growing mural thrombus is surely conducive to fragmentation of the more recently formed layers of that thrombus, and it is our belief that minute particles of blood clot, which are, however, too small to cause mischief unless laden with bacteria, are always washed from a non-occluding thrombus and from an occluding thrombus that has reached the parent stem of the vessel in which it lies. The process is a microscopic, symptomless embolism, and it accompanies the healing of all wounds involving blood-vessels, hence may be regarded as a normal phenomenon of repair.

In contradistinction to this physiologic embolism, pathologic embolism from a developing arterial thrombus or an arrested embolus

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is rare, at least so far as can be estimated from a clinical study of the subject. One of the reasons for this rarity is that the separated clot must be of a proper size to cause symptoms. If it is of microscopic dimensions and aseptic it is incompetent to work harm. If it is of great size, almost as large as the original clot, it becomes impacted immediately distal to the original clot and not in one of the branches of the affected vessel. Despite the greater blood-pressure in the arteries, which fact might lead to the inference that an intra-arterial clot would be more liable to suffer disintegration and dispersion than a clot in a vein, arterial thrombosis is decidedly less apt to result in harmful embolism than venous thrombosis. Owing to the composition of the arterial blood, a thrombus in an artery forms more slowly than one in a vein, hence is firmer in consistency. The walls of an artery are thicker than those of a vein, consequently a thrombus in an artery is less liable to be displaced by pressure from without. The arteries diminish in size in the direction of the blood current, as a result an occluding thrombus in an artery cannot be driven farther; whereas in a vein, which increases in calibre in the direction of the blood current, a thrombus may be washed *en masse* from its moorings.

Even though observation leads to the conclusion that emboli of proper size to cause trouble seldom arise from an intra-arterial clot, if the damage to the tissues deprived of blood by such emboli were great, ligation might still be urged to avert that damage. A small clot floating from a partly occluded artery is not likely to inflict more harm than total occlusion of that artery by ligation, whether the artery be the aorta, the brachial, the femoral, or the carotid. A small clot freeing itself from a mural thrombus which later becomes occlusive might, however, seriously interfere with the development of a collateral circulation, and the same result might be caused by a small clot thrown from an occlusive thrombus.

Even with the possibilities just mentioned in mind, however, ligation cannot, as a rule, be recommended, because the greatest danger of detachment of emboli is when the thrombus is forming, in other words, when the diagnosis of thrombosis cannot be made. When the diagnosis is certain, the thrombus is occlusive, and the danger of embolism is probably passed. Small particles can no longer be driven from the clot, and it cannot be displaced *en bloc*, because the vessel beyond is smaller than the thrombus.

2. *Arteriovenous anastomosis*, above the point of arterial obstruction, in order to induce the arterial blood to flow through the veins towards the periphery, and so reach the undernourished tissues, is an

operation which has enthusiastic advocates and strong opponents. Probably most surgeons are in a state of indecision as to the merits of this procedure. According to some experimenters, reversal of the circulation in the veins is impossible, owing to the resistance offered by the valves. Other experimenters, notably Carrell, have succeeded by arteriovenous anastomosis in filling the veins with red blood. None has demonstrated, however, that this red blood passes through the capillaries before returning to the heart.

It is probable that with time the valves might be forced to yield to the constant bombardment of the blood diverted from an artery into a vein, and that, aside from actual tearing or stretching of the valves, they might easily be rendered incompetent by the dilatation of the vein in obedience to the increased intravenous pressure. In either event, however, the time would have to be brief if the part threatened with gangrene is to survive, and the constant hurling of the blood against the valves with the consequent eddies in the stream would surely predispose to thrombosis, especially if the valves were lacerated, instead of simply bent back or separated. In addition to these theoretic considerations we have undisputed clinical evidence that in certain cases of varix and arteriovenous aneurism the blood flows centrifugally in the vein.

Reversal of the circulation in the capillaries and arteries, however, would seem to be possible only in an organ with a terminal circulation. If the veins, as is the case in the extremities, have numerous anastomotic branches, the arterial blood diverted to the principal vein will always seek these branches, and return to the heart in collateral venous channels, in which the pressure is feeble, rather than overcome the greater resistance of the capillaries and thus reach the arteries. Here again, *i.e.*, in the arteries, the presence of anastomotic branches, if functioning, would offer an insurmountable obstacle to a centripetal flow of blood from the capillaries, since the red blood in these anastomotic branches would quickly distend the main artery, below the site of the artificial arteriovenous junction, with greater force than that of the dark blood accumulating from the capillaries. This dark blood, even if regurgitated into arterioles without anastomotic branches, would, in most instances, only hasten their obliteration by thrombosis, since, in addition to the coagulative tendency of used blood, the arteries would be, in most instances, badly diseased and, owing to the fall of blood-pressure consequent upon their assumption of the function of veins, much reduced in calibre.

It is probable that in most of the cases of arteriovenous anastomosis

for threatened gangrene in which the results are reported as favorable the operation was a failure, *i.e.*, that thrombosis occluded the vein and the artery at the site of anastomosis, and that the amelioration noted in the symptoms was due, not to increased blood supply, but to interference with the venous drainage. This probability is supported clinically by those cases of Raynaud's disease temporarily benefited by the application of elastic constriction to the base of the limb, and also by von Oppel's experience in securing, by means of ligation of the popliteal vein, a return of warmth, color and sensation in a leg menaced by gangrene. If the arteriovenous fistula remains patent the chances are, unless our theories are entirely wrong, that the blood shunted from the artery to the veins does no more than hinder the return of blood in those veins, thus contributing to passive hyperæmia. Another explanation, applicable to a few of the "successes" in preventing gangrene, especially in the upper extremities, is that, owing to an adequate collateral circulation, gangrene would not have occurred without operation.

If the collateral circulation is adequate, and the anastomosis is made immediately above the point of arterial obstruction, the only harm that could be done, aside from the evil possibilities attending all operations, is obliteration of the vein by thrombosis, and perhaps this might prove, as pointed out above, beneficial rather than injurious. If, however, the collateral arterial circulation is not competent to irrigate the limb, and there is still some blood passing through the artery, or if functioning arterial branches exist between the point of obstruction and the anastomoses, failure of the operation, *i.e.*, thrombosis, would increase the danger of gangrene.

Since 1902, when San Martin reported the first case, arteriovenous anastomosis for restoring the circulation has been done about 70 times: Once between the carotid and the internal jugular, twice between the brachial vessels, four times between the popliteal vessels, once between the anterior tibial artery and the internal saphenous vein, and the rest between the femoral vessels. The indications were hemiplegia, probably embolic, in one case; embolism in two cases; traumatic destruction of the vessels (excision for sarcoma and aneurism, gunshot wound, rupture of the vessels from lightning stroke, crushing accident) in five cases; and to prevent or to limit arteriosclerotic gangrene (including Raynaud's disease) in the remaining cases. In about 20 per cent. of these cases the results are said to have been satisfactory. Most of these apparent "successes" are seriously questioned by unprejudiced observers, and it is highly probable that the operation is never successful

in so far as reversing the circulation is concerned, but that improvement in the symptoms, at least, temporary, occurs in a few instances there can be no doubt.

In view of this fact, and despite the theoretic objections to arteriovenous anastomosis, it cannot be condemned utterly. It may be that circumstances occasionally will arise under which the conscientious surgeon, forced to a decision between this operation and eventual amputation, will be willing, after laying the experimental nature of the proceeding before the patient, to perform an arteriovenous anastomosis, in the hope that he may do no harm and possibly may effect some good. It may be, too, that future experimental or clinical evidence will force us to alter our views of this operation.

If arteriovenous anastomosis is decided upon, the method to be employed should receive serious consideration. The method which is physiologically ideal, so far as the effort to obtain complete reversal of the circulation in the vein and the artery is concerned, consists in severing the artery and the vein and then uniting, end-to-end, the central segment of the artery to the distal segment of the vein, and the distal segment of the artery to the central segment of the vein. There are, aside from its technical difficulties, three important objections that may be lodged against this procedure. The vessels are crossed at the point of suture and exert pressure on each other, thus retarding the flow of blood through the anastomoses and predisposing to thrombosis. If the artery below the point of anastomosis is patent and its connections with collateral arteries undisturbed, part of the blood from these collateral branches will stream up the artery and into the vein, and thus be diverted from the capillaries where it is so greatly needed. If thrombosis occurs at the point where the peripheral arterial segment is joined to the proximal venous segment, a portion or the whole of the thrombus may be driven or drawn into the vein and be carried to the pulmonary artery or one of its branches. These objections may be overcome by sacrificing the physiologic ideal and tying the peripheral end of the artery and the proximal end of the vein, trusting that the blood which is driven into the distal segment of the vein may find its way back to the heart through collateral venous channels. The same result, *i.e.*, shunting the arterial blood into the vein and forcing the blood to seek channels other than those of the main artery and vein in its journey back to the heart, may be obtained by performing lateral anastomosis and then tying the vein proximal and the artery distal to the anastomosis, by implantation of the upper end of the artery into the side of the vein, with ligation of the vein above the anastomosis and

ligation of the distal arterial segment, or by implantation of the lower end of the vein into the side of the artery, with ligation of the artery below the anastomosis and ligation of the proximal venous segment. All of these substitutes for end-to-end anastomosis deflect and deform the blood stream as it passes from the artery to the vein, which irregularities in direction and form are important factors in coagulation. Further, these substitutes all lack the advantage of smoothness in the neighborhood of the anastomosis, the first leaving two pockets, and the second and the third each leaving one pocket, in which a propagating thrombus is likely to develop. Without ligation as described above, lateral anastomosis and lateral implantation of artery into vein short circuit the blood that finds its way into the vein, it being easier for this blood to follow the normal direction of the venous current than to flow towards the periphery. Lateral implantation of vein into artery, without ligation of the artery distal to the anastomosis, and lateral anastomosis with ligation of the vein proximal to the anastomosis, may seem to possess some elements of innocuousness, in that while part of the blood is diverted to the vein the circulation in the artery is not suppressed, thus permitting it to carry nourishment as far as it is patent. This plan for dividing the arterial current is a compromise between a frank effort to reverse the circulation and "watchful waiting," and is less likely to succeed than either. It predisposes to thrombosis in the artery because of the decrease in intra-arterial pressure consequent upon the leak at the site of anastomosis, and because of the decrease in intra-arterial pressure the blood which passes through the artery is less apt to permeate the capillaries. Further, the amount and the force of the blood diverted to the vein are necessarily less than when the whole arterial stream is directed into the vein, and the blood so diverted, instead of penetrating to the venous radicals, escapes into the returning collateral veins through the first anastomotic branches, unless in the meantime it solidifies into a thrombus.

3. *Arteriotomy*, for the purpose of removing an embolus, was attempted first by Sabanajew in 1896. The embolus, which was supposed to be in the femoral artery, was not found, however, and the limb was amputated at a lower level.

The first report of a successful embolectomy was made by the author to this Academy in May, 1907.

A man, aged sixty-one years, was suddenly stricken with excruciating pains in the right foot, followed by gangrene of the foot and the lower two-thirds of the leg. Pulsation could not be felt in any of the vessels below the bifurcation of the femoral. Thirty-six hours after the onset of the pain the femoral artery

was opened, the embolus extracted, and the artery sutured. Pulsation immediately reappeared in the femoral below and in the popliteal, but not in the tibial vessels, and this pulsation continued for eight days. The gangrene did not extend after operation. Forty-two days later the leg was amputated below the tubercle of the tibia. About 15 ligatures were necessary and the bone bled freely on section. The popliteal artery contained a small clot, and a probe passed up into the artery for several inches caused a slight flow of blood.

In 1907 three additional arteriotomies for embolism were reported. DOBERAUER opened the right axillary artery and removed an embolus 52 hours after its impaction. Thrombosis occurred within a few hours and the artery was again opened and the clot extracted. The thrombus reformed and two days later an anastomosis was made between the artery and the vein, whereupon the gangrene ceased to spread.

HANDLEY attempted to aspirate and to wash an embolus from the left common iliac artery, 12 hours after its impaction, by passing a catheter through the deep femoral, the common femoral, and the external iliac. He succeeded in inducing a pulsating flow of red blood, but death occurred 24 hours later.

MOYNIHAN removed an embolus that had lodged in the popliteal artery; the patient died four days later. The condition of the leg after the operation was not mentioned.

Arteriotomy for embolism of the pulmonary artery, which was suggested by Trendelenburg in November, 1907, and which has thus far always been followed by death, we have excluded from our discussion, as the pulmonary artery belongs physiologically to the venous side of the circulatory apparatus.

In 1909 MURPHY incised the femoral artery four days after the onset of acute ischæmia in the left lower limb, and dislodged an embolus from the common iliac by fragmentation, using a catheter and forceps. The lower limb was already gangrenous, and amputation was performed four days after the arteriotomy.

In the same year SCHIASSI extracted an embolus from the femoral artery, and amputated through the thigh four days later.

In 1911 two cases appeared in the literature. PROUST removed an embolus from the femoral artery 12 hours after its impaction. The patient died the following day.

MOSNY and DUMONT removed an embolus from the left femoral artery six hours after the onset of symptoms. The limb did not become gangrenous.

In 1913 three new cases were brought to light. KEY's patient complained of sudden, violent pain in the left popliteal space, with coldness and numbness in the leg. Seven hours later the dorsalis pedis was exposed by incision and found to be empty; next the popliteal artery was laid bare and it too was found to be empty. Then the femoral was uncovered, opened, and an embolus removed. The wounds healed kindly and gangrene did not follow, although, probably as the result of ischæmia, there was slight paralysis of the peroneal muscles and some contraction of the muscles of the calf.

In MATTI's case likewise, the symptoms were referable to the foot and leg, although no arterial pulsation could be obtained lower than a point 3 cm. below

Poupart's ligament. Thirteen hours after the trouble began the femoral artery was incised near its bifurcation, and a clot 3 cm. long withdrawn from the superficial femoral, and one 2 cm. long from the deep femoral. Later, owing to absence of bleeding from the lower part of the superficial femoral, this vessel was milked from below upward, and a clot 15 cm. long forced out through the wound. This was followed by copious bleeding and the artery was then sutured. After several days thrombosis recurred in the superficial femoral artery. The gangrene was limited to the toes, the superficial parts of the heel, and a narrow area of skin along the inner surface of the leg. The patient died two months after operation from cardiac disease and pneumonia.

BAUER'S case we give in detail because it is the first, and, indeed, with the exception of our own, the only one in which the abdominal aorta was opened to remove an embolus. The patient was a man, aged thirty-nine years, suffering from chronic articular rheumatism and mitral disease. Suddenly severe pain was experienced in both legs, which became useless, and in the lower abdomen. The pulse was irregular and the face cyanotic. Over both lower limbs, and over the abdomen as far as the umbilicus, the skin was cold and livid. No pulse could be felt in the femoral arteries. Sensation was abolished in the feet and the legs, and only partly present in the thighs and over the lower abdomen. Operation was performed three hours after the onset of the embolic symptoms. An incision was made in the linea alba, the small intestine drawn from the abdomen and laid on the right side of the abdominal wall, the posterior parietal peritoneum incised, and the aorta isolated. After the aorta had been compressed by the finger of an assistant an incision 2 cm. long was made into the artery just above its bifurcation, and the embolus extracted. The arterial wound was then closed with six sutures of silk. Pulsation was immediately felt in both iliac arteries. The operation lasted one hour and forty minutes. The embolus was about 3 cm. long and had the form of a molar tooth with two short roots; the "crown" lay in the aorta, the "roots" in the iliac arteries. Symptoms referable to the lower limbs promptly disappeared, except for some pain in the left foot and calf. The patient left his bed on the twenty-fifth day and was discharged on the thirty-second.

The history of our case of aortic embolectomy, hitherto unpublished, is as follows:

S. A., female, aged forty-nine years, had always been in good health up until a few years before admission to the Jefferson Hospital, when, following an attack of acute articular rheumatism, she began to suffer from dyspnoea. About three weeks before operation she was compelled to go to bed because of dizziness, cough, weariness, and severe headache. One week after this she suddenly lost her voice, and, although not unconscious, seemed unable to comprehend what was said to her. A few days later it was noticed that she frequently rubbed both legs and especially the right one, which quickly became dark in color. At the time of entering the hospital the patient was restless and constantly moaning. The voice had partly returned, but only a few words could be uttered distinctly. The pupils were small, equal, and

reacted to light. There was no paralysis of the tongue or face, no jaundice, and no enlarged lymph-glands. The tongue was heavily coated, the thyroid gland distinctly palpable. There was slight impairment of resonance and increased harshness of the breath sounds over the apex of the right lung. The heart was enlarged and very irregular in action, the apex beat diffuse, feeble, and in the sixth interspace, about 13 cm. from the median line. Over this point a presystolic thrill and murmur were present. The radial arteries were slightly atheromatous. No abnormalities were discovered in the abdomen. Pulsation of the abdominal aorta could be made out by palpation. Pulsation could not be felt in the external iliacs, or in any of the arteries in the lower limbs. The right foot was black and shrivelled, the lower two-thirds of the right leg purplish, with loosening of the epidermis and bleb formation. The left leg was painful, tender, useless, warm (because of the presence of external heat), and pale, except over an indurated area, about two inches in diameter, just external to the middle of the tibia, where the skin was reddened and oedematous. The urine showed a trace of albumin but no casts, the blood a negative Wassermann reaction and 21,600 leucocytes (polymorphonuclears 84 per cent., hyaline 5 per cent., lymphocytes 10 per cent., eosinophiles 1 per cent.). There was no fever.

In view of the advanced and extending gangrene in the right leg, with only prodromal symptoms of gangrene in the left leg, it was thought that an embolus had lodged in the right femoral artery sometime preceding the impaction of a second embolus at the bifurcation of the aorta, or that an embolus had been arrested at the bifurcation of the aorta, which embolus had completely occluded the right iliac artery and at first only partly occluded the left iliac artery, the obstruction of the latter vessel becoming complete at a more recent period as the result of a superadded thrombus proceeding from the embolus. As no induration could be felt along the right femoral artery the second explanation seemed to be the better, and indeed proved to be the correct one. The red indurated area in the left leg was considered to be due to a small embolus from the heart, or from the clot accumulating at the origin of the left common iliac artery.

Although, by reason of the feeble action of the heart, it was recognized that an effort to clear the aorta would be attended by great risk, it was deemed imperative to make the attempt, not only for the purpose of saving the right thigh and the left lower extremity, but also for the purpose of relieving the cardiac embarrassment that always accompanies aortic obstruction. The alternative was abstention, gangrene of both lower limbs, and death.

The operation was performed January 5, 1914, under ether,

administered by intratracheal insufflation. The abdomen was opened in the median line below the umbilicus, the small intestine segregated in the right side of the abdomen, and the sigmoid pressed to the left. The iliacs were motionless; the aorta pulsated to a point near the bifurcation, at which point it was hard. The posterior parietal peritoneum was incised, and a silk ligature passed beneath the aorta at a point one and one-half inches above the bifurcation. This ligature was not tied, but it was placed so that it could be tied in the event of bleeding that could not be controlled otherwise. While an assistant compressed the aorta with a finger a longitudinal incision, extending upwards from the bifurcation for three-fourths of an inch, was made in the anterior wall of the aorta. After removing, in several pieces, a dark friable clot, evidently of recent formation, which lay beneath the incision and protruded into the left common iliac artery, the embolus itself was uncovered, and easily forced through the wound by pressure, from below upward, on the right common iliac artery, into the orifice of which the lower end of the embolus had been driven. There were apparently no firm adhesions between the obstructing mass and the intima, which appeared to be smooth and undamaged. The embolus, or perhaps we should say the embolus with the old thrombi which had gathered about it, measured 3.1 cm. by 1 cm., weighed .75 gramme, and was bullet-shaped, the distal end being bluntly rounded, the proximal end irregular, as though a portion had been broken off. The ends were dark red in color, and separated by a white band, .7 cm. in width, which sent a narrow prolongation toward the proximal end. After milking several more small fragments of clot from the left common iliac, pressure on the aorta was relaxed for an instant, in order to wash any remaining coagula through the wound, and the aorta closed with a continuous through-and-through silk suture, over which a second continuous suture, including the outer coats only, was inserted. The posterior parietal peritoneum was drawn together with a continuous suture of catgut, the abdominal wall with interrupted stitches of silkworm-gut.

The operation, which lasted about one hour, had little immediate effect on the patient's general condition. The temperature remained normal, the respirations continued at the rate of 40 to the minute, and the pulse, which could be felt in both femoral arteries, was slightly accelerated, varying, as nearly as could be estimated, between 75 and 130. On the following day the pulse failed in the right femoral artery, the temperature rose to 101°, a small quantity of bright red blood was coughed up, and numerous moist râles could be heard over the chest. On the second day dulness appeared over the lower lobes of both lungs, the heart

became more feeble, and pulsation could not be felt in the left femoral artery. On the third day death occurred from cardiac weakness and pulmonary œdema. An autopsy could not be obtained.

On first viewing the patient whose history has just been related we discarded operation, because of the long time the embolus had lain in the aorta. Later, however, we realized the significance of the striking difference in the appearance of the right and the left legs and considered operation mandatory. In addition to this narrow escape from making an inaccurate "snap" diagnosis, several other features in this case stand out as highly instructive for the future building of the living pathology of embolic obstruction of the arteries, viz., the absence of occlusive thrombi in the femoral arteries, permitting them to resume their function after a number of days of inactivity; and, despite the long duration of the arterial obstruction, the absence of perceptible adhesions between the embolus and the intima, and the macroscopic smoothness of the intima, findings that allow us to entertain the possibility of restoring the circulation in the large vessels even after it has been interrupted for a long period. It may be that if our patient had survived, and the heart had contracted with a vigor approaching normal, thrombosis at the site of operation would not have occurred; it may be that cessation of femoral pulsation shortly before death was not due wholly or even principally to the alterations in the intima and the changes brought about by the arterial wound.

Notwithstanding the possibility just mentioned it cannot be emphasized too strongly that, in order to preserve a part from impending embolic gangrene, the embolus must be removed as soon after its impaction as possible, not only because of the increasing injury suffered by that portion of the intima which lies in contact with an unremoved embolus, which injury predisposes to thrombosis after arteriotomy, but also because impending quickly becomes actual gangrene, and dead tissues cannot be resuscitated. Further, in embolism of a large artery the early relief of the strain put upon the heart should be kept in mind.

The prompt diagnosis of embolism of the extremities generally presents no great difficulties, but even careful observers have, at times, been unable definitely to locate the exact site of the arterial obstruction. In four of the cases mentioned above (Sabanajew, Murphy, Handley, Key) and in another to be cited later (Stewart) the artery was incised some distance below the point of occlusion. In one of these cases the obstruction was not found, in two it was removed by indirect means

through the original incision, in the other two by a subsequent incision directly over the clot. An accurate diagnosis cannot be made from the symptoms of ischæmia merely. Pain, according to our observations, is acute in the region deprived of blood, and, despite the usual teaching, absent or trivial over the site of the obstruction in the artery. Pallor, fall of temperature, hypæsthesia, and paresis followed, in the event of local death, by the discoloration of gangrene, anæsthesia, and paralysis likewise are limited to that portion of the limb in which the circulation is arrested. All of these symptoms are indicative of ischæmia solely, and the area of ischæmia never reaches the level of the arterial obstruction. The reasons for this, although obvious, are often overlooked, and the site of obstruction is thought to be much lower than it really is. If the affected artery can be palpated there is no excuse for a mistake in the localization of the obstruction. At the site of obstruction the artery may be hard and tender; above this point it pulsates, below it does not pulsate. If the site of obstruction cannot be palpated one may find pulsation in the vessel or its superficial branches at a higher level and fail to find pulsation in the vessel or its branches at a lower level. These observations, with the knowledge of the usual site of embolic impaction, *i.e.*, where the vessel suddenly diminishes in size as the result of giving off a large branch or bifurcating, will generally suffice to determine with fair accuracy the point of occlusion. If the artery is exposed by incision at the suspected point and found to be pulseless throughout the length of the incision the artery should not be opened in this situation to determine whether it is empty or not (palpation suffices for that) or to permit the passage of probes or catheters, both of which are dangerous in that they injure the delicate lining membrane of the artery; but the vessel should be followed by lengthening the incision in the overlying tissues, or by making another incision, until a point is found above which there is active pulsation. The artery may then be incised, evacuated, and, with due regard to the rules laid down for angeiorrhaphy, sutured.

Arteriotomy for embolism, despite its rational and seductive character, must, of necessity, be followed by many disappointing results. All of the patients thus far operated upon were suffering from cardiac disease, most had atheromatous arteries, and in at least five cases there were evidences of previous embolism of arteries other than the one operated upon. Because of this tendency to embolic showers one can never be sure that the embolus that he is extracting is the last one to be thrown into the circulation. Notwithstanding these gloomy reflections we believe that, in view of the five cases in which undoubted

benefit has followed evacuatory arteriotomy, the procedure has attained a permanent place in operative surgery, and should be resorted to more frequently in the future with increasingly beneficent results. Aside from the technic necessary for successful angeiorrhaphy, and in addition to an early accurate diagnosis followed by immediate operation, the best results after embolectomy are likely to be obtained in a young patient with young arteries and a strong heart. Further, since obstruction is, generally speaking, more dangerous in a large than in a small artery, and since operation is easier upon a large than upon a small one, the greater the size of the affected vessel the more gratifying the results.

Arteriotomy for thrombosis was performed first by Lejars in 1902. His patient, a man aged twenty-six years, developed thrombosis of the femoral artery and gangrene of the foot following a severe contusion of the left inguinal region. Six days after the accident the artery was opened, a thrombus removed, and the artery sutured. Thrombosis recurred, and the leg was amputated below the knee. In 1905 we attempted a similar operation on the femoral artery with a similar result, as will be related in the next section of this article. In 1908 Lecène, and in 1909 Ranzi, each opened the brachial artery, the former for so-called spontaneous thrombosis in a tuberculous subject, the latter for traumatic thrombosis; in each instance the thrombosis recurred.

The results in these cases, with the knowledge of the lesions occurring in traumatic and "spontaneous" thrombosis, force us to the conclusion that simple removal of the thrombus is useless, or worse than useless. The cause of the thrombosis, *i.e.*, multiple fissures in or curling up of the intima (following a contusion) or endarteritis, is not suppressed; indeed, in view of the additional injury perpetrated by arteriotomy, the conditions are rendered more favorable for coagulation in the vessel.

4. *Resection* of a contused and thrombosed segment of an artery, followed by end-to-end union, would, if the vessel were healthy, offer as fair a chance for re-establishment of the circulation as circular arteriorrhaphy for accidental wounds, which operation we have on several occasions performed with success. Unfortunately, in many of the cases designated traumatic thrombosis injury is only one, and not always the chief, contributing factor; in these cases the artery is already diseased, and suffers obliteration from a contusion that might have failed to rupture the intima of a normal artery. Our only experience with resection for traumatic thrombosis was obtained in June, 1905, and related in this Academy in May, 1907.

The patient was a man, aged sixty years, with mitral regurgitation and advanced atheroma. Twelve hours after a contusion of the left inguinal region he complained of severe pain, first in the popliteal space and later radiating down the leg to the foot and toes, which pain was followed by the prodromal symptoms of gangrene. The femoral artery could not be palpated because of the swelling consequent upon the contusion. Owing to this fact, to the absence of ischæmia in the thigh, and to the seat of the initial pain, we made the mistake to which we called attention in an earlier paragraph, and concluded that a large clot embolus had been swept from the point of injury and lodged at the bifurcation of the popliteal artery; consequently about 24 hours after the injury we opened the popliteal artery and, finding no clot, passed a probe gently up into the vessel for about six inches, without encountering any obstruction, thus committing, according to our present ideas, two more mistakes, *i.e.*, opening an empty artery to see if it were empty, and extending the injury to the intima by probing the superjacent segment. After suturing the popliteal artery, the femoral artery was opened and the thrombus removed. It was then found that, like a valve, a calcified portion of the intima had been turned into the lumen of the vessel, probably occluding it one-half. The atheromatous plate was removed and the artery sutured. As pulsation below the injured point ceased almost immediately the arterial sutures were removed, the new thrombus extracted, and the artery resutured. After a brief period the thrombosis recurred. The injured portion of the artery was therefore excised and an end-to-end anastomosis performed. This likewise failed to reestablish the circulation and the gangrene progressed rapidly, finally necessitating amputation through the thigh. The patient recovered.

The only hope of success in arterial resection for "spontaneous" thrombosis would be in a case in which the causative lesion is a narrowly limited band of endarteritis; in all other instances of "spontaneous" thrombosis the tendency to coagulation would only be accentuated by contact of the blood with an arterial wound.

The amount of artery that may be excised, without rendering circular arteriorrhaphy impossible of execution, varies somewhat with the situation; in the neighborhood of joints, flexion of the limb can be utilized to diminish tension on the anastomotic suture; in regions in which the artery is bound to the surrounding tissues by branches anastomosis, after the removal of a large extent of artery, would be impracticable without severing these branches, an expedient that would generally be contra-indicated. Enderlen was able to approximate the ends of the popliteal artery after resecting 4 cm. for aneurism; Kümmel, the ends of the femoral artery after resecting 5 cm. during the excision of a carcinoma of the inguinal region.

The length of the resected segment could be greatly extended if, instead of directly uniting the ends of the artery, a section of another vessel were interposed between these ends. Since to repair a large artery by sacrificing another artery of equal size would, even is success-

ful, simply transfer the danger of ischæmia from one part of the patient to another, or, if an obliging friend or relative would surrender the needed bit of vessel, from one individual to another, an arterial graft would necessarily have to be taken from a fresh cadaver or from one of the lower animals. So far as we are aware only one attempt, which failed, has been made to transplant a segment of artery from a fresh cadaver to a living individual, and that by Delbet, who thus filled a gap between the ends of the femoral artery, after the excision of an aneurism. Owing to the cytolytic effect of the blood and the body juices on alien tissue, homoplastic transplantation, particularly from a cadaver, and heteroplastic transplantation would seem to be of little promise in vascular surgery, in which even slight degenerative changes in the vessel wall are sufficient to induce thrombosis.

Whether autoplasmic venous transplantation, which at once suggests itself as a simple method for overcoming the difficulties mentioned above, will prove reliable or not can be determined only by the results which future trials may bring to light. At the present time, however, the remarkable and stimulating experiments of Carrell, and the favorable clinical reports of venous grafting for conditions other than vascular obstruction, encourage the hope that a portion of a vein might be induced to functionate permanently for a thrombosed segment of an artery. In 8 of the 13 cases thus far published (Goyanes, Omi 2, Tuffier, Pringle 2, Mantelli, Lexer 2, Goecke, Krause, Enderlen, Pirovano), in which a venous graft was employed to replace a corresponding extent of artery (popliteal, femoral, brachial, axillary) that had been excised for aneurism or malignant disease, the immediate results were satisfactory (Moure).

Which vein should be chosen for transplantation depends upon the artery involved. If the artery has two *venæ comites* one of these could be selected. If there is only one venous satellite it should, as a rule, be spared, because in the event of failure both artery and vein would be obstructed. If the companion vein must be preserved the surgeon might employ a vein which does not accompany an artery, *e.g.*, the saphenous or the external jugular, or one of the *venæ comites* of an artery other than that affected.

It should not be forgotten that a venous transplant containing valves must be placed in such a way that the valves will not interfere with the passage of blood through the transplant. Another matter, to which attention should perhaps be directed, is the support of the walls of the transplant. Under the impact of the arterial stream the grafted vein dilates to twice the size of the artery, thus causing the blood to

swirl in eddies and, as in aneurism, predisposing to thrombosis. Efforts have been made to prevent this dilatation by turning the vein back on itself, like a cuff, and by suturing the surrounding tissues over it. We suggest a third method, which might be employed in suitable cases of thrombosis. Since in many instances of intravascular coagulation the intima alone is at fault, it has occurred to us that, instead of resecting the artery, its internal coat might be peeled out, and replaced by a piece of vein. This would leave the outer coats of the artery as a firm support for the vein, and the vein would form a new lining membrane for the artery. In some cases of traumatic thrombosis it would probably not be necessary to remove even the tunica intima before placing the vein in position.

5. *Catheterization* of the arteries of a stump left after amputation for arteriosclerotic gangrene, in order to remove clots and thus minimize the risk of necrosis of the flaps, was suggested by Severeanu in 1894. As the passage of catheters and probes into an artery can serve only to injure its delicate endothelial lining and encourage thrombosis, we believe the procedure to be harmful rather than beneficial.

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STATED MEETING, FEBRUARY 1, 1915

The President, DR. JOHN H. GIBBON, in the Chair

INGUINAL LYMPHOMA

DR. D. L. DESPARD presented a man who had been operated on at the Jefferson Hospital for enlarged inguinal glands. The glands on the left side, smaller than those on the right, were not removed; the largest of the glands of the right side measured, three or four days after removal, 4 cm. in diameter. Microscopic examination showed simple hyperplasia of the lymphatic glands, without increase in the fibrous tissue and no evidence of eosinophiles except here and there; nothing to suggest sarcoma or Hodgkin's disease. The cells had the appearance of ordinary lymph cells. History was practically negative. There was no venereal history; Wassermann, negative. He had, however, a leucocyte count of 12,000. The red cells were increased in number to 6,200,000. Beyond this the blood picture presented nothing unusual. The differential count showed polymorphonuclear cells of 66 or 67 per cent., in other respects it was practically normal. The reporter said that he had never seen an ordinary hyperplasia in which the glands were as large as those on the right side in this case. The question is whether this is an incipient Hodgkin's disease or a pre-sarcomatous condition.

DR. JOHN H. JOPSON said that this case is similar to one in which he had operated for polyglandular enlargement of one side of the neck. Some of the glands were found to be broken down at the time of operation, and the appearance seemed to disprove the possibility of Hodgkin's disease or sarcoma. Pathologists in two laboratories reported the condition tuberculous. There was local recurrence and a second operation was done some months later. This time the glands were examined by Dr. Canby Robinson who reported typical Hodgkin's disease.

OPERATION FOR OLD FRACTURE OF THE PATELLA

DR. JOHN H. JOPSON presented a woman thirty-nine years of age, weighing over 200 pounds, who fell in 1912 and fractured her left patella. She was treated by another surgeon without operation, some form of an extension apparatus being applied to the muscles of the thigh to aid in bringing about apposition of the patellar fragments. She was in bed for two months; there was marked stiffness of the knee following the removal of the apparatus. Four months after the original accident, the fragments became separated during passive