determined the condition of the viscera, the omentum is drawn through the incision and held upward by an assistant while the lower lip of the incision is sutured to the posterior surface of the omentum, care being taken to prevent wounding or including large vessels. The omentum is then drawn downward and tucked behind the recti muscles and round ligament. Several catgut sutures are necessary to retain the omentum in its new location. The upper lip of the incision is sutured to the omentum (see Fig. 3) and the abdomen is closed in the usual manner. In debilitated patients the linea alba should be overlapped.

REMARKS

The advantages of the technic are manifold. The more important are as follows:

1. Possibility of thorough inspection of the abdominal viscera.
2. Utilization of practically the entire surface of the omentum without disturbing the normal relation of the stomach and transverse colon.
3. Prevention of compression of the omentum between the muscle and its sheath.
4. Practical elimination of danger of postoperative hernia and intestinal obstruction.
5. Avoidance of injury to blood- and nerve-supply of the recti muscles.

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CONTRIBUTION TO THE SURGERY OF BONES, JOINTS AND TENDONS

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(Continued from page 990)

B. The repair of ununited fractures is one of the most important and practical fields for bone transplantation. It is unnecessary to consider here the causes of non-union, except to accentuate one fact that the *x*-ray brings out very clearly, namely, that non-union occurs frequently when the approximation of the bone ends is quite perfect and the fragments thoroughly immobilized, either with or without Lane plates or other external or internal supports. The *x*-ray shows in these cases that there is no osteogenetic effort on the part of the periosteum, medulla or compact bone tissue to span the gap with new bone. It is also a clinical fact that freshening, irritating, rubbing, wiring, or nailing these ends does not in a considerable percentage of cases stimulate the formation of an ossific callus. These failures are so numerous that a means more constantly and uniformly successful, without involving additional hazard for the patient, must be sought.

The means best adapted to meet these requirements, as I have demonstrated in a large number of cases, consists of the transplantation of the crest of the tibia from the same patient into the medulla, so as to span across the line of fracture. The medulla is reamed out with a reamer to the desired size and depth in the ends of both fragments. The transplant is then taken from the crest of the tibia of the patient and driven into one of the fragments to a degree sufficient to allow the other end to be inserted into the opposite fragment, so as to splint firmly and support the fragment across the line of fracture. The implant may be secured in this position by

means of a bone or iron nail driven through it transversely.

The transplant forms a bridge over which the haversian vessels from the living bone at both ends pass over the gap and coalesce to form a callus, thus building new bone in the transplant.

I have not had a single failure of union in this class of cases, nor have I had to remove the transplanted fragment. If this work is done in an aseptic field and in an aseptic manner, and if primary union of the soft parts is secured, the result is uniformly good and the period of convalescence short.

The transplant (Fig. 9) should be of sufficient size to give firm mechanical support. Usually it is of the size of the adult index or middle finger, measuring about $\frac{3}{8}$ by $\frac{1}{2}$ by $\frac{5}{8}$ inch, and of such length as may be desired. It must be firm enough to carry the necessary resistance. It should be removed from the crest of the tibia, and may or may not be covered by periosteum. The defect that is left in the tibia from which this graft is removed fills in rapidly, so that after from four to six weeks the

Figs. 7 and 8.—Side view and end view of the author's reamers of various sizes and shapes and the end mill used in securing the normal conformation of bones forming enarthrodial joints, such as hip and shoulder, and to ream out the medullary canal of long bones before the fitting in of the transplant.

site can scarcely be detected. A curved Buck chisel or Gigli or Butcher saw may be used to remove the fragment guided by my special retractor-guide. The transverse division of the bone above and below should be made with a saw before the fragment of bone is chiseled away from the tibia, because otherwise it is liable to split in a wrong direction. It should be lifted up carefully with forceps and placed in the bed prepared for it without coming in contact with any other material.

It requires about forty to sixty days for the graft to become firmly attached and therefore an external cast should support the limb during this time. Although it feels firm to the palpating finger within twenty days, it must not be strained until ample time has elapsed for complete regeneration to take place. It requires from seven to ten months to have a bone fully restored to the normal size.

OLD UNUNITED FRACTURE OF NECK OF FEMUR

CASE 1.—*Patient*.—Mrs. C. V., aged 58, was admitted to Mercy Hospital, June 18, 1909. Family history was negative.

Patient had had scarlet fever, measles, whooping-cough and mumps during childhood.

Present Trouble.—In 1905, while stepping backward from a slowly moving car, she landed on her right foot and fell to the ground, striking on her right hip. She was carried home and an osteopath called, who told her that her hip was dislocated and proceeded to reduce it. No cast or dressing was applied. Massage was instituted and continued up to the present time. Five months after the injury the patient was able to get around with crutches, but walked with a decided limp. There was slight pain in the hip on motion and some stiffness in the knee. She could not cross the right leg over the left without manual assistance. There was no loss of sensation. On pressure, hip was slightly tender. There had always been an enlargement of the hip since accident.

Examination.—Right leg, $33\frac{1}{3}$ inches; left leg, $35\frac{1}{2}$ inches. Tip of right trochanter almost up to level of a line drawn at right angles to the body through the anterior superior spine of the ilium. Tip of left trochanter $2\frac{1}{2}$ inches below this line.

Fig. 9.—Exposure of crest of tibia, showing trough from which transplant was removed (transplant on right-hand side).

Arc of rotation greater in left than in right hip. In walking there is a drooping to the right side, despite a high heel. X-ray picture showed failure of union in old fracture of neck of femur.

Treatment.—At the operation a fracture of the neck of the femur was found, with a large mass of cicatricial tissue surrounding the head of the bone. There was no effort at bony union. The head was exposed, the fractured surfaces freshened down to the cancellated bony tissue, and two nails were driven from the external surface of the shaft through it and through the neck well into the head.

Result.—Primary union of soft parts and firm bony union. Function normal.

C. The replacement of bone for osteomyelitic infection presents features not considered in the previous section. There is usually a large sequestrum and a considerable suppurating area. This suppuration must be entirely overcome and the wound healed before transplantation can be done. If it occurs in the leg, and par-

ticularly in the leg of a growing individual, the entire shaft of the bone may be involved.

The length of the extremity can be maintained by implanting the head of the fibula at the knee under the epiphysis of the tibia. If the femur or humerus be involved, extension must be maintained until the sequestrum is freed (Figs. 11-14).

If the periosteum is retained, a foreign body, such as a tube or column of magnesium, $\frac{1}{3}$ to $\frac{1}{2}$ inch in diameter, should be inserted into the granulating wound and contact at both ends with the bone, even in the presence of infection. It will thus prevent the shortening. This is more desirable and applicable to a necrosis of the femur and humerus than in the case of disease of the tibia or either bone of the forearm. The magnesium will be entirely surrounded by granulation tissue. If the periosteum has not been destroyed by the osteomyelitic process, an involucrum of bone will form around the

Fig. 10.—Transplant in place between ends of bones. The medullary canal is reamed out, the ends of the transplant shaped to fit, and the transplant fitted in tightly.

magnesium and the latter will ultimately be absorbed. Carbonated water, weak alkaline or mineral acid solutions (1 to 5 per cent.) may be injected to dissolve the magnesium after it has fulfilled its purpose, if it does not disappear after a reasonable length of time has expired. It usually is rapidly dissolved by the wound secretions with evolution of hydrogen gas.

When the sequestrum is removed and the space is covered with cicatricial tissue or skin, a fragment of bone from the crest of the tibia may be transplanted into the scar tissue at the site of the former bone. It must contact above and below or, at least, at one end with osteogenetic living bone denuded of its periosteum. It is preferable to have it contact with both ends.

A small contacting area may suffice to supply the haversian vessels with osteogenetic elements, as was beautifully illustrated in one of my cases. Here the contacting areas above and below were not larger than

the surface of an ordinary lead-pencil, and still there was supplied sufficient osteogenetic force for the full reproduction of the tibia to such an extent that it could scarcely be believed that it was a new tibia were it not for a hole that remains in the upper end and which is plainly to be seen in the skiagram (Fig. 13).

The periosteum over the living ends of bone must be removed carefully and the implant must be immobilized and firmly approximated at each end with phosphor-bronze wire, or any other non-absorbable material which would insure continued immobilization.

In tuberculosis of the shaft, a rare condition in this country, but a common one in Scotland, as shown by Mr. Stiles, the periosteum can be preserved, and preserved aseptically, as a rule. Here the bone can be reproduced fully without the implantation of a fragment of bone from elsewhere, but it will be evolved more rapidly and the conformation of the limb more perfectly maintained if a fragment of bone fills in the gap.

If bone is not accessible, then a bar, plate or perforated cylinder of magnesium may be inserted to maintain the normal conformation of the extremity during the process of evolution of the involucrum of bone around the foreign body. As stated before the mag-

the telegraph pole. He did not lose consciousness, but could not stand on his leg. A physician was called immediately, and pronounced it a bruise without fracture. The skin was not torn. The patient was confined to bed for ten days, and had walked on leg, with aid of crutches.

Examination.—There was great deformity just below the knee, with every evidence of the fracture. The line of tibial fracture was from the level of the upper tip of the fibula downward and inward, so as to break its inner surface $1\frac{1}{2}$ inches below the articular margin of the internal tuberosity. The internal malleolus of the right ankle was displaced inward 5 inches out of plumb.

Treatment.—An incision 2 inches long was made parallel to the long axis of the tibia and an inch to the inner side of the patellar tubercle. The tibia was completely divided with a Murphy-Buck chisel along the line of impaction. With the limb in a straight position, abduction was then made until the gap at the inner margin of the line of fracture was an inch in breadth. A magnesium plate $1\frac{3}{4}$ inches long, $1\frac{1}{4}$ inches wide and one-sixteenth inch thick was prepared and driven into a crease made by the chisel in the upper and lower fragments until it was entirely imbedded in the bone spanning the gap. This immobilized both of the fragments, prevented rotation and maintained the gap. The periosteum and fascia were sutured over the plate and the skin closed with horsehair. The limb was then dressed in a straight position, but hyper-abducted. A plaster mold was then applied extending from the trochanter to the toes. The mold was opened at the end of three weeks and showed a complete primary union of the soft parts, but they were vaulted forward as though there were a large quantity of serum or blood beneath. On percussion it was resonant. An aspirating needle was inserted and drew off gas formed from the secretions decomposed by the magnesium, a regular result when the wound is completely closed and the magnesium oxidizes more rapidly than the hydrogen gas is absorbed. The limb was in splendid position.

Result.—Five weeks after operation the x-ray showed that the magnesium had practically entirely disappeared and there was a good bony union of the tibia. The patient was permitted to walk on the limb, with the aid of crutches. Result was perfect.

UNUNITED FRACTURE OF TIBIA AND FIBULA

CASE 3.—*Patient.*—M. S., aged 22, was admitted to Mercy Hospital June 19, 1909. There was no record of family history or personal history.

Present Trouble.—Aug. 26, 1908, a laundry stove exploded and a piece of iron struck the right leg midway between the knee and ankle on the anterior surface. The patient became weak and dizzy and perspired, but did not vomit. He tried to walk, but was unable to do so because "his leg bent" at the point of injury. He had no pain, only a numb feeling. He said that blood ran down his leg and that there were two holes on the inner side of his leg. Then he had sharp shooting pains. He was taken to a hospital and operated on the following morning; double wiring of both ends was done. He thought that some muscle was united and a piece of bone removed. His temperature rose to 100 F. He had pain in leg on motion only. The leg was put in a mold. Patient remained in hospital until Nov. 22, 1908. Six weeks after the accident a very successful skin-grafting operation was done on the leg. Patient said that there was no infection at any time. He was in bed only fifteen days, and one month before leaving hospital was walking on crutches. He had a circular cast on all the time, from time of admission to hospital until now. Cast was removed every two weeks and new one applied. He had pain in the leg for two or three days following the operation. In December wound reopened and patient went to bed. He was in bed twenty days; had no pain, but at night would get a numb sensation. He had hobbled around on crutches. Slight tenderness on pressure.

Treatment.—Patient was operated on June 15, 1909. There was no callus production in tibia. Approximation was good. Effort at bone production made from the periosteum around the wire and outward. Ends of fibula had passed each other, the lower to the inner side of the upper. Edges were fresh-

Fig. 16.—An incision was made into the bone from the inner side so as to permit of straightening the bone without disturbing the opposite side. The magnesium plate was inserted to maintain separation.

Fig. 17.—Ten months after the operation. Correction of deformity, complete bony development in the gap and absorption of magnesium plate, except that portion imbedded in the muscle and outside of the periosteum.

nesium will disappear in time, if it does not become infected.

In the removal of a tuberculous shaft in the child, the periosteum should be freed from the bone, divided cross-wise, and the shaft evulsed from its epiphyseal attachment. *The epiphyses must never be disturbed in children*; therefore, the bone should be fractured on the shaft side of the epiphyseal osteogenetic line. The gap then remaining should be filled with some non-elastic compact supporting material during the period of regeneration. The rapidity of absorption of the magnesium can be seen in the cases in which it was used (Figs. 15-19).

IMPACTED FRACTURE OF THE INTERNAL TUBEROSITY OF THE TIBIA AND FRACTURE OF THE FIBULA

CASE 2.—*Patient.*—J. S., aged 62, was admitted to Mercy Hospital Feb. 3, 1912. Family history was negative. Patient had had measles, whooping-cough and typhoid when a child; no injury except that relating to the present trouble.

Present Trouble.—May 19, 1911, while the patient was standing between a telegraph pole and a slowly moving automobile, the running-board of the machine caught him on the inner side of the leg, just below the knee, jamming him against

Fig. 11. Destruction of the entire shaft of the tibia by osteomyelitis, the epiphyses and extremities remaining unaffected.

Fig. 12. Three months after transplantation of a piece of the opposite tibia six inches in length. Beginning regeneration of bone.

Fig. 13. One year after operation, showing almost complete regeneration of the shaft of the tibia.

Fig. 14. The leg operated on is normal in size, shape and function. The foot is placed squarely on the ground.

Fig. 15. Bowing of femur, result of injury to internal condyle, the bone development from that side of the epiphysis ceasing, but continuing on the other side.

Fig. 18. Impacted fracture of upper extremity of tibia and consequent deformity of leg.

Fig. 19. Refracture of tibia, correction of deformity and insertion of magnesium plate for retention of position. The magnesium was absorbed and the gap filled with bone. Perfect result.

Fig. 20.—Fracture of the anatomic neck of the humerus with dislocation of the head of the bone into the subglenoid space.

Fig. 21.—Replacement of head of bone into glenoid cavity and fixation of head to shaft by means of a wire nail.

Fig. 22.—Four months later. Nail removed, sutures in situ; regeneration of bone complete, with return of function in joint.

Fig. 23.—Fracture of neck of femur with separation of head, seven weeks after injury. Owing to separation of head from source of nourishment it was dead but aseptic, so that it could be used to bring about the formation of a new head. The globular mass in the center of the picture is the head of the femur. The shaft extends behind and above it.

Fig. 24.—Head nailed to femur after reposition of fragments.

Fig. 25.—Regeneration of head of bone, with perfect restoration of function, showing that the dead but aseptic head met all requirements of a transplant. Flexion and extension normal. Leg can be rotated naturally.

Fig. 26.—Old fracture of anatomic neck of femur. Absorption of bone and non-union. Four months after operation. A portion of the greater trochanter was removed and nailed to the femur to make a new head. The result was perfect. A firm bony union took place with restoration of function in the hip.

Fig. 27.—Cystic fibroma of upper third of humerus.

Fig. 30.—Showing full extension of arm.

Fig. 32.—Boy, aged 13, with osteitis fibrosa cystica of shaft of right tibia.

Fig. 28. Entire upper third of humerus removed and tibial transplant inserted with nail locking it in place. Upper end of transplant was sutured into capsule with the idea of securing a restoration of articular surface of humerus.

Fig. 29.—One year after the operation, showing regeneration of upper third of humerus, including the tuberosities and articular surface.

Fig. 31.—Showing complete flexion and ability to place hands on head.

Fig. 33.—Three weeks after resection of tumor and transplantation of 8¾ inches of patient's well tibia into the gap. The transplant is held in place above and below by wire nails.

Fig. 34.—Seven months after operation, showing regeneration of bone, except at lower end of transplant, where a necrosis occurred, probably from the irritation of the nail. No return of neoplasm.

Fig. 35.—Chondrosarcoma of femur involving great trochanter and upper surface of the surgical neck.

Fig. 36. The entire extremity of the femur, including a portion of the shaft, was removed and a piece of tibia about seven inches long implanted, the upper end being placed into the acetabulum and the joint capsule sutured around it. The fragment fractured at its upper end during its removal from the tibia. It was wired, nailed as shown and implanted. This picture was made four months after the operation. On palpation there seems to be considerable regeneration of bone. The skiagram shows ossification for three-fourths of the entire length, but not so far advanced.

Fig. 37.—Condition of bone after removal and splitting. No apparent involvement of head by tumor process.

ended of both fibial and fibular fragments, and approximation secured by the use of bronze wire. No union resulted.

He was admitted to our service Oct. 6, 1909. There was no ossification; slight callus production; apposition perfect. Bones were spread out, connective tissue removed from between them and ends of bones freshened with chisel and all cartilaginous and fibrous tissue removed.

It was planned to make an intramedullary transplantation from the left tibia. The left tibia was exposed and two holes were bored through and nails inserted in these to steady the bone for sawing. A portion of bone was thus removed from the crest of the left tibia, measuring about one-half by five-eighths by three-eighths, and about 3 inches long. The medullary cavity of both the upper and the lower fragment was reamed out and the transplant from the left tibia was driven into the lower end first, then the upper end was inserted and a nail placed into the implant transversely to keep it from being displaced on motion. The wound was closed with catgut. No drain. There was primary union in both the right and the left tibiae. Skiagrams were made repeatedly and showed the progress of ossification of the implant and of ossile union of the ends of the bone. An elongation of the tendo Achillis had to be made on account of the contraction that had taken place in the gastrocnemii during the long illness.

Result.—Perfect recovery, with full restoration of function.

FRACTURE OF TIBIA AND FIBULA; NON-UNION.

CASE 4.—Patient.—H. P. W., a man aged 32, was admitted to Mercy Hospital Dec. 27, 1911. Family history was negative. Patient had been a civil engineer in the Canal Zone. He had tropical dysentery in 1908, and malaria for past ten years.

Present Trouble.—June 9, 1911, was in railway wreck and his tibia and fibula were crushed, resulting in a compound comminuted fracture with division of anterior tibial artery. A purulent discharge started on the third day and continued for fifteen days, when the external wound was entirely healed. Temperature ranged from 100.6 to 102 for first three days. Otherwise there was no constitutional disturbance. The leg was placed in a mold on the fifteenth day. X-ray picture taken the next day showed an overriding of both bones, with angulation of 45 degrees. No extension was put on. The mold was removed in four weeks. There was slight motion at the site of the fracture. Another mold was applied and left on for a month. The patient walked on crutches six weeks after the accident. When the second mold was removed the callus was a little more solid, but there was still some motion at the fracture. A plaster-of-Paris collar, 12 inches wide, was put on round the fracture and left on for three weeks. During this time he used crutches. The collar was removed. After two and one-half months a second x-ray picture was taken (December 5) and showed an overriding of one and one-half inches, with considerable mobility at the line of fracture. This mobility had increased slightly up to the time of admission.

Examination.—This showed a non-union of the tibia. Four x-rays of this case showed how important it is to have the pictures taken from various angles. One showed an apparently excellent union; the second a fair union; the third almost failure of union, and the fourth a complete separation of the two fragments by an interposed cartilaginous or fibrous mass. The fibula was united. There was a slight external angulation at the site of fracture.

Operation.—An incision 4 inches long was made over the anterior surface of the tibia near its lateral margin. The line of fracture was exposed. A fibrocartilaginous mass was deposited between the ends of the bones; there was no effort at bone reproduction. A groove one-half inch wide and 3 inches long was chiseled through the anterior surface of the tibia down to the medulla, intercepting the fracture at its middle. The reamer was then used to free the medulla one-half inch above and 1 inch below the groove. The tibia was then ready for the implant. A transplant $4\frac{1}{2}$ inches by one-half by one-half by five-eighths was removed from the crest of the opposite tibia with the chisel in the regular way. It was driven into the lower fragment until the upper end of the transplant could be depressed into the groove in the upper fragment and admit of the insertion of the upper end into the medulla. It was then driven upward into the medulla beyond the end of the

groove, so that the transplant locked. At the completion of this the leg felt strong enough to walk on it at that moment; so firmly did the transplant fix the end. The periosteum was then closed over the graft with catgut and the skin closed with horsehair. A plaster mold was applied, extending from toe to 8 inches above the knee. Primary union resulted.

The mold was removed at the end of three weeks. The implant had healed in nicely. The mold was reapplied, and removed at the end of five weeks, when the x-ray showed that a bony union had taken place. A leather mold was then substituted for the plaster mold and the patient was allowed to place some weight on the limb and walk with crutches. End result was perfect. (Figs. 43-45).

Tuberculosis of the shaft of the bones is a disease of childhood and infancy, and in this country rarely a disease of boyhood or girlhood or adolescence. In the adult the tuberculous disease is an epiphyseal lesion, while in the child and infant it is a diaphyseal or, as Mr. Stiles terms it, a metaphyseal lesion. Of course, it is hardly necessary to say that preparatory to carrying out any of these measures in these cases, either human or bovine tuberculin should be used to effect immunization, the type of the tuberculin depending on whether the infection is human or bovine.

In all of these cases (a) it is desirable that the sequestrum be removed early and completely; (b) also that the infected shaft be removed before a mixed infection of the periosteum takes place; (c) the epiphysis must never be disturbed in the case of children; (d) the normal conformation and length of the limb must be maintained either by internal or external mechanical supports or by extension; (e) the joints above and below the infected zone must be controlled carefully so that no deformity will result during the inflammatory process of destruction or during the period of restoration and repair, as these articular deformities are often more detrimental to the patient than the primary lesion. *Over this we have practically complete control if we take the necessary precautions early.*

D. In fractures of the neck of the humerus there frequently occurs luxation of the head out of the glenoid cavity and before union can be restored one is often required to detach the head completely and replace it in the glenoid cavity. In these cases it becomes necessary to separate it entirely from its vascular supply. It then becomes a graft as the fragment always dies and is replaced by new bone.

In this treatment the head is removed from the subglenoid space, brought out on the table, the end of the fragment is freshened, and accurately applied over the head. It is secured in this position by one or two eight-penny nails, driven through the humeral shaft into the head by an ivory peg, or a bone peg may be taken from the tibia and used in place of the nails. I believe that the wire nails fill all of the indications and meet all of the requirements in these cases. This gives a positive contact for transmission of the osteogenetic elements from the neck into the head.

The bone rapidly regenerates from the neck side and the head retains its full shape and size (Figs. 20-22).

FRACTURE OF SURGICAL NECK OF HUMERUS WITH LUXATION OF HEAD AND NON-UNION

CASE 5.—Mrs. M. K., aged 19, was admitted to Mercy Hospital Sept. 10, 1911. Family and personal history negative.

Present Trouble.—June 20, 1911, patient was thrown from an automobile. She did not know how she landed or whether she was unconscious. She was lying on her right side, with her arm under her, and was assisted to her feet by being picked up under both arms, when she felt a pain in the right shoulder-joint which increased on motion. She had shooting

pains down the arm. After the accident the arm was put in a De Sault splint and a diagnosis made of dislocation. This was changed later to fracture of the neck. An x-ray picture taken a week later was said to show nothing (showing how dangerously misleading a defective x-ray may be). The arm was left in the original position for three weeks, when passive motion and massage were begun. The patient could now abduct the arm and had some deltoid motion, but could not raise it with the elbow flexed.

Examination.—Skiagram showed fracture of the neck of the humerus with displacement of the head out of the glenoid cavity into the subglenoid space. On examination it was found that the patient could abduct the arm 4 inches from the body, as she had some deltoid motion, but could not raise it with the elbow flexed.

Treatment.—Under ether anesthesia the shoulder-joint was opened by an incision 5 inches long, parallel to and in the anterior portion of the deltoid. The glenoid was freed from the remnants of the capsule and the cartilage exposed. The head of the humerus was then freed from its attachment in the luxated subglenoid position and brought out on the table. The fractured end was freshened and it was prepared for replacement in the glenoid. The fractured edge of the humeral neck was then freshened so that the cancellated tissue clearly showed. The head was then replaced in the glenoid cavity and nails were driven through the humerus well into the head. The first skiagram showed the bloodless head in position, and the second skiagram showed the head fully regenerated. There was primary union, and motion is rapidly returning. The joint is practically painless. Excellent result.

The head of the femur may also be luxated or, when separated from the neck, it may become necrotic through its retention and the separation or strangulation of the ligamentum teres. In the secondary operation it should be managed as above. As in the humeral separation, the head should be retained or replaced in the acetabulum and secured there either with a bone peg or two wire nails, which I prefer.

As shown in one case (Figs. 23-25) full regeneration of the head takes place without ankylosis of the joint following. In this case the time that had elapsed between the date of the injury and the operation was seven weeks. The head of the bone had been necrotic for that period, still its haversian canals acted as transmitting tubes for the osteogenetic capillaries coming from the living end of the neck of the femur. This forces me to the belief that a dead aseptic head of the femur from another individual might be transplanted into the acetabulum and grow, as it has in this case. The practical clinical test and demonstration of this belief, however, is left for the future.

When the head of the femur has been destroyed by absorption, due to its separation, with a fracture of the pelvis, as is shown in Figure 26, it can be reproduced by excising four-fifths of the trochanter with its cartilaginous ligamentous cover and as much of the external margin of the shaft as is necessary to fill the vacancy left in the neck of the bone. This trochanteric fragment can be nailed to the freshened end of the neck with the nail-head pointing toward the articulation. If it remains aseptic, regeneration of bone will take place through and into the transplanted trochanter, and the latter will make an excellent head. This was demonstrated in the case mentioned above (Fig. 26). This man can now place his entire weight on the new head; he can lift his leg and extend it horizontally at right angles to the body, when in a sitting position, which he could not do before the operation. This case also supports my belief that a new head may be transplanted from an aseptic cadaver.

The trochanter may be used in the same manner in the reproduction of a head for the humerus, in cases in which ankylosis exists, or in which the head has been destroyed by disease or injury.

The earlier these operations are performed, the better the results should be, as but little shortening will have taken place before the operative procedure is instituted. This favors a speedy full restoration of motion and function.

FRACTURED PATELLA

CASE 6.—Patient.—J. D., a man aged 48, was admitted to Mercy Hospital, Dec. 25, 1910. His mother had had carcinoma of nose. Patient had had scarlet fever at 18, typhoid at 20, and frequent attacks of acute articular rheumatism, last attack being at age of 40.

Present Trouble.—April 10, 1910, patient received an injury on his left knee, being struck by a door. The knee showed all evidence of a contusion and he could not walk away from the scene of the accident, but had to be carried, on account of the weakness of the knee and inability to control flexion and extension. On examination, a transverse fracture of the patella with a median fragment was palpable. As soon as the swelling disappeared from the knee, a posterior splint was applied and the fragments drawn into apposition by means of adhesive. For the following eight months the knee was kept perfectly at rest by means of posterior splints for the first eight weeks, after which a leather case was applied and the patient allowed to go around on crutches. On December 5 the leather case was taken off. There was a very little amount of flexion of the knee. December 9, 1910, while walking, he felt something tear in his knee and he gradually sank to the sidewalk. After this he could flex the knee, but with considerable pain. Examination showed the patella to be refractured in the old place. Since then the knee had been kept perfectly at rest.

Examination.—This showed a transverse fracture of the left patella with a large upper fragment, a smaller lower fragment, and a small median fragment. The leg could not be flexed. There was no effusion in the joint.

Treatment.—Dec. 27, 1910, the knee-joint was injected with 20 c.c. of a 2 per cent. dilution of liquor formaldehydi in glycerin (it had been mixed more than twenty-four hours). It was then placed at rest in extended position, a 15-pound Buck's extension being applied. This was kept up for seven days.

Operation.—Jan. 3, 1911, Esmarch bandage applied. An incision 8 inches long was made, beginning at the lower end of the patella and extending up over its mid-line and over the mid-line of the quadriceps tendon. It extended down to the bone and to the fibrous surface of the quadriceps tendon. The fibrous tissue and cartilaginous surface of the fractured edge of the patella were all removed, and the edges of the fibrous capsule elevated clear across the transverse surface of the patella and for three-fourths inch to either side of the fractured angles. The ends of the bone could now be drawn into apposition with the assistance of heavy catspaw retractors. A strip of quadriceps tendon, three-fourths inch wide and 5½ inches long, was then elevated from the middle of the quadriceps tendon with its patellar attachment retained. The aponeurosis of the patella was sutured all across and on both sides of the patella, with phosphor-bronze wire suture, so the bone came into good apposition. This flap of tendon was reflected downward, its end split up for 1½ inches, and both fragments drawn through a split in the tendon patella, and then one-half twisted around to the right and the other half to the left of the divided portions of the patellar ligament, and both ends united across the front of the patellar ligament below the split, locking firmly in it. This tendon flap was the same as I used to supplant the patella when I removed it for tuberculosis in 1904, and frequently since. It gives an ideal support to the patella after fracture, and it is so easily applied. The slit in the quadriceps tendon was closed with catgut suture.

This is a very effective means of supporting the patella, particularly in old cases.

Primary healing and good recovery resulted.

BOWING OF FEMUR

CASE 7.—Patient.—D. S., a boy, aged 16, was admitted April 20, 1910. Patient's father died at 58 of paralytic stroke; family history was otherwise negative. Patient had chicken-pox at 8; no other acute diseases.

Present Trouble.—When 3 years old, while trying to steal a ride on a wagon, the patient stuck his left foot through the spokes of the wheel and was thrown to the ground. The wagon passed over his left knee. He was unable to rise and was immediately taken to a hospital, where it was said that his patella was fractured. The leg was flexed on the thigh and could not be straightened out. The patella was removed and splint applied, with extension. The patient remained in the hospital for three or four months. On leaving he could not put his foot on the ground, and could walk only with crutches. The leg was straight, shorter than the right leg, but not painful. He finally discarded the crutches and then his leg began to bend, or bow, outward at the knee. Three years later another operation was performed and plaster mold applied for two months, and when it was removed the patient could walk without the crutches. About three years afterward his leg again began to bow outward at the knee, and at the end of the fourth year he was again removed to the hospital and operated on. The plaster mold was left on for three or four weeks. He then went home with his leg straight and he could walk without crutches. The leg was stiff, but not painful. Gradually it again bowed outward at the knee, and in four years the patient returned to the hospital for a third operation. The plaster mold was left on for five weeks. When it was removed he could walk, but the leg was stiff. It remained straight about three years. About eighteen months ago he was struck on the knee by a piece of coal weighing 20 or 30 pounds, falling from a height of about 4 feet. The patient walked home. The next day he had an aching pain in his thigh and hip which bothered him for about a month. When he began to walk again he noticed that the leg was gradually bowing once more. He had no chills, fever or sweats.

Examination.—There was an outward bowing of the knee, with an abduction of the leg and some rotation inward of the toes. The knee was in a state of complete bony ankylosis. This patient was under my care during his original treatment at the Cook County Hospital. There was then a compound fracture of the femur with a destruction of the inner half of the lower epiphyseal line, taking off a part of the internal condyle and a part of the shaft. The bowing which occurred subsequently is a beautiful illustration of the effect of the removal of a part of the epiphyseal line so early in life. The femur grew in length in its outer half, where the external condyloid epiphyseal line was intact, but did not grow at the inner condyle. This caused a recurrent abduction of the leg and bowing out at the knee. The internal malleolus was 7 inches out of plumb when he appeared for operation. Considering the patient's age it may be assumed that there will be little if any further growth in length of this femur.

Treatment.—I made a complete transverse division of the femur through a longitudinal incision just above the internal condyle, using a thin flat Buck chisel. The bone was divided and fractured. It was hyperadducted, so that there was a gap in the bone three-fourths inch wide at the inner extremity, which was the seat of the greatest bowing. A crease was chiseled in the bone upward and downward for the insertion of the magnesium plate, which measured $1\frac{1}{4}$ inches in width and three-sixteenths inch in thickness. This plate was driven into the crease, so that it spanned clear across the line of fracture. It was driven down to within one-sixteenth inch of the level of the bone. This firmly fixed the fractured ends, preventing lateral or anteroposterior displacement. The deep tissues were approximated with catgut, and the skin with horsehair. Primary healing occurred and primary bony union.

Result.—The last skiagram made in this case shows that the magnesium plate was entirely absorbed except that portion which was extra-osseous. Here some of the plate is still visible. Perfect bony union has taken place.

E. The restoration of bone removed for non-malignant neoplasms, such as osteofibrosis cystica, hemorrhagic cysts, myeloma, etc., has also been accomplished

successfully. The bone should be removed for a sufficient extent, with or without its periosteum, depending on one's ability to make a diagnosis from the gross appearance as to the probability of malignancy. If the periosteum can be preserved, regeneration of bone will always take place, but the conformation of the limb and the speed of reproduction and restoration of usefulness of the extremity are greatly facilitated by the implantation of a fragment of bone from the crest of the tibia. Where the periosteum is removed, it is essential that the implant contact with the living bone at least at one end, so that osteogenetic living elements can pass over into the transplant.

The best plan is to implant the fragment into the medulla and to prevent its penetration to a deeper degree than that desired by blocking it with a nail placed transversely, as has been mentioned previously. If the articular end of the bone has been removed, one end of the transplant should be inserted into the capsule and relieved from pressure by an extension until such time as a soft callus or a mass of fibrous tissue has formed about the implant to fix it. The muscles should then be sutured around the implant in their normal anatomic position. In one case (Fig. 28) $7\frac{1}{2}$ inches of the shaft of the humerus with the epiphyseal line and articular end were removed.

By studying the radiograph (Fig. 29) one can observe the stages of reproduction very well. At the end of five weeks, on palpation, the humerus appeared to be as large as a normal humerus, although the x-ray showed small calcareous deposits only here and there. The development of compact bone proceeded along definite lines— from extensions of the periosteum, from the medulla, through the implant, up to the capsular attachment and into the joint, as shown in the last x-ray picture taken nine months and some days after the operation.

Here also can be observed the evolution of the tuberosities at the points of muscular fixation. Again, it will be noted in Figure 29 how the transplanted periosteum remained as a white line for seven months after the implantation, and that it was an apparent detriment to the production of bone. It was finally involuted by bone formed from the new periosteum around the new-formed callus.

This shows how completely the humerus can be regenerated and how perfectly function of the extremity can be restored in cases in which formerly amputations were made. This patient does not know from anything, except her inability to lift her arm up close by the side of her head, in an extended position, that any operative procedure has been performed on her. This case shows how completely a new bone may be produced in a transplant, and how it enlarges to meet the anatomic and functional requirements.

In the case of my associate, Dr. Golden (Figs. 32-34), it will be seen that ossification commenced from the upper end and that there was a small zone of late infection at the lower end around the nail. Some absorption has taken place at the site of the infection so that osteogenesis in this case must come entirely from the proximal attachment, because of the gap present at the distal attachment. It has extended down now within half an inch of the lower fragment as shown by the dark color in the x-ray made seven months after the operation. In this case Dr. Golden took a fragment, nine and a half inches long, from the opposite tibia and implanted. This case also shows that an infection may take place at one end and not spread throughout the entire bone.

The infection, however, did not show itself until about three weeks after the operation, and then only a very circumscribed accumulation of seropurulent material made its appearance at the point where a nail was placed.

In the myeloid tumors excision of the diseased area well above and below the neoplasm should be the practice, and a bone fragment should be inserted to fill the gap. The same line of treatment is applicable in the case of hematogenous cysts, as these are occasionally infected and it is not safe to resort to curettement and implantation of a fragment of bone.

In septic osteomyelitic cavities fragments of bone should not be used for filling material unless the cavity is rendered absolutely sterile, and of this one can never be certain, except as the subsequent course of the disease may indicate. The aseptic blood-clot of Schede will give as good results as the implantation, if asepsis is attained. The bony canopy of the osteomyelitic abscess should be retained, attached to the periosteum and soft tissues after the plan of Tillmonns and depressed into the cavity at the completion of the operation.

F. For malignant disease of bone, such as giant-cell sarcoma, large spindle-cell sarcoma, encapsulated chondrosarcoma and circumscribed intra-osseous sarcomata, the bone and periosteum can and should be removed for a considerable extent above and below the malignant focus. A fragment is then implanted to fill the gap. We know that a giant-celled sarcoma can be removed by a local operation and the patient survive without local or constitutional recurrence for years. We also know that the same thing is true, in a smaller percentage of cases, however, in the case of chondrosarcoma. In a still smaller percentage of cases the removal of a spindle-cell sarcoma by a local operation without an amputation can be accomplished and the patient live for years without recurrence.

This has led me to hope that the early removal of these neoplasms while they are still circumscribed and encapsulated should give good results. The bone can be removed to a considerable extent with its periosteum, with its musculotendinous attachments, and still an excellent functioning extremity be preserved. With this operative outlook early operation will be conceded by the patient, whereas early operation is practically never conceded when amputation is suggested.

In the case of Mr. N., I removed 5½ inches of the upper extremity of the femur for a chondrosarcoma of the trochanter, which originated from a trauma received two years previously. The x-ray picture showed that the sarcoma involved the trochanter and a portion of the neck and of the shaft for a considerable length downward. The trochanter, neck head and shaft with its immediate muscular attachments, were all removed, as is shown in the skiagrams (Figs. 35-37).

A fragment of bone, 6 inches in length, was taken from the opposite tibia, and inserted into the medulla of the femur at the distal end and the proximal end was inserted into the acetabulum and surrounded by the capsule. A nail was driven through a hole in the fragment to which the muscular attachments could be fixed, thus preventing motion of the fragment and at the same time securing the future function of the leg. Later, when pressure was put on, the bone split at this point. The fragments were immobilized by a circular wire and catgut ligature. The muscle ends were drawn around the shaft in various positions approximating as nearly as possible their normal location. The wound healed *per primam*. Extension was applied to maintain the full length of the thigh during the process of regeneration.

The skiagram (Fig. 36) shows the evolution of bone from the medulla and from the periosteum of the living bone, making a bony involucrum around the soft callus.

In eight weeks the upper end of the femur, judging by external manipulation, appeared to be of full size. The skiagram, however, showed only here and there bony deposits. Regeneration is taking place, as can be seen in the most recent skiagrams taken three months after the operation, between the split fragments and well up into the acetabulum. The patient is going about on crutches and suffers but little pain. He is not permitted yet (3 months after operation) to put any weight on his leg.

The extensions were removed at the end of three months. It appeared to me after operating in this case that it would have been a good plan to use bones from the embryo to surround the compact bony tissue that was taken from the patient's tibia, because this might stimulate regeneration or act of itself in the reproduction of bone.

(To be continued)

VOLUNTARY SUBMISSION TO TREATMENT AND CUSTODY IN HOSPITALS FOR THE INSANE*

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The lunacy laws of some states — and particularly the District of Columbia — are strikingly deficient. While the makers of these laws manifestly knew little of the needs and condition of the unfortunates for whom they sought to provide, the fault must not be charged in whole to them. These legislators acted in accord with the then existing views of the people, and, we may assume, in response to the dictates of their own best judgment. But the knowledge of the people at large on this subject, and that of the legislators in particular, was vague, and the whole face of the problem was charged and surcharged with doubt and suspicion. In place of actual knowledge, there were the long existing traditions that the insane were "mad," that they could be cared for only in strong rooms under constant restraint, and that their very presence was to be shunned as full of danger. Moreover the prognosis of the layman was always very positively unfavorable, and the possibility of a complete recovery never seriously considered. Public knowledge, however, and the sentiment which is its outgrowth, have increased in late years in wonderful degree.

The open methods more recently employed in the management of hospitals for the insane, the publicity concerning such institutions incident to the inspections and reports of lunacy commissions, the activities of boards of charities charged with the care and maintenance of insane persons, and the more intimate professional association of medical men in private practice with those conducting hospitals for the insane, are some of the factors which have brought about an enlightenment of the public. And so it happens that the people are coming into possession of actual facts and laying hold on new beliefs concerning the temporary detention, the early care, the adjudication and court hearings, and the custody and treatment of the insane. The ignorance of the past is giving way to intelligent understanding

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