quantity of discs which normally passes from the ampullæ into the pulp spaces is increased while a share of the blood still passes over into the veins, just as is the case in the intestine when infarction is taking place after ligature of the superior mesenteric artery. With the spleen pulse present, however, the constant pressure upon the pulp produced by the elasticity of the connective tissues and the tone of the muscle are sufficient to drive the blood discs through the channels of the least resistance, as is the case when a distended spleen is injected (Fig. 4467).

The balance between the arterial pulse, ampullæ, and spleen pulse is so delicate that when it is proper the blood discs will "creep single file" over into the vein, while the least overthrow of it will drag an increased number of corpuscles with the normal flow of plasma over into the pulp spaces to make a pathological condition—hemorrhagic infarction.

The Nerves of the Spleen.—The nerves of the spleen accompany the artery and are composed mostly of non-medullated fibres.[14] It is quite easy to separate them by the ordinary methods of dissection and to follow them far into the spleen. With the aid of the dissecting microscope Kölliker was able to follow them to the Malpighian corpuscles, while with the aid of Golgi's method Retzius followed them to their terminations in the spleen substance. Rich plexuses of fine nerves surround all of the arteries which supply the muscle fibres of the media. A second group of nerves go to the muscle fibres of the trabeculæ. This distribution explains the physiological experiments: (1) Irritation of the splenic artery causes contraction of the whole spleen; and (2) cutting these nerves causes paralysis of these muscles followed by hyperæmia and hemorrhagic infarction. According to Kölliker the presence of some medullated nerve fibres in the spleen accounts for the pain felt in this organ at times. It is impossible to determine with certainty by the method of Golgi whether or not the nerve fibres leave the trabeculæ and walls of the arteries to enter the substance of the pulp, for the precipitation of the silver often outlines the reticulum fibrils also.

The Spleen Pulp.—The red substance of the spleen, the true spleen pulp, is arranged in bands which anastomose in all planes, inasmuch as it fills all of the space between the capillary veins, similar to the arrangement between the cells and capillaries of the liver. The framework of the pulp is composed of reticulum, the nature of which has been already discussed. There appear to be some elastic fibres encircling the veins, and also within the Malpighian corpuscles, as is the case in all lymph glands.

The small mononuclear lymphocytes, which form the main mass of the Malpighian corpuscles, are found scattered throughout the pulp substance, except along the arteries, where they form a kind of a sheath to the outside of the muscle wall.

The large leucocytes are in general more numerous, and they are also numerous in the centres of Malpighian corpuscles. They are partly unicellular and partly multicellular, and in addition there are granular forms, some of which are intensely stained with eosin (eosinophile cells). The large brown cells (phagocytes) which contain much blood pigment must also be recorded with the leucocytes. They are found scattered in an irregular fashion throughout the pulp of the spleen. The contents of the phagocytes are also found free in the pulp. Red blood corpuscles lie scattered singly and in groups within the meshes of the reticulum of the pulp. As a rule giant cells and nucleated red blood cells are not found in the pulp of the adult spleen, but there are cells present which cannot for the present be arranged with certainty in the series of leucocytes or the series of erythrocytes. These cells are pretty large and have a very fine granular protoplasm which stains more intensely with eosin than does the protoplasm of leucocytes. The nucleus is round or oval, seldom constricted, and never lobulated, and often contains marked nucleoli. In preparations made from tissue hardened in sublimate the nuclei of these cells resemble those of the reticulum, but unlike them lie free within its meshes. Large giant cells, similar to those in bone marrow and in the liver of the embryo, are also found. Their nuclei are large and lobulated, or are pressed together into a heap. In order to differentiate them from the giant cells with many nuclei they are called megacarocytes. It has been found by Kölliker that they are present in the spleen of embryos and of young animals and occasionally in the spleen of the adult—the mouse for instance. There are also constantly present in the spleen of young animals very small granules which can be found in very large numbers in teased preparations. They resemble very much blood platelets, but are more resistant, for they can be preserved for a very long time in salt solution. They also have a tendency to take on irregular shapes and to form clumps.

The question is naturally asked, Is the spleen a blood-producing organ? The more the question is studied the less probable it becomes that the spleen plays any rôle in the production of blood. The coarse counts of the number of white and red cells in the artery and in the vein or the increased number of white cells in leucocythæmia are of little value when examined critically and experimentally. According to Ehrlich,[15] to whom we owe much regarding our knowledge of the blood, the leucocytes are greatly increased in number after extirpation of the spleen, which is accompanied with a marked hypertrophy of the lymph glands of the body. Extensive experiments were carried on in Ehrlich's laboratory by Kurloff, from which the following conclusion is drawn: That the spleen of the guinea-pig plays an insignificant rôle in the formation of the white blood corpuscles.

It is also very apparent that the relation of the spleen to the formation of red blood corpuscles varies much in different animals and at different periods in the development of the same animal. In lower vertebrates the spleen is a great factor in the production of red blood corpuscles. In mammals, however, it generally plays no rôle whatever in their production. Nucleated red corpuscles are found in relatively large numbers in the mouse's spleen; in smaller number in the spleen of the rabbit; in that of the dog during the anæmia following hemorrhage; and in the human spleen only during leukæmia.

It appears as if the spleen of higher animals is a place for the destruction of blood corpuscles, especially those which have been partly destroyed. So Ponfick has found that in the destruction of red corpuscles the spleen takes up a part of the "shadows" of the red cells and produces a spleen tumor, and Ehrlich has found that the enlarged spleen in many infectious diseases is produced by the products of disintegrated leucocytes which are there accumulated.

Franklin P. Mall.

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SPLEEN, DISEASES OF THE.—General Considerations.—Developmentally, the spleen belongs to the mesoblastic tissues. It is derived from the mesogastrium, and in its origin is closely related to the pancreas, but has none of the hypoblastic elements which enter into the formation of the latter. It first appears during the second month of fœtal life and develops slowly, so that it is not complete until nearly the end of that period.

Structurally, and, as will be seen later, to some extent physiologically, the spleen is closely allied to the lymphatic nodes or glands. The framework of the spleen is connective tissue, which is massed especially in the capsule, giving the general form of the organ; in the trabeculæ, which are processes running from the capsule into the substance of the viscus, and dividing it into smaller parts; and, finally, in a fine meshwork which fills these parts and divides them into minute spaces, the so-called pulp spaces of the organ. Connected with this fine connective-tissue meshwork are many stellate branching cells. The walls of the pulp spaces are lined with small or large endothelial cells. In the meshes of the connective tissue framework, that is in the pulp spaces, are great numbers of small round cells or lymphocytes. The blood supply is the splenic artery, whose main divisions run along the trabeculæ of the organ, then, subdividing into smaller branches, pass into the so-called pulp. Upon the walls of, or around, the smaller arterioles are clustered here and there masses of lymphoid cells which constitute the Malpighian bodies of the spleen. These bodies correspond in a general way with the lymph follicles of the lymph nodes, and the pulp spaces of the spleen correspond to the lymph sinuses of the nodes. The pulp spaces constitute the beginnings of the venous radicles of the organ, which gather up the blood to pass it on to the splenic vein. The nerves of the organ are derived from the cœliac plexus and the right vagus, and to some extent they accompany the branches of the splenic artery.

The size and weight of the spleen vary considerably even in conditions of health. During the first year of life it weighs from 15 to 20 gm., in adult life from 140 to 200 gm.

Anatomically the spleen stands in close contact with the stomach, and the blood supplies of the two are closely related. In some of its functions also it is associated with the stomach and liver. It is therefore not uncommon to find it classified as belonging to the digestive system.

From what has already been said with regard to the structure of the spleen, its close kinship to the lymphatic apparatus, and its anatomical relations to the digestive organs, we may expect that it will but rarely become the seat of primary disease, but that it will participate largely in systemic disorders and in local disturbances, especially those involving obstruction to the circulation in the portal system. In fact, apart from the extremely rare cases of primary malignant disease of the spleen, there are but two affections in which it appears to play the primary or chief rôle. These are the splenic form of leukæmia, and the disease or group of diseases which has lately been designated as splenic anæmia. It is, however, still an open question whether in either of these the rôle of the spleen is primary. We can only say that in some at least of the cases included in these categories such seems to be the case.

Abnormalities.—Absence of the spleen is met with in some cases of acephalic monsters and in premature fœtuses with imperfect development of the skull. Litten records two cases in which no spleen could be found in bodies otherwise perfect, but as one of them dates back to the sixteenth century, the condition must be an exceedingly rare one. Supernumerary spleens, on the other hand, are extremely common, being found in about one body in four. In number they vary from one or two up to forty. They are found near the hilus of the spleen, in the gastrosplenic omentum, in the great omentum, and even in the pancreas. In size they are usually small, 0.5 to 1 cm. in diameter, but they may reach considerable proportions. The absence of the usual symptoms after splenectomy in some instances has been explained on the basis of the presence of supernumerary organs.

A recent study by Parsons shows that there is great variation as to the number and arrangement of the notches and fissures of the spleen. On the anterior border he found that some spleens had no notch, while, when they were present, they varied from one to eight in number. About one-third of the specimens examined showed notches on the posterior border and one-fifth had fissures on the parietal surface.

Abnormal Placement.—Congenital abnormalities in the position of the spleen are observed in rare instances. The most interesting of these is the placement of the spleen in the right hypochondrium in cases of transposition of the viscera. The spleen may be found outside the usual limits of the abdomen in cases of large umbilical hernia, and has even been found in the left thorax in connection with defect of the diaphragm. Von Löwenwald records a case in which the spleen was found attached upon the spinal column.

Movable or Wandering Spleen.—The spleen is normally in position in the left hypochondrium, touching the ninth, tenth, and eleventh ribs, its long axis almost in the line of direction of the tenth rib, its upper and posterior end being about 2 cm. from the vertebral column and its anterior and lower extremity being about 3 cm. from the margin of the ribs in front. It is suspended by several folds of peritoneum, one passing from the greater curvature of the stomach to the hilus, another from the upper end of the spleen to the diaphragm, and a third from the diaphragm to the splenic flexure of the colon. The last of these suspends the spleen as in a sling and is its chief support.

The normal spleen enjoys a certain amount of mobility and may be depressed from above by effusions in the left thorax, emphysema, etc., or may be displaced upward by fluid in the abdomen or by distention of the colon with gas or fæces. In the condition of movable or wandering spleen, however, all the suspensory ligaments are lengthened or relaxed and the spleen is displaced downward into either the abdomen or the pelvis.

Etiology.—The condition may be one of the features of a general splanchnoptosis produced by trauma, such as sudden falls, or by lifting heavy weights, but is most commonly a result of the persistent dragging of an enlarged and heavy spleen upon its attachments, especially likely to be seen in such affections as malaria, leukæmia, or splenic anæmia.

Morbid Anatomy.—The spleen itself may present any one of the various types of chronic enlargement, or in rare instances it may be normal. The ligaments are all stretched, and with them the splenic artery and vein. The latter may be dilated to enormous size. The tail of the pancreas and the greater curvature of the stomach are dragged down with the spleen and deformity or dilatation of the latter organ may result. The pedicle of the spleen may become twisted upon itself with secondary atrophy of the organ, or even, in case of complete obstruction of the circulation, with gangrene.

Symptoms.—There may be no symptoms whatever, and the displaced viscus may be discovered by accident. There may be pain due to the weight and pressure of the spleen in an abnormal location, or dragging pain due to the stretching of the ligaments. In many instances the patients are neurasthenics and present characteristic symptoms of that disorder.

Diagnosis.—This rests upon two points: First, the recognition of a solid tumor in the abdomen or pelvis as the spleen; and, secondly, the demonstration of the absence of the spleen from its normal situation. The first is usually easy, if the possibility be present to the mind, the smooth, hard, rounded external surface, the sharp anterior border with its notch or notches, and the rounded ends being characteristic. The second point depends upon the absence of splenic dulness in the left hypochondrium. Litten suggests the observation of the colon when distended with fluid, and then again evacuated as an aid to diagnosis, but this is not usually required.

Treatment.—An abdominal bandage or binder may be sufficient to retain the spleen in its normal place; if not, operative measures are called for. A number of instances are on record of successful suturing of the spleen in its proper bed, but splenectomy seems to be the preferable operation.

Acute Hyperplasia of the Spleen; Acute Splenic Tumor; Acute Splenitis.—*Etiology.*—In all the acute

infectious diseases an acute enlargement of the spleen may be met with, especially in malaria, typhoid, pyæmia, pneumonia, and the exanthemata. The exact significance of this change in the spleen has not yet been clearly determined. That in all cases of bacterial invasion of the blood the spleen plays the part of a filter is well known, and also that even in cases in which the bacteria are but rarely found in the blood, such as typhoid fever, they nevertheless abound in the spleen. We also know that in these cases there is always a more or less active hæmolysis going on in the spleen. So much is clear. The interpretation of these facts and many kindred ones developed by experimentation has furnished a difficult problem. Metschnikoff and his followers regard the spleen as a centre for the manufacture of phagocytes, and therefore as an active agent in the protection of the body against microbic invasions. Extensive experiments have been conducted upon normal and splenectomized animals to test the part played by the spleen in this relation. The results of such investigations as those of Kanthack, Tizzoni and Cattani, Blumreich and Jacoby, have been entirely indecisive of this question. Jawein has recently published the results of a long series of experiments, from which he concludes that the essential function of the spleen is one of hæmolysis, that its enlargement in the acute infectious diseases is in exact proportion to the extent of the hæmolysis occurring in each particular case, and that in the cases in which no hæmolysis occurs there is no splenic enlargement. After full consideration of all these data Rolleston concludes that the spleen in fact is and behaves like a lymphatic gland broken up and embedded in erectile tissue. The Malpighian bodies and adenoid tissue play much the same part that lymphatic glands do elsewhere, while the open, loose, vascular tissue of the organ serves rather as a filter in which various bodies are deposited by the blood, perhaps to remain, perhaps to undergo subsequent changes.

Morbid Anatomy or Pathology.—The spleen is regularly swollen, the capsule stretched, and in many instances it shows patches of thickening. The organ is usually soft, but may be even firmer than normal. On section the pulp is usually found to be deep red and soft, or even diffluent. In some instances the Malpighian bodies show more prominently than usual and the cut section at first sight looks as though studded with miliary tubercles; in other cases these bodies are quite obscured by the swelling and congestion of the pulp. Microscopical examination shows the enlargement to be due to congestion and swelling of the pulp or the glomeruli or both, together with some increase in cells. The chief increase is in cells resembling those of the normal splenic pulp, but multiplication of the living cells of the pulp spaces may be observed, as well as large multinucleated or ovoid and polyhedral cells whose origin is not clear. In some instances small areas of softening, looking like small abscesses, are met with. These are the so-called focal necroses seen also in the liver, kidneys, and lymph nodes in various infectious disorders.

Symptoms.—Apart from the change in size this affection is usually devoid of symptoms. In some instances, however, it is attended with a sense of weight, or distinct pain, in the left hypochondrium, and the organ itself may be tender to pressure. The enlargement of the spleen is detected by palpation, as a rule; but in some instances the spleen may be enlarged and yet not be palpable. In such cases the results of percussion must be relied upon, but they are always very uncertain and often deceptive.

Treatment.—From what has been already said it is apparent that acute hyperplasia of the spleen is in itself a symptom of many disorders, not a primary disease. The treatment of the primary affection is all that is required.

Chronic Hyperplasia of the Spleen.—*Etiology.*—Chronic hyperplasia of the spleen, like the acute affection, is not a primary disorder but a symptom seen in a variety of affections,—congenital or acquired syphilis, rickets, prolonged fevers, especially typhoid,—and most of all, in chronic malaria and in leukæmia or pseudo-leukæmia. The enlargement observed in the affection known as splenic anæmia will be considered elsewhere.

Pathology.—As a rule the enlargement of the spleen in this condition is marked, amounting in some instances to an increase of ten or fifteen times the weight of the normal organ. The spleen may, however, be but little larger than normal. The enlargement is usually symmetrical, so that the organ preserves in general the normal outline, and the notches and fissures can be seen or felt. The organ is usually harder than normal, and the change of consistence may be very marked. The capsule may show some patches of thickening, or in many instances it is generally thickened and a chronic perisplenitis with adhesions to the surrounding parts, the diaphragm, abdominal wall, intestines, stomach, etc., is a feature of the condition. The appearances upon section vary greatly. As in acute hyperplasia, the Malpighian bodies may be lost in the swelling of the pulp, but more often they are notably enlarged and prominent. The color may be uniformly dark, deep brown, or even black, but is more frequently mottled, red, and gray. The trabeculæ may be thickened to such an extent that they are readily visible as bands of fibrous tissue running in from the capsule of the organ and interlacing in a complicated network. Pigment may be collected in such masses as to be visible.

The microscopical picture varies even more than the gross. The enlargement may be due to uniform hypertrophy of both the pulp and the reticular tissue, but in most cases the increase in fibrous tissue is the more striking feature of these cases. The trabeculæ may show extreme hypertrophy, and even the meshwork of the pulp may be greatly thickened. The glomeruli may in some cases be enlarged, while in others they are almost obliterated by the hyperplasia of the pulp cells and the connective tissue. The endothelial cells of the pulp spaces may show increase both in size and in number. Pigment is often found in the cells, either of pulp or glomeruli, and even in the connective-tissue reticulum. This pigment regularly gives the reaction for hæmosiderin, and is, therefore, probably a derivative of the hæmoglobin of the blood.

Symptoms.—The symptoms of chronic hyperplasia of the spleen are those of enlargement of the organ, or are disturbances secondary thereto.

A sense of weight or oppression in the left hypochondrium is most common; this rarely amounts to positive pain. By pressure upon the stomach nausea or vomiting may be induced, and in some instances vomiting of blood in considerable quantities occurs. Any of the abdominal viscera may be disturbed in function by the pressure of an enlarged spleen, and at least one case is on record in which the pressure upon the uterus resulted in hemorrhages, which were attributed to fibroid tumor of that viscus. The enlargement of the spleen may cause it to fill the left hypochondrium, or the whole left half of the abdomen, or even to pass over into the right half and occupy the right iliac fossa as well. As has been already noted, the enlargement is regularly symmetrical, the spleen maintaining its accustomed shape, the anterior edge being sharp and notched and the lower end rounded, so that it is easy to recognize the tumor as the spleen.

Treatment.—As with the acute enlargement, treatment must usually be directed to the underlying complaint—syphilis, rickets, malaria, or the blood diseases. By such means the enlargement may be reduced to some extent; but if true fibrous hyperplasia or hypertrophy has taken place, the organ cannot return to a normal size. Usually the improvement produced by medicinal treatment is slight. An abdominal belt, properly fitted, will sometimes relieve distress of an enlarged spleen by supporting it.

In the more serious cases splenectomy may be required, but it is astonishing how little disturbance patients may have from a spleen large enough to fill the whole left half of the abdomen, without any treatment.

Rupture of the Spleen.—*Etiology.*—Rupture of the

spleen is a rare occurrence. It may occur in a normal organ, but is relatively much more frequent in the enlarged spleen of malaria, typhoid, or the blood diseases. In the case of a normal spleen considerable violence to the abdomen is required to rupture the organ. It has occurred in cases of severe falls or blows upon the abdomen or of crushing of the body by great weight, such as the passage of a vehicle over it. In the case of an organ already enlarged by disease, rupture may occur spontaneouly or as the result of slight violence. The explanation of this fact is not difficult in view of the pathological changes. Rupture seems to be especially common in malarial spleens, and for this reason is much more frequently observed in the tropics than in the temperate zones. Playfair is said to have seen twenty cases of rupture of the spleen during two and a half years in the East Indies. In one case within the writer's knowledge the enlarged spleen of a primary splenomegaly (splenic anæmia) was ruptured by a slight fall upon the abdomen.

Pathology.—The spleen may be torn in various directions. There seems to be no rule as to the location or extent of the tears which are often multiple. Usually the capsule as well as the substance of the organ itself is torn, and the escaping blood is poured into the abdomen. The tear may be in the pulp alone, the capsule remaining intact, and the hemorrhage being into the organ itself. In case of extensive adhesions of the spleen to the neighboring viscera and parietes, the hemorrhage may be encapsulated and so prevented from entering the peritoneal cavity. Litten says that when the spleen is adherent to the stomach or intestines, rupture may occur in such a way that the blood is poured into one or both of these parts. Rupture of the spleen is frequently associated with rupture of other viscera, most often the liver.

Symptoms.—These are essentially those of any abdominal injury associated with internal hemorrhage. There is usually severe pain referred to the splenic region, then the symptoms of profuse hemorrhage—pallor, rapid and feeble pulse, air-hunger, faintness or unconsciousness, possibly vomiting, and in some instances convulsions. The diagnosis is not likely to be made until the abdomen is opened, unless the presence of an enlarged spleen has been previously known and the location or nature of the operative violence be such as to suggest the result.

Treatment.—The only treatment must be laparotomy with suture or packing of the wound in the organ, or splenectomy. In a case recently reported by Eisendrath, attempts to suture a rupture of the spleen failed because the sutures would not hold in the softened substance of the organ and splenectomy had to be performed. The accident is generally fatal, but a few instances of successful operation are on record.

Infarcts of the Spleen.—Infarction of the spleen may arise either by the plugging of a splenic artery by a thrombus derived from some other part of the body, or by a local thrombosis. The thrombi which are carried to the spleen by the circulation have their origin in almost all cases in an endocarditis affecting the left side of the heart and resulting in the formation of thrombi upon the diseased valves. In some instances atheroma of the aorta may be the underlying process. Litten mentions the possibility of air or fat emboli, derived in one case from the opening of a vein and in the other from a broken bone, passing the capillaries of the lung and ultimately lodging in the spleen; but such occurrences, though possible, must be rare indeed.

As a result of an endarteritis of a branch of a splenic artery or vein, thrombi may form in the spleen itself, and either block the vessel at their point of formation or be carried farther to act as emboli in some of the smaller branches of the artery.

Pathology.—As the result of the occlusion of a branch of the splenic artery we have the circulation cut off from the area supplied by the artery in question. The resulting infarct usually appears as a wedge-shaped area in the periphery of the spleen, the base often being on the surface of the organ, paler in color than normal, and surrounded by a deeper zone of hemorrhage. The paler color is due to the death of the cells of the infarcted area, which undergoes the process of degeneration commonly termed coagulation necrosis, and becomes the so-called white infarct. Later, the degenerated cells are absorbed or replaced by connective tissue, and only a scar is left to mark the site of the infarct.

It was formerly supposed that the whole infarcted area immediately after the arrest of the circulation became charged with blood by an inflow from the veins, and that this blood was later absorbed to give rise to the appearances of the white infarct, but Litten has proved this not to be the case.

The deep red granular infarctions in which the tissue is found infiltrated with red cells as in an apoplexy Litten finds to be produced most often by a thrombosis in one of the branches of the splenic vein. They, therefore, do not represent a stage in the life of the ordinary infarct, but a condition due to a somewhat different process. In either case the terminal condition remains the same.

The most important question from the clinical standpoint with respect to these infarcts is whether they are septic or aseptic. If aseptic, the process follows the course indicated above. If septic, in which case they have developed usually in the course of a pyæmia or a malignant endocarditis, the infarct undergoes suppuration and an abscess of the spleen results.

With either of these two forms there is usually associated more or less perisplenitis, the greater development of this feature being, of course, seen in the suppurative cases.

Symptoms.—Localized pain, sometimes quite sharp at the time of the lodgment of the thrombus, swelling of the spleen, and in some instances a localized friction rub to be heard over the spleen are the only symptoms of the condition.

Treatment.—There is no direct treatment of the condition, and, as a rule, none is required. The cases of suppuration will be considered under abscess.

Abscess of the Spleen.—The chief cause of abscess of the spleen, as indicated in the last section, is the lodgment of an infected thrombus, derived most often from an ulcerative endocarditis or from some pyæmic focus. Abscess of the spleen may, however, arise from the extension of a suppurative inflammation from some neighboring organ or from the perforation of a gastric ulcer. It is also met with, probably from the formation of infected thrombi, in cases of typhoid, typhus, and, most especially, recurrent or relapsing fever. Abscess of the spleen is also said to have developed in malarial fever; but if so, it must have been due to a secondary infection. Some cases of abscess have been attributed to injury, and in other cases no definite cause of the abscess formation could be disclosed.

Pathology.—The majority of the abscesses of the spleen are small. If multiple, they are scattered through the organ and the intervening tissue is but little changed. Larger abscesses may, however, form, and in some instances the organ is reduced to a sac of pus. Such an abscess has been known to rupture into the stomach, the colon, the peritoneal cavity, or through the diaphragm into the pleura; or, if the lung is adherent, even into the lung itself.

Symptoms.—Many of the smaller abscesses of the spleen, especially if deeply placed, run their course without definite symptoms. With the larger abscesses, particularly those on the surface, there may be pain and tenderness in the region of the spleen, enlargement of the organ, and the irregular or intermittent fever of septic conditions. If the abscess be very large, it is possible that fluctuation may be obtained. In doubtful cases exploratory puncture may be required, but it should be resorted to only in extreme cases. If the abscess rupture, symptoms will depend upon the course which the pus takes, that is, whether it enters the peritoneum or discharges into the stomach, colon, pleura, or lung.

Treatment.—Naturally the treatment of this condition is purely surgical. In rare instances repeated aspiration

has been successful. In the majority of cases incision and drainage are required. In some few cases splenectomy has been performed for this condition.

SPLENIC ANÆMIA.—Clinical interest in affections of the spleen at present centres in the question whether there is a definite symptom-group which can be denoted by the title splenic anæmia. After a thorough consideration of all the data obtainable Osler concludes that from among the conditions with which anæmia and enlarged spleen are associated a well-defined disease may be separated and may well be designated as chronic splenic anæmia. Various other names—splenic pseudoleukæmia, splenic lymphadenoma, splenic cachexia, primitive splenomegaly, and Banti's disease—have been proposed for the disease, but for many reasons the simplest designation seems the best. The description which follows is taken from Osler's recent review of the subject.

Incidence.—The affection is a relatively rare one. Rolleston records thirty-seven cases. Osler by inquiry among the members of the American Association of Physicians secured the details of twenty-six cases which could be grouped under this title, and has reported fifteen cases which he himself has observed. A few other cases which possibly belong in this category have been reported by Harris and Herzog, Brill, Field, and the writer.

Etiology.—In this relation the striking thing is that no adequate explanation of the affection can be had. There is no malaria, no syphilis, no tuberculosis, no leukæmia, in short, no apparent cause for the splenic enlargement.

C. Wilson has reported a family in which in three generations six members had enlarged spleen. Collier and the writer have each reported two cases in sisters, and Brill three cases in one family. In none of the other reported cases is there any family history.

Symptomatology.—The symptoms of the affection may be briefly summarized as a remarkably chronic and often enormous enlargement of the spleen, associated with more or less marked anæmia, frequently accompanied by hæmatemesis and pigmentation of the skin, and in a few cases showing jaundice or ascites at a late stage. The splenic enlargement may exist for five, ten, even twenty-five years. The size of the spleen varies greatly, but in many instances the spleen is huge. In one of the writer's cases a girl, weighing seventy-two pounds, had a spleen weighing twelve and a half pounds. With this enormous enlargement the spleen retains its general shape, the edge remains distinct, and the notches in the anterior margin can be readily felt. Even with very large spleens the patients, as a rule, have no great pain, but complain only of a sense of weight and pressure or occasional dragging in the left side. As the organ enlarges, it emerges from beneath the left costal arch, gradually fills the left hypochondrium, then extends downward, filling the whole left half of the abdomen, and finally may pass the middle line and fill the right iliac fossa.

The anæmia which accompanies the condition is usually of a moderate grade. Of Osler's cases the average count of the red cells was 3,425,000 per cubic millimetre, the average hæmoglobin estimation forty-seven per cent. The hæmoglobin is relatively lower than the count of the red cells. The leucocytes occasionally show an increase, but are generally below normal. The differential count of the leucocytes shows nothing characteristic.

The pigmentation of the skin occurs in most of the cases, especially those of long standing. It is a general diffuse bronzing, especially upon the exposed parts of the body, very closely resembling that seen in Addison's disease.

In many of the cases the liver is notably enlarged, but without definite disturbance of its functions; in other cases the enlargement is associated with signs of obstruction and the cases suggest cirrhosis of the liver with secondary enlargement of the spleen. Ascites and jaundice, when they do occur, are terminal events in the development of the disease.

Pathology.—In this regard two quite distinct conditions have been observed. In one there is a chronic hyperplasia of the spleen with increase of connective tissue, atrophy of the pulp, and degeneration of the Malpighian bodies. In the other group, which has usually been described under the title of primary splenomegaly, the spleen is enormously enlarged, the fibrous hyperplasia is excessive, but in addition there are irregular spaces, apparently the enlarged and deformed spaces of the splenic pulp, filled more or less completely with very large endothelial cells, having clear protoplasm and two or more nuclei, with occasional giant cells. In the original description of Gaucher the condition was termed a primary epithelioma. The writer, after careful study of many sections from his case, concluded that the condition could not be regarded as a new growth, but was an unusual form of hyperplasia of the organ. In this view he has been supported by Harris and Herzog, although these observers do not agree in the view that the endothelial cells, which form so striking a feature of the picture, may later undergo transformation into fibrous tissue. A similar structure has been observed by Picou and Ramond, Collier, Harris and Herzog, and Banta. A remarkable feature of the writer's case was the marked pigmentation found in the spleen, retroperitoneal lymph nodes, and the liver. The lymph nodes also showed changes analogous to those in the spleen, and in the intralobular connective tissue of the liver there were groups of cells closely resembling the large endothelial cells of the spleen. As a rule the changes observed in the liver are those of a simple cirrhosis. The enlargement of this organ may be marked, but is not nearly so striking as that of the spleen.

Moderate enlargement of both external and internal lymph nodes is found in some of the cases, but this enlargement is not comparable to that of leukæmia or pseudoleukæmia.

Treatment.—The only treatment so far found effective in these cases is the removal of the spleen. Sippy tabulated seven splenectomies for this condition, to which Harris and Herzog have added twelve. Out of the total of nineteen, fourteen recovered and five died. In the majority, at least, of the recoveries the condition has been completely relieved by the splenectomy. Osler regards recurrent hæmatemesis as the most important indication for operation.

TUMORS OF THE SPLEEN.—Although the spleen is frequently involved secondarily in cancer and sarcoma, primary tumors of the spleen of any form are exceedingly rare. Both solid and cystic tumors have, however, been met with. Among the cystic tumors Litten distinguishes three groups: (1) Uni- or multilocular cysts of non-parasitic origin, including serous, blood, and lymph cysts; (2) echinococcus cysts; (3) dermoid and atheromatous cysts. These are very rare. Among 235 cases of echinococcus of the abdominal organs Finsen found the spleen the seat of the parasite in only 2, and Neisser in 900 cases of echinococcus collected from literature found 28 cases of echinococcus of the spleen. The only peculiarity of these cystic tumors is the sense of fluctuation which may be obtained upon palpation. Naturally this can be had only when the cyst has reached a considerable size. In the case of echinococcus it is claimed by some that a peculiar hydatid crepitation may be obtained upon palpation, but so great differences of opinion as to its occurrence exist, even among those who have had opportunity to study these cases, that one must doubt the value of the phenomenon in diagnosis.

Fibroma, cavernous angioma, and lymphangioma of the spleen have all been observed, but are all exceedingly rare. Carcinoma, so frequent secondarily in the spleen, is almost unknown as a primary growth. Litten says that there are ten primary cases recorded in literature.

Primary sarcoma is also very rare, secondary sarcoma of the spleen not very uncommon. A number of cases of removal of sarcomata of the spleen are on record.

The symptoms and diagnosis of these various tumors present no unusual features by reason of their occurrence in the spleen.

The only treatment must be the removal of the organ.

With the recent advances of surgery removal of the spleen has become much more frequent, and has been attended with much greater success than was formerly had. For the details of the operation and its results one may refer to the elaborate articles of Jonnesco, Bessel Hagen, Warbasse, Bolton, and Warren. From the standpoint of medicine the interest of splenectomy lies in the effects produced upon the organism by the operation, and the light which is thereby thrown upon the function or lack of function of the spleen. (*Cf.* also the following article.)

Effects of the Splenectomy in Animals.—Ewing briefly summarizes the results of the work of several observers as follows: Splenectomy in animals is followed by moderate reduction in red cells lasting for from one to twelve months, by relatively greater loss of hæmoglobin more slowly restored, and in some cases by the appearance, during the first year, of megalocytes. Leucocytosis follows the operation, but its extent and duration are very variable. A polynuclear leucocytosis is observed during the first days or weeks, followed by relative or absolute lymphocytosis during the first year, while during the second year distinct eosinophilia may be observed.

With these changes in the blood are associated marked cellular hyperplasia of the marrow, approaching at times that of leukæmia, and often also affecting the lymph nodes. In the swollen nodes an excessive number of nucleated red cells have been found by Winogradoff, Tizzoni, Gibson, Komloff, and Grünberg.

Effects of Splenectomy in Man.—Ewing also gives a résumé of this subject. In comparatively healthy subjects splenectomy has often been performed without affecting the blood more than does any other laparotomy. In many graver cases the loss of blood and the shock of operation give rise to a considerable grade of secondary anæmia. The red cells in favorable cases are restored in from one to three months, but in less favorable cases there may be more persistent anæmia. The restoration of hæmoglobin seems to fall behind the improvement in cells rather more than in most secondary anæmias. The operation is usually followed by considerable polynuclear leucocytosis (15,000 to 50,000) which commonly lasts from two to six weeks, but may continue for months, in which case the polynuclear cells may be largely replaced by lymphocytes. Eosinophilia has been observed in a few cases in the second and third years.

In traumatic cases suffering from large hemorrhages splenectomy, especially when complicated by infection, may lead to very profound anæmia, marked by extreme loss of red cells, the presence of very many large, pale, sometimes polychromatic, and dissolving red cells, nucleated red cells, and to a high grade of leucocytosis. Among the leucocytes there may be a considerable proportion of large, pale mononuclear cells and myelocytes, so that the blood resembles that of acute leukæmia. This condition, however, is transitory and the blood may improve rapidly.

Leukæmia and amyloid degeneration of the spleen are contraindications to splenectomy. In other conditions the choice of operation may depend entirely upon the general condition of the patient. Beyond a moderate persistent leucocytosis or lymphocytosis, and possibly a slight delay in the restoration of hæmoglobin, there are no specific effects of splenectomy in man.

It therefore appears that whatever the function of the spleen, the organ is not indispensable, and its functions may, in case of need, be performed by other parts or organs. The changes found in the bone marrow and in the lymph nodes of animals after splenectomy suggest that it is these parts that are called upon for extra work, and indicate in this way that the functions of the spleen must be, in part at least, those of the marrow and lymph nodes.

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SPLEEN, SURGICAL AFFECTIONS OF THE.—Surgical interest in the spleen is increasing, for of late years quite a number of operations have been performed upon it on account of traumatism, abscess, inflammatory enlargement, tumor, or displacement.

ANATOMY.—The spleen is placed between the ninth, tenth, and eleventh ribs, being separated from them by the diaphragm, and in its upper portion also by the lung. In gunshot wounds of the spleen, therefore, the pleural cavity is frequently opened, and an abscess of the spleen may easily break into the pleural cavity. It is held in position by a suspensory ligament which attaches it to the diaphragm, and also by an extension of the greater omentum from the spleen to the stomach, which is called the gastro-splenic omentum. Behind this membrane is situated the splenic artery with its numerous branches and the splenic vein. Any incision which is made use of to expose the spleen should give the surgeon easy access to these ligaments, in order that he may control hemorrhage when the ligaments are cut. Various incisions have been employed: for example, a vertical incision along the outer border of the rectus muscle, combined if necessary with a transverse incision parallel to the costal margin; or a lumbar incision similar to that employed for operations upon the kidney. In some cases it is necessary to resect portions of the ribs and reach the upper end of the spleen through tee pleural cavity.

Traumatism.—The spleen, especially if enlarged by disease, may be ruptured subcutaneously. It may also be injured by incised, gunshot, and stab wounds. If the capsule is not torn there may be hemorrhage into the substance of the spleen, producing a large hæmatoma with subsequent cyst formation. But usually the capsule is also ruptured and there is profuse bleeding into the peritoneal cavity. The chief symptoms are those of internal hemorrhage, the source of which is not likely to be suspected except in case of open wounds. A portion or the whole of the spleen may prolapse into an open wound.

The treatment is free exposure of the organ, repair of its injuries, if slight, and removal of the spleen if the injuries are extensive. Partial splenectomy has been performed, but in most cases it is more dangerous than total splenectomy; and, since the removal of the spleen has little or no permanent effect upon the health of the individual, partial resection of the organ should generally not be performed.

The mortality following removal of the spleen after traumatism is about forty per cent. for one hundred and thirty operations, two-thirds of which were performed previous to 1900. The mortality of forty-five cases treated in 1900–1901 was only twenty-eight per cent.

Abscess.—Abscess of the spleen is usually secondary, occurring in connection with endocarditis, pyæmia, typhoid fever, acute rheumatism, malaria, etc. Primary abscess may develop in a contusion of the spleen due to traumatism. Some splenic abscesses produce marked septic symptoms and terminate fatally in a short time. Others run a chronic course, the pus breaking through the capsule of the spleen and burrowing in various directions.

The proper treatment, if a diagnosis can be made, is to expose the spleen and open the abscess. If one has to pass through the peritoneal cavity to reach the spleen, it is better to fix the organ in the abdominal wound and to wait the formation of adhesions before opening the ab-