bulb; in such a case it would necessarily be wounded in the operation of lithotomy. It may arise from the accessory pudic; when this happens it would be placed well in front of the usual incision for lithotomy.

The *dorsal artery of the penis* has in some cases been seen to arise from the obturator artery near the thyroid foramen, from the external pudic of the femoral, and from the deep femoral. In the first case it would be in danger of being wounded in lithotomy. The two arteries

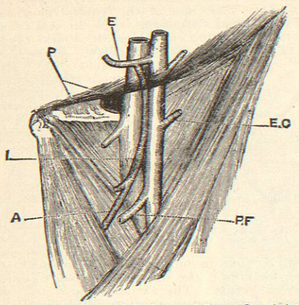

FIG. 311.—Abnormal Origin of the Internal Circumflex Artery (I): E, epigastric artery; PF, profunda femoris.

of the penis sometimes unite to form a single trunk, or are united by transverse branches. Mr. Spence has described a large prostatic artery which gained the perineal surface of the prostate without dividing into minute branches. Wounds of the prostatic arteries have led to fatal hemorrhage in cases of lateral lithotomy.

The *sciatic artery* is sometimes replaced by a branch from the gluteal. In a few cases this artery has been seen of large size, taking the place of the femoral (see under Variations of Femoral). There is sometimes a large comes nervi ischiatici artery. The gluteal artery has been reported as absent (Roberts), its place being taken by a large branch from the femoral, passing outward and backward to the gluteal region.

EXTERNAL ILIAC ARTERIES.—The length of these arteries varies according to the point at which the common iliacs bifurcate; they usually measure 7.50 cm. (three inches) to 10 cm. (four inches) in length. In those rare cases in which the main artery of the limb is a continuation of the sciatic, it is much reduced in size.

Epigastric Artery.—May arise at a higher point than usual. R. Quain reports it in one case 6.4 cm. (two and a half inches) above Poupart's ligament. It arises from the femoral in about one case in twenty. The usual place of origin is close to or opposite Poupart's ligament. It may, in rare cases, arise from the deep femoral.

The origin of the obturator from the epigastric has already been noticed. In a few cases the epigastric has been seen coming from the obturator when that vessel is a branch of the internal iliac.

I have, in four instances, seen the epigastric arise in common with the internal circumflex artery of the deep femoral. In three of the cases the common stem arose from the femoral 2 cm. below Poupart's ligament; in the fourth, 2 cm. above the ligament. In the last-named case the internal circumflex passed beneath Poupart's ligament in the same compartment of the femoral sheath as the artery, and continued down the thigh about 5 cm., lying between the artery and vein; it ended, after giving off a large branch to the adductor muscles, as the internal circumflex proper (Fig. 311). A similar anomaly has been observed by Mr. A. Thompson (*Journal Anat. and Phys.*, April, 1883), but in the cases described by him the artery passed internal to the femoral vein, and would, he thinks, have been wounded in the operation for relieving strangulated femoral hernia. A similar arrangement of vessels exists normally in the American black bear. I have met with four cases in which the obturator, epigastric, and internal circumflex arose by a common stem, two below Poupart's ligament and two above.

Circumflex Iliac Artery.—The origin of this artery is sometimes from the femoral. It is occasionally double.

FEMORAL ARTERY.—The femoral artery has, in some rare cases, been found of small size, and terminating near the knee joint. When such a condition exists, the main artery of the limb is furnished by a branch from the internal iliac, generally the sciatic (Fig. 312), which is much enlarged, and accompanies the sciatic nerve to the popliteal space, whence the course of the artery is the same as if the distribution had been normal. This is the usual arrangement in birds.

Cases have been reported in which the femoral divided into two portions, which united below to form again a single vessel. Sir Charles Bell, when ligaturing the femoral for popliteal aneurism, met with this anomaly.

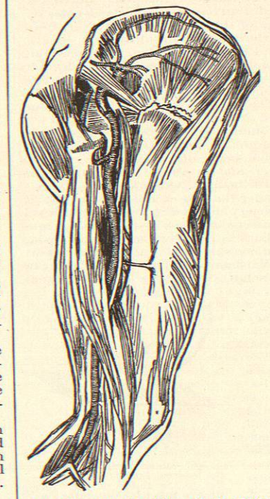

FIG. 312.—Posterior View of the Right Thigh. The ischiatic artery much enlarged, accompanying the sciatic nerve, and taking the place of the femoral artery. (After Dubreuil.)

FIG. 313.—Bell's Case of Double Femoral Artery. Showing ligature of one of the trunks and the aneurismal tumor below. (After Bell, from *London Medical Gazette.*)

Though the ligation of the femoral did not arrest the pulsation in the aneurism, the cause was not recognized till after the death of the patient, when it was found that the femoral was double, and only one of its divisions had been ligatured (London *Med. and Phys. Jour.*, vol. lvi., 1826). (See Fig. 313.) Tiedemann, Houston, Dubreuil, Tyrrell, and Quain also report cases. Mr. H. A. Kelly (*American Journal of the Medical Sciences*, January, 1882) reports three cases (one of which is doubtful), met with in the dissecting rooms in Philadelphia. In two of these cases the artery divided below the profunda, and reunited just above the opening in the adductor magnus.

The division has been seen above the origin of the profunda.

The two femorals, when this arrangement occurs, run down the thigh, side by side, in separate fibrous sheaths, so that in cutting down on one the other would not be seen.

I have occasionally seen, in cases of high origin of the profunda, the latter artery quite as large as the superficial femoral, and running down the thigh parallel to it, beyond the apex of Scarpa's triangle. In such a case it would be difficult, in the living, to distinguish between the vessels, should ligature of the femoral be necessary. As a rule, the profunda lies to the outer side. The appearance of the above-described condition in Scarpa's triangle is very similar to those cases figured as double femoral, and I imagine that the cases of double femoral reported as seen in amputating the thigh are only cases of large profunda arteries, especially as the disposition of the vessels below the amputated point is not described.

The *profunda*, or deep femoral artery, may be given off from the inner side of the main trunk, or even in some cases from the back part of the vessel. It may arise above Poupart's ligament, or as much as 10 cm. (four inches) below it. It not uncommonly arises 1.2 cm. (half an inch) below the ligament. When it is given off low down, one or both circumflex arteries arise from the femoral. The deep femoral has been occasionally altogether wanting, its branches arising separately from the main artery.

The *external circumflex artery* not infrequently arises directly from the common femoral. It may be represented by two branches, and even three, which arise from the femoral or profunda—I have seen it arise in common with the internal circumflex. The *internal circumflex artery* also frequently arises directly from the femoral. It occasionally arises in common with the deep epigastric, and passes down to the thigh in the same sheath as the femoral vessel. This variety I have described under the Epigastric. It may arise with the epigastric from the femoral artery before the profunda is given off, and in some cases might be injured in the operation for strangulated femoral hernia. I have twice seen it arise with the obturator and epigastric from a common stem.

Unusual branches are, in rare cases, given off from the femoral. I once saw the dorsal artery of the penis given off from the common femoral, cross the thigh at right angles, and reach the dorsum of the penis by piercing the deeper scrotal tissue.

A large saphenous artery has been found which accompanied the great saphenous vein. It may arise above or below the profunda, course down the thigh between the adductor magnus and internal vastus, and pierce the deep fascia of the thigh on the inner side of the knee joint, where it reaches the internal saphenous vein and accompanies it to the internal malleolus. This arrangement is the normal one in the rabbit and in some other mammals.

I once saw this branch, after reaching the inner side of the knee, wind round to the front of the joint, below the patella, and divide into a cutaneous branch and a branch which pierced the ligamentum patellæ to supply the interior of the joint.

POPLITEAL ARTERY.—This artery is not subject to many variations. The chief deviation from the normal disposition consists in a high division of its terminal branches. I saw this only twice in 250 subjects: in both, the artery divided immediately above the upper edge of the posterior ligament of the knee joint. In 227 subjects Quain found a high division in 10. Portal reports a case of low division of the popliteal, the artery dividing about the middle of the leg into anterior and posterior tibial. In some cases of high division, the peroneal artery arises from the anterior tibial; this was the arrangement in one of my cases. The artery and vein, usually so constant in their relation, may, in rare cases, change places. When there is a third head to the gastrocnemius muscle it usually passes between the artery and the vein. Ward Collins has seen the popliteal artery dividing in the upper part of the popliteal space into two branches which united again below after a separate course of two inches.

Cases are reported (Otto) of branches from the popliteal proceeding upward along the semimembranosus muscle, and ending in one of the perforating arteries of the profunda. Also an aberrant artery is described as being given off above the knee joint, and joining the popliteal before its division (Hyrtl). A small saphenous artery has been seen which accompanies the short saphenous vein behind the external malleolus and anastomoses with one of the tarsal branches (Hyrtl). The azygos artery may be given off from one of the articular arteries. I once saw a common trunk give off the two superior articular arteries and the azygos. One or other of the articular branches may be absent, their place being supplied by an enlargement of the remaining arteries.

Posterior Tibial.—In cases of high division of the popliteal the tibial is larger than usual. It may be increased or diminished in size. When increased, it partly takes the place of the peroneal or anterior tibial, and when diminished, it may be reinforced by transverse branches from the peroneal near the ankle. The posterior tibial may be of very small size and end near the middle of the leg, its place being taken by a large peroneal artery which furnishes the plantar arteries. In a lesser degree of diminution of the posterior tibial, the anterior tibial, or rather its dorsalis pedis branch, furnishes the arteries which form the plantar arch and its branches. In these cases the external plantar artery ends near the accessorius muscle. I have several times seen a muscular slip (flexor accessorius), which arose from the lower end of the fibula, or more commonly from the tibia, cross the tibial vessels behind the internal malleolus. The nerve is occasionally placed to the inner side of the artery, at the lower part of the leg.

Peroneal Artery.—This artery, as described above, may take the place of the posterior tibial, or it may be of small size, and its place be supplied by a branch of the posterior tibial. The anterior peroneal branch may be of large size, and may take the place of the lower part of the anterior tibial, furnishing the arteries supplying the dorsum of the foot.

In cases of high division of the popliteal, the peroneal artery generally arises from the anterior tibial. It also arises in the same way, occasionally, when no high division takes place. I have seen it furnish a large internal calcanean branch as well as an external. An accessory peroneal sometimes exists.

The *internal plantar artery* is sometimes of very small size, ending in the flexor brevis pollicis muscle, or it may be of large size, and furnish digital branches to the great and second toes.

The *external plantar* is occasionally very small, ending in the accessorius muscle; when such a condition exists the dorsalis pedis artery furnishes the deep plantar arch and digital branches. I have several times seen this anomaly. The artery is occasionally of large size, and partly takes the place of the dorsalis pedis branch of the anterior tibial. The digital arteries of two toes, generally the second and third, not infrequently come from a common stem. The deep arch is, in rare cases, double.

Anterior Tibial Artery.—In some cases this artery is given off from the posterior tibial in the middle of the leg. When there is a high division of the popliteal it may give off the peroneal, and may pass beneath the popliteus muscle. In the leg it may be subcutaneous, its pulsations being easily felt under the skin. Velpeau reports a case in which this artery did not pierce the interosseous membrane, but passed to the front of the leg round the fibula with the musculo-cutaneous nerve. It may be altogether wanting, its place being supplied by perforating branches from the posterior tibial, or it may end in the muscles about the middle of the leg. When there is such a distribution the deficiency is made up by an enlarged anterior peroneal or plantar artery. It not infrequently fails to furnish digital branches, which, in

this event, come from the plantar arteries. The artery may be of larger size than usual, and may take the place of the peroneal artery in some cases, and of the plantar branches of the posterior tibial in others; the dorsalis pedis branch being of very large size, as mentioned in the description of the varieties of the posterior tibial. The dorsalis pedis artery sometimes ends in the neighborhood of the cuneiform bone. The anterior tibial, in some rare cases, gives off an anterior tibial recurrent to the knee joint. *Francis J. Shepherd.*

ARTERIES, COMPRESSION OF. — INDICATIONS. — Compression of arteries for the arrest and prevention of hemorrhage and for the cure of aneurism is a very old procedure, and one which, although in many instances superseded by ligation, made safe by the introduction of antiseptic surgery, is still employed to a considerable extent, particularly in the prevention of hemorrhage. Compression of the carotids, thereby lessening the blood supply to the brain, has been recommended and practised at different periods in the treatment of epileptic convulsions, maniacal excitement, congestive headache, and for the purpose of producing sleep. Dr. Corning, of New York, in 1882, strongly urged the advantages of this procedure and devised a special instrument for the compression of the carotids.

MEANS.—Compression is accomplished either by means of the hand or by some mechanical device. Digital compression may be either direct or indirect, that is, in the wound or over the vessel of supply, and may be employed for the immediate arrest of existing hemorrhage or for the prevention of hemorrhage during an operation. This means is occasionally still used in the treatment of aneurism, but has largely been superseded by the ligature, and by the combined use of gold or silver wire and electricity. For the instant arrest of bleeding nothing is more readily and satisfactorily employed than the fingers, placed either directly in the wound or over the arterial trunk supplying it. The greatest disadvantage of the method is that it is impossible to keep it up for a great length of time without the help of a number of intelligent assistants. There are two ways of applying digital compression, one by pressing the vessel between the fingers and a bone, the other by compressing it between the forefinger and the thumb. The former method is more satisfactory, because it can be kept up for a much longer period of time. When a change of hands is made the fresh hand should always be placed above the point of former compression before the first hand is removed. Digital compression can much more readily be employed when a wound has been made, thus exposing the vessel, than when it is attempted with considerable tissue intervening between the finger and the vessel, as, for instance, in compression of the abdominal aorta.

Innumerable forms of compression apparatus have been invented for compressing blood-vessels, one of the oldest and most universally used being the tourniquet of

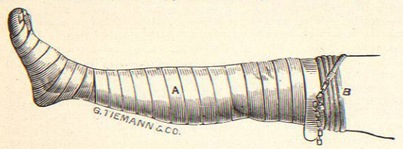

FIG. 314.—Esmarch's Elastic Compressor.

Petit (Fig. 120), which consists of two metal plates, connected by a spiral screw, whereby they may be separated, and a strap which buckles around the limb. In the use of this tourniquet many surgeons apply a roller bandage over the vessel to be compressed and buckle the strap over this. The separation of the plates by the screw tightens the strap and increases the pressure. In order to prevent the strap from cutting the skin it is well to apply first a turn or two of muslin bandage about the part. In an emergency, when a tourniquet cannot be had, a fillet may be employed by passing a handkerchief or piece of cloth or cord about the limb and then tightening it by twisting it with a piece of wooden stick. The most generally used means of compression to-day is the Esmarch bandage and tube (Fig. 314). The bandage is an ordinary rubber roller applied from the tip of the extremity up to the point where it is desired to place the tube, and its object is the saving of the blood in the extremity, in case of amputation, and the freeing of the limb of blood when any operation is to be done upon it. The tube is of rubber, flat, and about one inch wide. This is passed tightly about the limb and fastened by a hook at one end of the tube and a chain at the other. Certain precautions must be observed in the use of this form of compression. One is to move the part as little as possible after the tube is applied, as tearing of the tightly bound-down muscles may occur, and another is to see that each turn of the bandage and tube overlaps the preceding, else pinching of the skin occurs. When a limb is diseased, compression with the bandage is not to be made over the diseased area, but it is to be applied above and below it, or else it is not to be used at all, but the limb is simply to be elevated for a time, after which the tube alone is to be used. This method of elastic constriction has the great advantages of simplicity and cleanliness over other forms of mechanical compression.

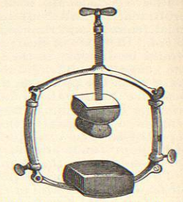

FIG. 315.—Skey's Arterial Compressor.

Other forms of compression apparatus are so constructed that the pressure is exerted over the main artery without constricting the surrounding tissue. These forms are specially advantageous in the treatment of aneurism, for they are much less likely to cause gangrene, which is so apt to follow the prolonged use of the two forms of compression above described. Esmarch's elastic compressorium for the aorta and Skey's compressor (Fig. 315) illustrate this point.

About ten years ago Dr. Wyeth, of New York, introduced a new method of compressing the vessels of the thigh in hip-joint amputation. This method (see Figs. 191, 192, on page 265), which is a combination of the older methods of Trendelenberg and Dieffenbach, consists in passing through the muscular tissue and skin above the point of amputation two long steel mattress needles, and then applying above them the constricting band of Esmarch. This method is also used in amputation at the shoulder joint and has done a great deal to reduce the mortality of these operations, in which the loss of blood had formerly been so great. It must not be forgotten that all forms of compression, if kept up for a great length of time or if the pressure is too great, may be productive of destruction of tissue at the point of application or of gangrene in parts below. Also it must be remembered that after circular constriction of an extremity reactionary hemorrhage may occur, and hence it is necessary to tie all bleeding points before closure of the wound.

SPECIAL ARTERIES.—The *aorta* cannot be compressed until it has passed through the diaphragm into the abdomen, and then only with difficulty, unless the abdomen be opened. Compression of the abdominal aorta is resorted to as a means of preventing severe hemorrhage from its distributing branches or for the purpose of temporarily arresting the circulation in them: for example, in a hip-joint amputation, or in an attempt to cure an aneurism. It can be satisfactorily accomplished without abdominal section in thin persons, but in those with thick abdominal walls it is very difficult of accomplishment. As to the precise mode of effecting the desired pressure, one may employ an Esmarch's elastic compressor or that of Skey,

both of which are shown in the illustrations (Figs. 314, 315), or the hand of an assistant may be employed. All of these methods are open to objections: they may cause an injury to the overlying intestine—and this is more likely to happen when an apparatus is used—or the compression may prove to be inefficient, as when the instrument is not properly applied, or when it slips, or when the assistant's hand moves to one side of the artery. The usual position for the compression pad or the hand is just below the umbilicus and a little to the left; but the pulsation of the vessel must be definitely felt before compression is applied, and after the application of compression no operation should be done until all pulsation has ceased in vessels below. There will be less danger of injuring the intestinal canal if it be first emptied by means of a cathartic or an enema; and before applying the pad, the bowels should be pushed to the right side of the abdomen by rolling the patient on that side. When the abdomen is opened compression of the aorta is rendered easier and safer; it may be accomplished with the

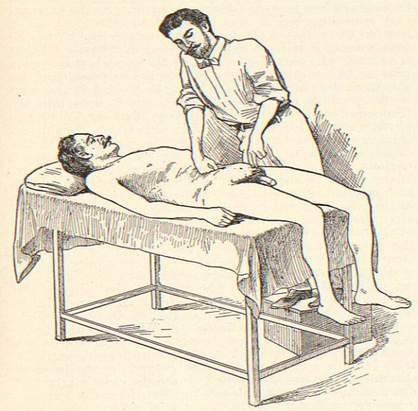

FIG. 316.—Compression of the Aorta. (Dr. W. W. Keen.) Right hand closed, a little to the left of the median line; knuckles of index finger just touching the upper border of the umbilicus; left hand feels patient's pulse (femoral) at brim of pelvis.

fingers or with a specially devised clamp consisting of two blades, one of which fits into the other somewhat after the style of a lithotrite. Great care should be exercised in the use of such an instrument or an injury may be done to the vessel itself or its neighbors.

The *common iliac* may be compressed through the abdominal wall, through the rectum, or through an incision in the abdominal wall. The last method, which enables one to use the fingers, is by far the most satisfactory of the three and the only one that has been practised with anything like good results. It has become now one of the recognized means of preventing hemorrhage in hip-joint amputation, particularly in those cases in which, because of diseased anterior flap, the Wyeth pins cannot be used. Dr. Charles McBurney first employed this method of preventing hemorrhage in 1894. Experience has shown that the common iliac can very readily be compressed with the fingers in the abdominal cavity without the exertion of much force and without increasing the dangers of the operation. Compression through the rectum by means of Davy's lever is not so safe or so satisfactory as are the other methods.

External Iliac.—This vessel can be compressed with the fingers or with an instrument placed just above Poupart's ligament, midway between the symphysis pubis and the anterior superior spine of the ilium.

Femoral.—The course of this vessel is covered by a line drawn from the point midway between the symphysis pubis and the anterior superior spine of the ilium to the adductor tubercle on the inner condyle of the femur, and can be compressed by the fingers or by the tourniquet anywhere throughout its course, the force being exerted toward the bone.

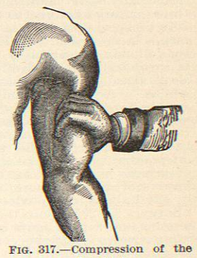

FIG. 317.—Compression of the Brachial.

The *popliteal* occupies the middle of the popliteal space; it can best be compressed against the femur in the upper part of its course.

The *posterior tibial* can readily be compressed by the finger as it passes midway between the internal malleolus and the point of the heel.

The *anterior tibial* lies between the tendons of the tibialis anticus and the extensor longus hallucis, and can best be compressed after it becomes the dorsalis pedis and passes under the annular ligament.

The *subclavian* can only be compressed, unless exposed by incision, in its last one-third, where it crosses the first rib. Pressure should be made with the thumb in the angle formed by the posterior border of the sterno-cleido-mastoid and the clavicle, and should be directed downward, backward, and inward against the rib. The tip of the shoulder should be depressed.

Axillary.—Compression of this vessel can be made only in the last part of its course, and is accomplished by making pressure from within outward against the upper part of the humerus.

The *brachial* artery can very readily be compressed against the shaft of the humerus, the inner edge of the biceps being the guide to its situation.

FIG. 318.—Compression of the Femoral.

The *radial* can be compressed against the anterior surface of the lower end of the radius between the tendons of the supinator longus and the flexor carpi radialis.

The *ulnar* artery can be compressed against the anterior surface of the ulna between the flexor carpi ulnaris and the flexor sublimis digitorum.

The *common carotid* and the *external carotid* can be compressed with the fingers or by means of one of the instruments specially devised for the purpose. The anterior border of the sterno-cleido-mastoid is the guide to the vessels, and the pressure should be directed backward and inward.

The *facial* can be compressed with ease as it passes over the lower jaw just in front of the masseter muscle.

The *temporal* may be controlled by making pressure on the zygomatic process just in front of the tragus.

The *labial* artery may be controlled by compressing the lips between the finger and thumb.

John H. Gibbon.