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of hemorrhage and for the cure of aneurism is a very old procedure, and one which, although in many instances superseded by ligation, made safe by the introduction of antiseptic surgery, is still employed to a considerable extent, particularly in the prevention of hemorrhage.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 This means is occasionally still used in the treatment of aneurism, but has largely been superseded by the ligature, and by the combined use of gold or silver wire and electricity.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

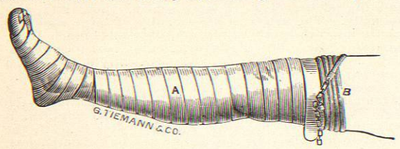

FIG. 314.—Esmarch's Elastic Compressor.

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.

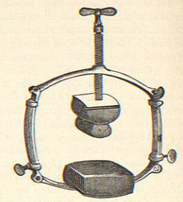

FIG. 315.—Skey's Arterial Compressor.

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

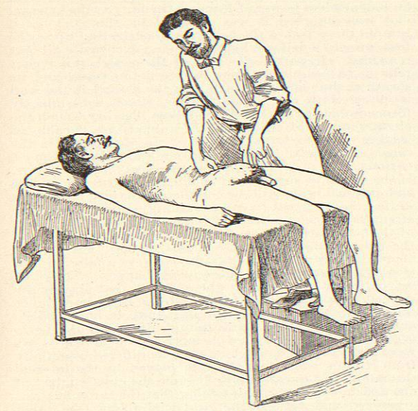

FIG. 316.—Compression of the Aorta. (Dr. W. W. Keen.) Right hand closed, a little to the left of the median line; knuckles of index finger just touching the upper border of the umbilicus; left hand feels patient's pulse (femoral) at brim of pelvis.

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.

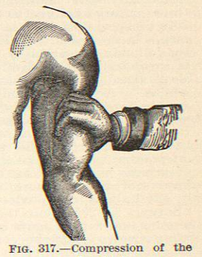

FIG. 317.—Compression of the Brachial.

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.