9. In all cases unsuited to plastic measures above outlined, gastroenterostomy.

10. And, because it is held doubtful that the artificial opening will be permanent in the presence of a patent pylorus, any of the above-mentioned operations or combinations of them preliminary to or part of the operation of gastroenterostomy.

508 Dekum Building.

THE TREATMENT OF BONE CAVITIES.

REPORT OF A CASE OF COMPOUND COMMINUTED FRACTURE OF THE HIP, FOLLOWED BY BONY UNION AND A MOVABLE JOINT.*

JAMES E. MOORE, M.D.

MINNEAPOLIS.

I have had so many inquiries concerning an article on the treatment of bone cavities published in *THE JOURNAL*, May 20, 1905, that it seemed that a brief paper on the same topic might interest the members of this Section.

The obliteration of dead space in the soft tissues is a very simple matter since we have learned to use buried catgut sutures, and the treatment of abscesses of the soft parts by incision and drainage is usually followed by speedy convalescence. The obliteration of dead space in bone, however, has been very unsatisfactory. In fact, it has been so difficult that in the majority of cases we have not tried to fill the cavity, but have treated it as an open wound until Nature furnished an epithelial lining for the whole cavity. The method of Neuber, in which the integument is turned into the bottom of the wound and fastened there, is the most certain and speedy of the older methods, but it is only applicable to very superficial bones, like the tibia, and it leaves a most unsightly scar. Schede's method of healing by blood clot is even more unsatisfactory in bone cavities than in the soft tissues, because even when successful the blood clot is absorbed long before Nature can furnish new bone, and the integument is drawn in, leaving a bad scar. In septic and tuberculous bone cavities, and most bone cavities are such, this method is unsatisfactory, because the clot usually becomes infected, no matter what methods of sterilization have been employed. The prevailing method is to pack the cavity with gauze until it is filled with connective tissue and covered by epithelium, and is about the most tiresome and unsurgical procedure surgeons are guilty of. I have one patient who calls on me occasionally now, on whom I performed a sequestrotomy two years ago and treated after this method. He packs his wound himself, and still has a small point deep in the wound without an epithelial covering. Since that time I have learned how to fill bone cavities, and even those operated on but a short time ago are healed, and the healing process has not been accompanied by the tortures of pulling out and putting in gauze. The treating of tuberculous cavities in bone by packing is eminently unsatisfactory, because it is not only tedious and painful, but very commonly unsuccessful, the granulations becoming infected by the tubercle bacillus.

FAULTY TECHNIC.

While our lack of success in the treatment of bone cavities is, in a measure, due to the physical make-up of the tissue, it is largely due to faulty technic, for the

technic of bone surgery has not kept pace with that of surgery of the soft parts. The consequence is that many cases of bone disease have been neglected. It is too common a practice to treat an abscess in the end of a long bone by means of braces and plaster splints until it breaks into the neighboring joint; and this is termed conservatism by those who practice it.

MacNamara's book on "Diseases of the Bones and Joints," published in 1887, is the best book ever written on bone surgery, but it makes no mention of an artificial filling for bone cavities. In 1888, Gerster published his excellent book on "Aseptic and Antiseptic Surgery," in which he advocated the filling of bone cavities by blood clot after Schede, but he made no mention of an artificial filling. Later Senn advocated the use of decalcified bone chips, dusted with iodoform, for the filling of bone cavities. The interspaces between the chips were allowed to fill with blood clot, as in the Schede method. This was the first successful method of artificial filling and was a decided advance, but was too often followed by failure to become popular.

MOORHOF'S BONE WAX.

My experience in the past two years leads me to believe that a new era in bone surgery has dawned and that we can secure so much better results than we have been able to heretofore that bone surgery will become more popular, and that the technic will improve accordingly.

Surgeons have long felt the need of a material with which they could successfully fill bone cavities as dentists fill cavities in teeth, but the filling of a bone cavity which must be covered by soft parts is very different from filling a cavity in a tooth.

With our present knowledge of infection and its results it is easy to understand why all experiments along this line in preantiseptic days were failures.

In 1903, von Mosetig reported a large number of successful results from the use of a new bone plug. Moorhof also reported many successes with it in his clinic at Vienna. In this country it is very commonly known as Moorhof's bone wax. This material consists of twenty parts iodoform, forty parts spermaceti and forty parts of oil of sesame. The ingredients are slowly heated to 100 C. and, when allowed to cool, form a soft solid which remains solid at the temperature of the body. For use it is heated to 50 C., being constantly stirred to keep the iodoform evenly distributed. At this temperature it can be poured into the cavity, where it immediately solidifies. The material does not act as a foreign body, nor does it act as a culture medium. It possesses the inhibitory and medicinal properties of iodoform, without causing iodoform poisoning. Its physical properties are such that it is gradually absorbed and replaced by granulations, and finally by new bone. Moorhof shows many skiagraphs illustrating this process.

The wax, or bone plug, as its inventor terms it, has demonstrated beyond all controversy the feasibility and practicability of an artificial filling for bone cavities.

After the average operation at the present time the surgeon expects to close the wound and to have very little to do in the way of after-treatment, and he is inclined to neglect cases where this agreeable program can not be carried out. With this artificial means of filling dead space in bone, the after-treatment in cases of bone surgery need not be disagreeable or prolonged.

In acute infections of bone there is no place for an artificial filling, because the parts can not be sterilized.

* Read in the Section on Surgery and Anatomy of the American Medical Association, at the Fifty-seventh Annual Session, June, 1906.

but, fortunately, it is not needed when the operation is performed early, as it should be, because there is no great loss of bone substance and Nature promptly makes good the defect after drainage is established. When these acute cases are neglected, or when the process is so acute as to cause speedy necrosis, there comes a time when the necrosed bone must be removed, leaving a bone cavity to be filled.

TECHNIC.

The preparation of the cavity is the first step. The bloodless method must be employed so that the cavity can be made sterile and dry. When the bone wax is to be used, the opening in the bone need not be larger than is necessary to permit the removal of the sequestrum and the thorough cleansing of the cavity. The periosteum must be carefully preserved, as it makes an important covering for the bone plug. After removing the sequestrum and thoroughly curetting out all débris, the cavity must be washed and dried and thoroughly swabbed with 95 per cent. carbolic acid. After about two minutes the acid should be wiped out and the cavity washed with alcohol, after which it must be thoroughly dried, as moisture will prevent the melted wax from penetrating every crevice in the bone, which is necessary for the success of the treatment. Moorhof has a hot-air blast for drying the cavity, which is a great advantage, but not a necessity. The melted wax is then poured in and as soon as it is hardened the periosteum and other tissues are closed by catgut sutures, a dry gauze dressing is applied and held snugly in place by a roller bandage, after which the rubber bandage is removed. When there is a good periosteal covering no drainage is necessary, but when the soft parts come in contact with the wax it is advisable to provide temporary drainage by means of strands of catgut or small strips of rubber tissue. In most cases, when no drainage is necessary, primary union is secured, but in a few there will be some oozing of serum between the stitches for a few days, after which union takes place. In drained cases union usually takes place soon after the removal of the drain, but occasionally serum and particles of iodoform escape for some time after; but so long as the wound is kept sterile all goes well. Even when the wound becomes infected the infection is superficial and it is in a better condition than if it were being treated by gauze packing.

The first case reported in my former paper was that of a boy who had an ankylosed elbow from a badly united fracture. I opened the joint, trimmed the displaced condyle with a knife and filled the space with the bone wax. The boy now has perfect motion in the joint.

I have found that when the wound is so situated that immediate closure is impossible the wax may still be used to advantage. In one case the patient had a chronic abscess in the lower jaw from an ulcerated tooth. The tooth was extracted, the abscess opened and disinfected and the cavity filled with the bone wax, and, although a portion of the wax was exposed inside the lower lip as large as the end of a lead pencil, the result was perfectly satisfactory. The patient reported three months later with the opening closed. She stated that she thought the wax all came out, but so slowly that by the time it was out the cavity was filled.

In old cases in which there is loss of soft parts so that the wound can not be closed, the cavity can be curetted, disinfected and filled with wax which will sometimes remain under a dry gauze dressing until it is gradually absorbed and replaced by granulations. When the wax comes out, as sometimes happens in these open cases, the

cavity can be resterilized and again filled with wax which makes a very much better and more comfortable dressing than gauze packing.

CHRONIC BONE ABSCESS.

Chronic bone abscess which has too often resulted in amputation can be successfully and comfortably treated with the bone wax by evacuating the pus, sterilizing the cavity, filling it with the wax and closing the periosteum and soft parts over it.

I have filled the cavity after excision of the elbow in two cases with most gratifying results.

When a pyogenic infection of bone threatens the integrity of a joint, surgeons promptly operate to save it, but a tuberculous focus in the same locality is very commonly neglected and treated by so-called conservative methods until the joint is invaded. A tuberculous focus in bone near a joint, although not so rapid in its course as a pyogenic infection, is just as great a menace to the soundness of the joint and should be treated in the same manner. The bone should be opened, the focus scraped out, the cavity swabbed with carbolic acid, followed by alcohol, filled with wax, and the periosteum and soft parts closed over it. Treated in this manner, a local tuberculosis is speedily curable. This treatment is not open to the objections of gauze packing. It saves the joint and is followed by speedy convalescence.

My greatest victory with the use of the bone wax was in a compound comminuted fracture of the hip joint in which I secured bony union and a movable joint.

Patient.—E. E., aged 26, was referred to me by Dr. A. Ridgway, Belgrade, Minn., Jan. 17, 1905.

History.—On January 16, while hunting, he was accidentally shot with a shotgun. He was at such close range that the shot acted as a large bullet. It entered from behind, passing through the trochanter and neck of the femur, opening the joint. Dr. Ridgway packed the wound with gauze as a temporary dressing and to control the hemorrhage.

Examination.—When he arrived at the Northwestern Hospital all the usual signs of fracture of the neck of the femur were present, including one and one-half inches shortening. The wound was large and ragged. Gun wads and parts of clothing were found deep in the thigh, where they had been driven directly through the bone.

Treatment.—The shot, fragments of bone and other foreign bodies were removed, the wound cleansed, packed with gauze and the Maxwell dressing for fracture of the neck of the femur applied, that is, the usual weight and pulley were placed at the foot of the bed and a side pull from the upper and inner side of the thigh upward and outward at an angle of about 45 degrees, with a 10-pound weight, which made the joint capsule taut and held the short fragment in place. The wound was treated by gauze packing for two weeks, when the temperature disappeared. The gauze was then removed, the cavity disinfected by 95 per cent. carbolic acid, followed by alcohol, and filled with bone wax.

Result.—At the end of seven weeks the wound was closed, the weights removed and the patient allowed to sit up. At the end of the eighth week he went home, using crutches and bearing some weight on the limb. He began his usual work on the farm on August 1. October 20 a small piece of bone came away, and since then he has had no trouble. He now has good use of the joint and walks without any artificial aid save an inch lift on the heel of his shoe.

AUTHOR'S EXPERIENCE.

In my two years' experience with the bone wax I have demonstrated many times that it is all that has been claimed for it, and have been gradually extending its use to new fields, but with all its advantages it is not perfect. The principal objections to it are that it is expensive and the iodoform settles to the bottom while

the oil floats on top in the liquid state. One physician tells me that he paid ten dollars for enough to fill one large cavity. The iodoform is the objectionable ingredient both as to price and consistence, and I question its real value. It is used, of course, for its antiseptic and inhibitory properties, but these are probably due to the iodine set free in the process of absorption. I have been experimenting with a number of different mixtures with a view of eliminating the objectionable features and have met with some very gratifying results. At one time all surgeons used iodoform very freely as an antiseptic and continued to use it for this purpose until bacteriologists taught them that it would be wise to sterilize it before using, as it very commonly contains bacteria.

EXPERIMENTS WITH SUBSTITUTES FOR IODOFORM.

In my experiments I have acted on the belief that iodine is the active agent in the bone wax above described, and that it would be better to use the iodine flakes than the iodoform, because they are soluble and so little is required that the expense is trifling.

At my request Dean Wulling, of the College of Pharmacy of the University of Minnesota, had his assistant, Mr. Beckman, work out the formula. I suggested various ingredients, always with 1 per cent. of iodine as the antiseptic, stipulating that the melting point must be about 110 F. This strength of iodine was adopted because it has proved so eminently satisfactory in the sterilization of catgut. The following is the most satisfactory combination in our experience:

Spermaceti, 8 parts.

Olive oil, 2 parts.

Iodine, 1 per cent.

The spermaceti is melted at a low heat on a water bath and the olive oil added. The heat is withdrawn and the iodine dissolved in the liquid and stirred until it congeals. Heat must not be used after the iodine is added on account of its volatility.

This mass is solid at the body temperature, melts at 108 F., and is antiseptic without being irritating.

I have only recently completed this work and have not had sufficient experience with it to justify any extravagant claims. It is mentioned with the hope that others may take the matter up and, now that the filling of bone cavities by artificial means is proved to be practical, we may discover a perfect material.

THE MEDICAL TREATMENT OF GALLSTONE DISEASE.*

REYNOLD WEBB WILCOX, M.D., LL.D.

Professor of Medicine at the New York Post-Graduate Medical School and Hospital; Physician to St. Mark's Hospital.
NEW YORK.

If one should formulate his conclusions from the reading of current medical literature, he would likely be of the opinion that my paper would be, of necessity, an extremely brief one. However, voluminous as is the surgical literature on gallstones, a careful consideration of the subject leads me to place surgery as adapted only to gallstones of gall-bladder origin, and then only under conditions which demand mechanical relief—obviously a very small part of the subject of gallstone disease which is almost entirely medical. When we consider that postmortem records prove that from 6 to 10 per cent. of all cadavers show the presence of gallstones—

three-quarters of these being in persons over 40 years old—and that not more than one person in twenty who carries a gallstone becomes aware of its presence through any symptoms which it may cause, and of those whose symptoms have attracted attention, not all require operation, it is readily seen that the field of surgery is decidedly limited, although of great importance when it is indicated. In other words, the treatment of gallstone disease is practically entirely medical; that of gallstones themselves is generally surgical. If this distinction is kept clearly in mind, more will be expected of the internist and fewer disappointments laid at the door of the surgeon.

ETIOLOGY.

To present this question intelligently, let me premise that gallstones are either (1) hepatic in source, originating in the bile ducts, because of a slow catarrhal process which results in the secretion of an albuminous substance which, in combination with the bile, precipitates a bilirubin-calcium calculus, or (2) are formed in the gall bladder, because of a catarrhal process of low grade which induces a secretion of cholesterol from the mucous glands and cells in its walls. Of these, the former is by far the most frequent. These facts also explain why, after a cholecystotomy has been performed, gallstones continue to be discharged from the fistula for weeks and even months. It also explains why removal of the gall bladder itself is not followed by a cessation of attacks of gallstone colic.

The recognition of the microbic origin of gallstones dates only to 1886. In 1897, it was clearly shown that the colon bacillus could be responsible, gaining access either (1) by the intestinal canal by way of the common duct, or (2) through the portal vein. Although jaundice as a sequel to enteric fever had been observed as early as 1826, it was not until 1889 that the typhoid bacillus was recognized as a causative factor, entering by way of (1) the portal vein, (2) the hepatic artery or (3) the common duct. That other infections are directly responsible has been my experience, for low-grade cholecystitides have been observed after acute infectious pneumonia, acute rheumatic polyarthritis and chronic tuberculosis. That gallstones do not oftener result may be explained by the fact that acute suppurative inflammation of bile ducts or gall bladder does not result in calculi, but these are due, rather, to attenuated infections.

TREATMENT OF THE MICROBIC CAUSES OF GALLSTONES.

The treatment of microbic causes of gallstones is the treatment of the infection itself and the limitation of the opportunities for entrance of the infectious agent.

Of the mechanical causes: (1) Foreign bodies, if aseptic, are harmless. If they produce stagnation they favor catarrhal processes, and so give opportunity for infection. (2) Stagnation of bile *per se* does not favor gallstone formation, but, since stagnation favors infection, it may lead indirectly to gallstone formation. (3) Chronic venous congestion of the portal system is a most potent cause for gallstone formation, since it is the great underlying cause of the gallstone disease. This may be caused by (a) chronic heart disease (especially mitral obstruction), (b) chronic pulmonary disease (especially chronic emphysema, chronic interstitial pneumonia), (c) intestinal catarrhs, the results of the abuse of alcohol, gluttony, and rarely from excessive use of vigorous purgatives. Much more frequently intestinal catarrhs result from constipation, which not only predisposes to

* Read before the American Therapeutic Society, at its Seventh Annual Meeting, New York City, May 3, 1906.