cludes the various types initiated by infection present within the urinary tract.

The term "pyelitis" long ago came to be used as a general classification for any form of urinary infection. I do not think this gives us an adequate description of the many forms of infection within the urinary tract. In Doctor Hinman's classification, in addition to the type of lesion, we are given the method of invasion and also the area responsible for the infection. The value of this clear-cut classification is apparent when we consider the necessity for satisfactory hospital records and the opportunity for clearly defined descriptions in referring patients to other consultants. In place of classifying a lesion under the general term of pyelonephritis or pyelitis we can now say, for example: Transurethral pyelonephritis (instrumental) which will immediately explain the case as one of renal infection with the primary focus in the urethra due to instrumentation.

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CHARLES P. MATHÉ, M. D. (450 Sutter Street, San Francisco).—We are greatly indebted to Doctor Hinman for his comprehensive clinical classification of renal infections into three distinct groups, viz., specific, focal, and urogenital. The necessity of classification at the present time is indeed very great in order that urologists may have a mutual understanding of how to classify the various infections that we encounter daily in the kidney.

The diagnosis of the focal group of coccal infection of the kidney; acute suppurative nephritis, single and multiple cortical abscess formation and renal carbuncle and those of the renal loge, paranephritis, perinephritic abscess, etc., has always been quite obscure because of the paucity of urinary findings as compared to the severity of the patient's illness. In these cases very little evidence of infection can be found in making a routine examination of the urine. It has been my experience, however, that centrifugalization of the urine collected over a long period of time will often reveal the invading staphylococcus and is of great significance in aiding in the diagnosis of these lesions. They are more often found in cortical lesions of the kidney and less readily encountered if the infection is in the perinephritic tissues. In these cases the history of preëxisting foci in the skin, such as boils, furuncles, carbuncles, paronychia, etc., is of great significance. If the infected embolus lodges in the end arteries of the glomeruli, suppurative nephritis, cortical abscess, or renal carbuncle results. On the other hand, if the staphylococci lodge in the terminal arteries in the perirenal fat, perinephritic abscess develops. Perinephritic abscess may also be formed from direct extensions of a cortical abscess through the kidney capsule or by way of the lymphatics. The significance of early diagnosis of acute suppurative nephritis was pointed out by Brewer in 1906, who recommended early nephrectomy before involvement of the opposite kidney had taken place. It is very important to distinguish between acute suppurative hematogenous nephritis due to the staphylococcus and severe acute pyelonephritis due to the colon bacillus. Early nephrectomy is usually always indicated in the former, whereas renal drainage and lavage through the ureteral catheter is adequate in the latter.

The great incidence of infection of the urethra, prostate and seminal vesicles favor renal infection, often acting as a focus of pyelonephritis. This was strongly emphasized by Professor von Lichtenberg and myself in papers delivered before the American Urological Association in 1929. The relation of infections of the gastro-intestinal tract, gall-bladder, appendix, etc., has long been realized and this entro-renal syndrome was strongly emphasized by Heitz-Boyer a number of years ago. Any treatment directed to relieve renal infection, in order to be efficacious must also be directed toward eradicating all possible foci of infection elsewhere in the body.

Doctor Hinman has done well to emphasize the rôle of congenital and acquired urinary obstruction and stasis in the production of renal infection. Back pressure in the kidney not only may lower its local resistance, making it more susceptible to infection, but may also cause invasion of the renal cortex by organisms that had existed in the pelvis and collecting tubules for years. Thus, a pyelonephritic infection which had not been severe and had caused little appreciable damage to the kidney may extend to its periphery and invade the parenchyma forming numerous abscesses which result in destruction of this organ, thus necessitating nephrectomy.

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LIONEL P. PLAYER, M. D. (384 Post Street, San Francisco).—The author's classification gives surgeons a means of communicating their findings and diagnoses clearly and intelligently. Doctor Hinman's paper is the most concise and comprehensive, yet simple of any offered, to my knowledge, in the literature, and I wish to express my appreciation of his very excellent contribution.

An outline for the classification of urinary infections, may I suggest, should embody the following:

1. Type or types of organisms.
2. Origin of organisms, *i. e.,* skin, sinuses, tonsils, etc.
3. Mode of invasions, *i. e.,* hematogenous, lymphogenous by continuity of tissue or from contiguous tissues.
4. Areas or points infected in the particular organ attacked by these organisms or their toxins.
5. Effect on the organ itself.
6. Effect on contiguous and connecting structures and the general system.
7. Previous knowledge of the general or selective action of these bacteria and their toxins. With these data in mind in a classification as an aid to the various methods of diagnosis, the more apparent and also the obscure lesions due to urinary infections would be recognized more readily.

LENGTHENING OF THE LOWER EXTREMITIES*

By LEROY C. ABBOTT, M. D.
San Francisco

DISCUSSION *by George H. Sanderson, M. D., Stockton; H. D. Barnard, M. D., Los Angeles; S. L. Haas, M. D., San Francisco.*

THE purpose of this article is to describe methods of operative lengthening of the bones of the lower extremity which were developed by the writer † at the Shriners' Hospital for Crippled Children in St. Louis. During the past six years these methods were used in a series of seventy-three children in whom shortening was due to infantile paralysis, congenital malformation, and destructive disease of the hip and knee joints. In forty-eight cases the tibia and fibula were lengthened, while in the remaining twenty-five cases the lengthening was done on the femur. The experience gained in this group of patients has been interesting and profitable, and the results have been decidedly encouraging.

These methods are based on three fundamental principles of bone lengthening, which are as follows: (1) To lengthen the bone, traction and countertraction must be taken directly upon that bone; (2) to overcome the elastic resistance of the soft parts, this traction must be of the slow,

* Read before the General Surgery Section of the California Medical Association at the sixtieth annual session at San Francisco, April 27-30, 1931.

† The writer is indebted to his former associates, Dr. C. H. Crego and Dr. A. O. Adams, for their aid in the development of the apparatus for lengthening of the extremities.

continuous type; and (3) to prevent harmful pressure on soft parts with sloughing of the skin and infection of the bone, accurate contact and alignment of the fragments must be maintained during the lengthening process. The first two principles have been emphasized by Putti in his article on the "Operative Lengthening of the Femur." The importance of the third principle has been stressed in our previous publications on this subject, and its observance is essential for successful lengthening without the development of serious complications.

Theoretically the above principles may be realized by osteotomy of the bone, insertion of pins through the upper and lower fragments, and the application of a special apparatus to provide traction and control while the bone is being lengthened. The practical application of these principles in lengthening of the tibia and fibula has led to the development of a standard method which has been used with uniform success in our clinic and in other clinics in various parts of the country. In lengthening of the femur, however, we have been less fortunate because we have experienced great difficulty in devising apparatus which will maintain alignment of the fragments. In attempting to overcome this difficulty we have developed a number of methods. Satisfactory lengthening and fair alignment can be secured with any of them. With no one of them, however, have we been able to maintain the same uniform contact and alignment of the fragments as in lengthening of the tibia and fibula.

In the following paragraphs, therefore, we shall describe in detail our method for lengthening of the tibia and fibula, but in lengthening of the femur we shall confine our remarks to a general discussion of the various methods employed, emphasizing the advantages and disadvantages of each.

LENGTHENING OF THE TIBIA AND FIBULA

The procedure for lengthening of the tibia and fibula has passed through several stages of development. Originally we used two pins which were drilled through the tibia above and below the site of an osteotomy. Traction was acquired by screw extension pieces fastened to the ends of the pins on both sides of the leg. A special splint with four turnbuckles, also attached to the ends of the pins, was utilized for control of the fragments. Failure to maintain alignment of the bone, however, led to the use of two additional pins which were turned through the upper and lower fragments, respectively. With four pins excellent control of the fragments was maintained and their application aided us in the elimination of the turnbuckles and complicated supporting splint. Furthermore, when four pins are employed, their diameters may be reduced and, consequently, the healing of the wounds is proportionately diminished.

THE APPARATUS FOR LENGTHENING OF THE TIBIA AND FIBULA

The apparatus for lengthening of the tibia and fibula consists of the following parts:

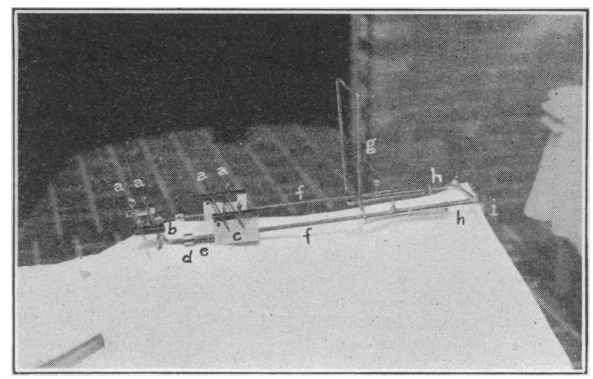

Fig. 1.—Apparatus for lengthening of the tibia and fibula. (a) Stainless steel pins fixed to the stationary and movable blocks b and c. (d and e) Thumb nut and spring fitting against movable block c. (f) Lateral threaded bars. (g) Foot support. (h) Telescopic metal tubes for lengthening of lateral bars. (i) Metal rod for fixation of lateral bars.

1. Four stainless steel drill pins.
2. An adjustable pin guide.
3. A combined traction and supporting splint (Fig. 1).

The pins are nine inches in length and one-eighth of an inch in diameter. They are made of stainless metal, because our experience has shown that there is less irritation to the soft parts than when ordinary steel is employed. The ends of the pins are drill-shaped so that they can be turned through the compact bone without preliminary drilling. This single operation reduces trauma to the soft parts and thereby minimizes the danger of infection.

To insure proper fitting of the traction apparatus it is essential that the pins be turned through the bone parallel to one another and in the same horizontal plane. For this purpose a special appliance termed a "pin guide" was devised. It may be described as consisting of two parts rectangular in shape, each six inches in length, which telescope at their inner ends. Each part has two holes drilled at its lateral extremity into which are fitted cylinders about three inches in length. The telescoping feature of the guide permits insertion of the pins in the upper and lower ends of the tibia in legs of various lengths.

The traction and supporting splint has been gradually modified until at present it consists of two threaded bars connected at their lower ends by an adjustable steel rod.** Attached to each bar are two solid blocks of metal; one is fixed to its upper end, while the other slides freely over its threaded surface. Each of the blocks, the stationary and the movable, have two holes drilled through their substance to receive the ends of the pins. Between the stationary block above and the movable block below a thumb nut and coil spring are attached. With tightening of the thumb nut the spring is forced against the movable block which moves downward and away from the fixed block. Thus the pins fastened to the blocks are separated and a telescoping of the fragments occurs with lengthening of the bones.

** This splint was devised by my former associate, Dr. C. H. Crego.

Two adjustable metal tubes slide over the lower ends of the lateral bars and are fitted with cylinders at their lower ends. After the lateral bars have been adjusted to the ends of the pins the metal rod is placed through the cylinders and held firmly by thumb screws. Thus a rigid and readily adjustable frame is secured. The entire apparatus is simple, easily applied, and possesses a high degree of mechanical efficiency.

THE DESCRIPTION OF THE OPERATION

A forty-eight-hour preparation of the skin of the leg and thigh is preliminary to the operation. On the operating table a tourniquet is applied above the condyles of the femur and the skin is painted with 70 per cent alcohol. The steps of the operation should be carried out in the following order:

1. Lengthening of the tendo Achillis.
2. Osteotomy of the fibula.
3. Insertion of the pins.
4. Application of the extension apparatus.
5. Osteotomy of the tibia.
6. Closure of the wound with drainage.
7. Removal of the tourniquet.
8. Suspension of the apparatus to the overhead bed-frame.

We advise lengthening of the tendo Achillis as a preliminary procedure in all cases except in those which have a calcaneus deformity of the foot. Otherwise the tension thrown on this structure during the process of lengthening forces the foot into equinus. The method is that used by Hoke.

Our next step consists of an osteotomy of the fibula through an incision anterior to the peroneal tendons. We also incise, transversely, the fascia covering the peroneal tendons and the bands which separate these tendons from the extensor longus hallucis anteriorly and the flexor longus hallucis posteriorly.

The pins are now inserted at the upper and lower ends of the tibia, the two above through the anterior third of the bone, and the two below through the middle third of the bone. These positions selected for the pins minimize the danger of injury to the anterior tibial vessels and nerve. With the skin pulled toward the center of the leg, the pin guide is placed firmly against the lateral aspect of the tibia and stab incisions are made at the levels of its four cylinders. The upper pin is then drilled through the tibia at right angles to the long axis of this bone and parallel to its anterior border. The upper cylinder of the pin guide is then passed over the projecting portion of this pin. The lower pin is then inserted by passing it through the lower metal cylinder of the pin guide and turning it through the bone. The two middle pins are now placed in a similar manner. All pins emerge through counter incisions on the inner surface of the tibia.

The lateral bars of the traction apparatus are now placed on the lateral aspect of the leg, fitting the drill holes of the stationary and movable blocks to the ends of the upper and lower pins. The lower ends of the lateral bars are then joined by the metal rod which is fixed in place by thumb screws.

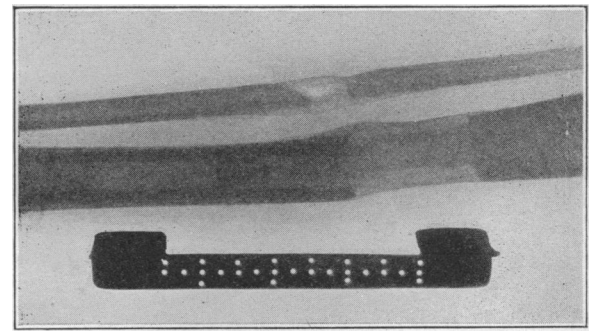

Fig. 2.—Anteroposterior roentgenogram of tibia and fibula two and one-half months after operation. A gain of one and three-fourths inches was secured.

The tibia is exposed through a gentle curved incision, five inches in length, made over the anterolateral aspect of the bone. To minimize the injury to the circulation of the periosteum this incision is carried down to the bone without dissection of the soft parts. The periosteum is then separated from the entire circumference of the tibia for a distance of about four inches, and with a motor saw two parallel cuts, about four inches in length, are made at its inner and outer surfaces. These cuts are joined at their upper extremities by a transverse section through the posterior cortex, and at their lower extremities by a transverse section through the anterior cortex. This provides a tongue on the lower fragment which lies behind the tongue on the upper fragment. At the middle of the wound the periosteum is incised transversely in its entire circumference, together with division of the interosseous membrane and deep fascia on the anterolateral aspect of the leg. The division of these fibrous structures decreases the resistance offered to lengthening of the bones.

The wound is closed in layers and at its upper end a small rubber tissue drain is inserted. The use of the drain prevents marked swelling of the leg subsequent to operation. The foot is suspended to the foot piece by means of an adhesive strip which is glued to its plantar surface. The apparatus is then attached to an overhead bed frame. This allows free motion of the knee throughout the process of lengthening.

POSTOPERATIVE LENGTHENING OF THE LEG

No attempt is made to lengthen the leg until all swelling has disappeared, which is usually at the end of the first week. The drain is removed in forty-eight hours.

Lengthening is begun by tightening of the thumb nuts an equal number of turns on the two sides. Measurements are then taken between the ends of the pins and recorded. On the second day a few more turns produce a little more separation of the fragments and again the measurements are taken. This procedure is carried out daily until the desired length is secured. The average daily gain is one-sixteenth of an inch,

and the entire time of traction is from four to five weeks. To provide a check on the length gained and the position of the fragments, roentgenograms are taken at intervals (Fig. 2).

The extension apparatus remains in place from eight to ten weeks. Upon its removal the leg is encased in a plaster of Paris cast. This cast is bivalved to allow dressing of the pin wounds and motion at the knee and ankle joints.

To determine the state of the repair process, roentgenograms are taken every two to three weeks. In the majority of cases sufficient callus has formed in four or five months to allow the patient to walk with a Thomas walking caliper splint. This splint is worn continuously for two or three months and then gradually discarded.

Your attention should be directed here to the importance of the care of the foot during the period of postoperative traction. Despite the lengthening of the tendo Achillis at the time of operation there is a tendency, during the process of stretching, for the foot to be forced into equinus. Moreover, the foot frequently assumes a marked valgus position, even if it had been stabilized previously. We deem it unwise, therefore, in dealing with cases of infantile paralysis, to stabilize the foot before lengthening of the bones is done. During the process of lengthening of the leg we aim to control the position of the foot as far as possible, but if unpreventable deformities arise we correct them by stabilization at a later date.

LENGTHENING OF THE FEMUR

In the first stages of our work on lengthening of the femur we attempted to use traction on one side of the thigh in a similar manner to that advocated by Putti. In our hands the method was unsatisfactory; first, because the pins were not secure and, second, because we were unable to control the position of the fragments. Consequently a procedure was devised similar to that used early in the development of a method for lengthening of the tibia and fibula. Two pins, three-sixteenths of an inch in diameter, were inserted in a transverse direction in the upper and lower ends of the shaft of the femur. The lower pin was introduced through a stab incision on the lower inner thigh three-fourths to one inch above the epiphyseal line. To avoid injury of the femoral and profunda vessels the upper pin was inserted through an incision made on the upper inner aspect of the thigh which exposed the inner border of the adductor longus muscle. The fascia overlying this muscle was traced inward until the femoral vessels were seen lying between this muscle and the inner surface of the femur. The vessels were retracted forward and the pin was then passed through the substance of the adductor longus muscle and turned through the bone and a counter incision on the outer aspect of the thigh. The femur was then exposed through an incision on its posterolateral aspect with separation of the biceps femoris and vastus lateralis muscles. After elevation of the periosteum about the entire circumference of the bone for a distance of four to five inches, a Z-shaped osteotomy was performed with a motor saw and osteotome.

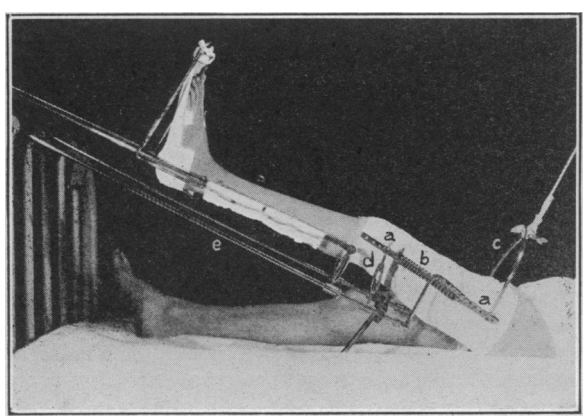

Fig. 3.—Apparatus employed in two horizontal pin method for lengthening of the femur. (a) Upper and lower pins. (b) Screw extension pieces attached to the ends of the pins. (c) Steinman stirrup for support of upper pin. (d) Turnbuckle for control of lower pin. (e) Supporting splint with knee flexion piece.

Traction was secured by screw extension pieces which were fastened to the ends of the pins on both sides of the thigh. The screw extension pieces also prevented lateral displacement of the fragments. Control of their position in the anteroposterior plane was facilitated by the use of a supporting splint, knee flexion piece, and turnbuckles (Fig. 3). The results secured in the fifteen cases operated upon were entirely satisfactory from the standpoint of lengthening secured. In one case we obtained as much as three and one-half inches. The chief difficulty was inability to maintain contact and accurate alignment of the fragments, particularly in the anteroposterior plane. In several cases a very considerable displacement occurred. Again there is a reasonable objection to this method because of the incision required to place the upper pin. A rather painstaking dissection must be carried out and the risk of infection of the wound is increased. Our experience with this method has shown that mild sepsis with long-continued drainage is prone to occur where the pins are inserted through incision and dissection.

Anticipating better control of the fragments, we used four small pins with the same traction splint which we now use in the lengthening of the tibia and fibula. We found, however, that the insertion of four pins parallel to one another and in the same horizontal plane in a very much shortened femur was a complicated procedure. While better control of the fragments was acquired in the two cases operated upon, we abandoned the method because of the technical difficulties of operation.

To avoid an incision on the upper inner thigh we transfixed the upper fragment in a vertical direction as advocated by E. C. Bull of San Francisco. Traction was then applied by screw extension pieces, the upper ends of which are fastened to the vertical pin while the lower ends are attached to two horizontal bars which are

fixed to two vertical uprights. Through perforations in their substances these vertical uprights are attached to the ends of the pins. The use of the vertical pin lessens the chances of displacement of the upper fragment in the anteroposterior plane, but it does not eliminate its deviation in a lateral direction. A further objection is that the wound in the region of the buttock may become infected, and in one of our cases a considerable slough of this wound occurred from pressure of the traction apparatus. Nevertheless we are favorably impressed with this method and believe it worthy of a more extended trial.

We have also used an upper vertical and two lower horizontal pins in two consecutive cases. In both instances satisfactory lengthening was secured. In one, good alignment was maintained, while in the other, considerable displacement of the fragments occurred.

In patients with ankylosis of the hip we have lengthened the femur by means of the Hoke traction plaster with a horizontal pin through the lower fragment. A plaster of Paris spica is applied to the sound limb, bringing the plaster well down over the pelvis on the opposite side. The free end of a U-shaped stirrup of iron bar about six inches longer than the shortened leg is then incorporated in the plaster spica. To the lower end of this stirrup a rachet is attached. Traction is obtained through chains which are fastened at their upper ends to the pin, at their lower ends to the rachet. Countertraction is effected against the sole of the foot on the sound leg. It is surprising the facility with which lengthening occurs with this method. The alignment of the bone is more readily maintained because of fixation of the upper fragment.

In one case with a freely movable hip we employed the Hoke traction method with a vertical pin to maintain alignment of the upper fragment. Satisfactory lengthening was obtained with only a moderate displacement of the fragments.

From the foregoing paragraphs it will be seen that none of the methods developed for lengthening of the femur were satisfactory in every respect. In ankylosis of the hip joint, lengthening can be accomplished in the simplest and most effective manner by the Hoke plaster apparatus and skeletal traction. With a movable hip-joint transfixion of the upper fragment by horizontal or vertical pins seems necessary to maintain alignment. This alignment and contact of the bony fragments is of importance in the prevention of delayed union, and we find that the time required for consolidation of the callus is in direct ratio to the degree of their separation. The undesirable feature of transfixion of the upper fragment by horizontal or vertical pins is the danger of infection with subsequent drainage of the wound. Therefore the most scrupulous technique should be used in their insertion and in after-care of the wounds. It is possible that the danger of infection may be further minimized by the use of a fine wire in place of a steel pin, and it is our intention to try this method in the near future.

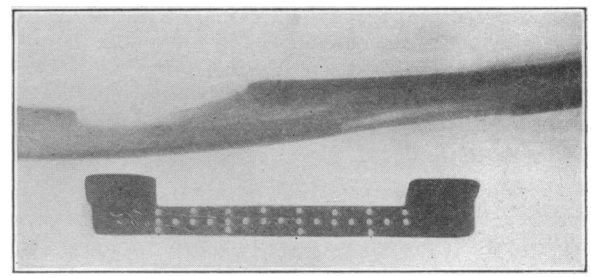

Fig. 4.—Lateral roentgenogram four months after lengthening of the femur in a case of infantile paralysis. A gain of two and one-half inches was secured.

POSTOPERATIVE LENGTHENING OF THE FEMUR

The postoperative lengthening of the femur is much the same as described for the tibia and fibula. In the former, however, we have found it feasible to begin traction on the fourth or fifth day after operation. Furthermore, we are able to lengthen this bone with greater rapidity and have gained as much as one-eighth of an inch per day in comparison with the average daily lengthening of one-sixteenth of an inch obtained in the tibia and fibula (Fig. 4).

After consolidation of the callus, ambulatory treatment is best carried out by supporting the limb in a plaster of Paris spica. The walking caliper splint is not sufficient for protection and does not prevent leverage action at the site of union. In two of our patients fractures occurred which were directly attributable to this leverage action.

RESULTS

The operation has been performed on seventy-three patients. In forty-eight the tibia and fibula were lengthened, while in twenty-five the lengthening was performed on the femur. The maximum gain in length of the tibia and fibula was three and one-fourth inches, the minimum one and one-half inches. In the femur the maximum gain was three and one-half inches, the minimum one inch. The gain of but one inch occurred in a child five years of age in whom union took place before the desired length could be obtained. In two patients gains from four to four and one-half inches have been secured by separate lengthening of the femur and tibia. The oldest patient operated upon was nineteen, the youngest eight.

The average time of union of the fragments in operative lengthening of the bones of the lower extremity sufficient to permit weight bearing with protective splints was from four to five months. In lengthening of the femur, where there was separation of the fragments, the time required for union was increased in direct proportion to the degree of their separation. In both tibia and femur lengthenings with good alignment of fragments, restoration of the medullary canal was observed in from ten to twelve months after operation.

COMMENT

To obtain the most satisfactory results with these procedures the surgeon must use discretion in the selection of his cases. He must be certain

that the shortening of the limb plays a major part in the production of the disability. In the presence of other contributing causes, as is so frequently seen in crippling conditions of childhood, the determination of the importance of the shortening as a source of disability must not rest alone on comparative measurements of the extremities. It has been our practice, therefore, to have the patients walk on boards of various heights so that we may detect any change in gait. The height of the board which produces the greatest improvement in gait may be used as an index for the length desired. A striking example of the importance of this preliminary examination of the patient's gait is seen in cases of anterior poliomyelitis with gluteus medius paralysis. Such a patient often walks better with a certain amount of shortening, and to lengthen the limb to the full amount, as disclosed by measurements, would often increase the disability. It should also be pointed out here that contributing causes of disability should be removed as far as possible before lengthening of the leg is to be considered. The notable exception to this rule is deformity of the foot which is often best corrected subsequent to lengthening of the bones.

Complications have occurred much less frequently in lengthening of the tibia and fibula than where the lengthening was done on the femur. In the former we have had two incomplete fractures through the callus subsequent to operation. In the latter we have had seven fractures through the callus occurring in cases with displacement of the fragments and in which inadequate protection was provided during early weight bearing. In instances of faulty alignment with massive callus formation the danger of fracture may be lessened by immobilization until consolidation has taken place, and by providing proper protection when the patient becomes ambulatory. In all of the fractures union has occurred with conservative methods of treatment, namely, complete rest and fixation of the limb.

We have had three cases of paralysis from injury to the nerves. In one operative lengthening of the tibia and fibula a paralysis of the dorsiflexors occurred immediately after operation. We attributed this to direct pressure of the upper pins against the anterior tibial nerve. That we were correct in our assumption was proven by the disappearance of the paralysis a few weeks after the pins were removed. In this patient we gained two inches of lengthening. In two cases of femur lengthening we had injury of the sciatic nerve with paralysis of the muscles which control the foot. In one of these the stretch on the sciatic nerve was produced by a faulty position of the limb following the operation. To maintain alignment of the fragments we fixed the extremity with right-angle flexion of the hip and complete extension of the knee, a position which placed the maximum tension on the sciatic nerve trunk. This resulted in paralysis of the foot muscles after we had secured one inch of length. Despite this paralysis we brought the hip into full extension and gained two inches in length. The second case of paralysis of the sciatic nerve was caused by subluxation of the knee, prominence of the head of the fibula and lengthening with the hip held in flexion. In the first patient the paralysis cleared up entirely in three months' time; in the second, a partial recovery had taken place at the time of the last observation, which was about four months after operation.

Infection of the wounds for exposure of the bones occurred in one case of operative lengthening of the tibia and fibula. A localized osteomyelitis developed which required drainage and sequestrectomy. Despite the infection a gain of two inches was obtained. In another patient, sepsis of the operative wound in lengthening of the femur was due to an infection of the operator's throat. Cultures from the wound and throat of the surgeon showed hemolitic streptococci. Thorough drainage of the soft parts was instituted, but no operation on the bone was necessary.

Infections of the pin wounds have not been a troublesome feature in the operative lengthening of the tibia and fibula. In the four-pin method the wounds have healed in an average time of three weeks. With the larger pins in femur lengthening, a period of four to six weeks is usually required for complete healing. In several cases where the upper pin was introduced through the femur by incision, infection with prolonged drainage has occurred. In some of these, healing was not secured until after removal of small ring-shaped sequestra. This again emphasizes the importance of avoiding incisions for insertion of the pins.

SUMMARY

1. In this article the writer has described methods which he has developed for the operative lengthening of the tibia and fibula and the femur. These methods have been used in seventy-three children. The oldest patient was nineteen, the youngest eight.

2. The method for lengthening of the tibia and fibula may now be regarded as an excellent procedure where marked shortening is a cause of serious disability.

3. A number of methods have been developed for lengthening of the femur. Our difficulty with all of them has been in maintaining alignment of the fragments. Failure to control the position of the fragments is the main cause of delayed union and postoperative fracture. In its present stage of development we regard the operation for lengthening of the tibia and fibula as safe and sound in the hands of those experienced in bone surgery and who, in addition, have familiarized themselves with every detail of operation and postoperative care. We are hopeful that with further experience a method for operative lengthening of the femur will be devised which will be as simple and effective as that employed for the operative lengthening of the tibia and fibula.

2000 Van Ness Avenue.

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DISCUSSION

GEORGE H. SANDERSON, M. D. (809 Medico-Dental Building, Stockton).—Operations to equalize the length of the lower extremities have been done for many years by various methods and with varying degrees of success. Rizzoli as early as 1847 equalized the lower extremities by shortening the normal leg, and this method has been more or less in use ever since.

Leg lengthening is far more constructive as it aims at the production of the natural length of the leg by operating on the affected side. It has the additional advantage of being no risk to the normal, or the more normal leg. However, bone shortening has its indications. It is much easier to do, is somewhat less risk, and the period of postoperative disability is considerably shorter. Where a person happened to be taller than desirable, and the legs unequal, the desired shortening would be accomplished. This is however, rarely the case, as almost all cripples are below the average stature, and would therefore much desire to be taller.

Sensing the desirability of the preference of lengthening, Codivilla in 1905 began lengthening the lower extremities in cases shortened following fractures, by means of osteotomy followed by skeletal traction. Many others then used this method. The results were not very satisfactory as the desired degree of lengthening was not obtained, and delayed union usually ensued.

In 1918, Putti reported the use of an instrument which produces both traction and countertraction directly upon the bone to be lengthened, as well as continuous elastic expansive traction, by means of an incorporated spring. This instrument embodies some of the principles which Doctor Abbott has developed in his method.

While Putti reported some excellent results, in spite of the inevitable delayed union, his apparatus was not successful in the hands of others, and leg lengthening became quite unpopular, most operators returning to the old shortening operations for equalization, or being content with shoe irons and other unsightly and clumsy mechanical contrivances to make walking possible on the two legs.

Up to the time of Doctor Abbott's work, bone lengthening had been done almost entirely on the femur, and practically all successful cases had been those where shortening had been due to fracture. Doctor Abbott set out to develop a method applicable to shortening due to infantile paralysis and other conditions in childhood which result in growth disturbances. This is a more difficult problem in that it deals with a condition where the desired length has never existed. He soon found that in infantile paralysis, shortening takes place to a greater extent in the tibia and fibula than in the femur, and made his apparatus applicable to the lengthening of these bones as well as to the lengthening of the femur. Furthermore, he developed the only method which maintains contact between and accurate alignment of the fragments. This was found to be more easily maintained in the lower segment of the leg, while the lengthening itself was found to be somewhat more difficult there. This method has also practically done away with the development of delayed union, which was the rule with previous procedures. Last year I had the good fortune to visit the Shriners' Hospital at St. Louis and see this wonderful work going on under the supervision of Doctor Abbott. I was truly amazed to find not less than eight patients there undergoing leg lengthening at the same time. It was most pleasing to see this very major complicated procedure being carried out there with no evidence of concern, in a matter of fact way as if it were practically a routine procedure. I am sure you will all feel after seeing his pictures, as I did, after visiting his clinic, that this development is really a great contribution to surgery.

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H. D. BARNARD, M. D. (2400 South Flower Street, Los Angeles).—The bone lengthening procedure, as worked out by Doctor Abbott, constitutes a distinct contribution. Our experience at the Orthopedic Hospital in Los Angeles dates back to May 1929, and in our total of eight cases, we have been decidedly conservative in selecting patients with proper regard as to the indications, and have been impressed with the results.

The procedure is undoubtedly a major undertaking and requires scrupulous attention to detail. The results obtained by the use of the four-pin apparatus indicate that the keeping of proper alignment is decidedly facilitated. In our series, one infection occurred which apparently in no way affected or compromised the end result, which was perfectly satisfactory. In these cases we obtained an average increase in length of approximately two and one-eighth inches. The procedure should not be attempted by surgeons not accustomed to the frequent surgical invasion of bone, nor in a hospital where the entire personnel is not familiar with the practical problems associated with the care of patients in apparatus of this type. We feel that great credit is due Doctor Abbott in placing this procedure on a practical basis.

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S. L. HAAS, M. D. (450 Sutter Street, San Francisco).—Bone lengthening has been placed on a sound practical basis by Doctor Abbott. One is prone to forget after performing this operation that it took some courage primarily to sever practically all the main hindering tissues of the leg and then subject the vessels and nerve to a stretching of one or more inches. Just how much would the vessels and nerve stand without permanent injury, the possibility of gangrene, infection, failure of union and the yielding of the soft osteoid callus to traction, were important problems that had to be solved. The success of the operation is sufficient proof that all these questions have been answered during the period of investigation.

At the Shriners' Hospital in San Francisco twenty-five tibial lengthenings have been performed. We have utilized the original Abbott apparatus with two pins, without the equalizer, in most cases. Although at times there has been some displacement of the fragments, the clinical results in all the patients have been satisfactory. Recently we have been using an apparatus designed by Moore of Chicago which is rather simple to manipulate and gives good results. We have subtituted movable side pieces with multiple holes instead of his fixed side plate. This does away with the necessity of sterilizing the apparatus and driving the pins in an exact line. With the movable plates the apparatus can be put on at the completion of the operation.

It is important, as Doctor Abbott pointed out in his original article, to inspect frequently the line of incision on the dorsum of the foot and to watch out for pressure necrosis of the skin. Do not try to hold the fragments down with external pressure over the crest because of the danger of skin necrosis. In one patient we had a wide separation of the skin after the stitches were removed, but the wound healed without any bone infection. We have had no cases of osteomyelitis.

It may be well to postpone the stabilizing operation until after the lengthening, but we usually perform the stabilization of the foot about the ninth year and

the lengthening two or more years later. We have not been bothered by the subsequent deformity of the foot, but there has been a tendency toward loss of motion in the ankle joint and increase of the equinus.

The selection of a suitable case for lengthening demands considerable judgment, as stated by Abbott. In the patients with weak hip muscles it is often difficult to decide whether the bad gait is caused by the weak glutei or by the shortening. Whenever it is necessary we have performed the Ober or Legg operation as a supplementary procedure.

Some surgeons advise against lengthening operations unless the shortening is at least two inches. It is well known that the pelvic tilt will take care of one and one-half inches of shortening, but a shortening of one inch in paralytics may cause more disturbance than two inches in a nonparalytic. Furthermore, it is often difficult to determine the amount of lengthening that is best for the individual. The alignment test and walking with a raise on the shoe is advisable, but I believe that lengthening up to the full amount of measured shortening is advisable because, as a rule, a further shortening takes place up to the time of full growth.

As most of our lengthenings have been done on patients already suffering from a rather severe degree of paralysis, one may experience more trouble should an attempt be made to lengthen a leg without primary nerve disturbance.

The observation on femoral lengthenings is limited to the results of eleven operations. The most troublesome complication has been the restriction of flexion of the knee joint after operation. This I believe is due to a fibrosis in the joint itself, secondary to reaction of the pin near the quadriceps pouch.

With the use of the Hoke traction apparatus, one could perform a lengthening of the femur quite satisfactorily. It may be advisable to place one pin in the upper end of the tibia for the first part of the lengthening and then, if necessary, utilize a pin in the femur for the completion of the operation.

TEMPORAL LOBE LESIONS: DISTURBANCES OF THE VISUAL PATHWAYS*

REPORT OF CASES

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DISCUSSION *by Howard W. Fleming, M. D., San Francisco; Carl W. Rand, M. D., Los Angeles.*

THE object of this paper is to call attention once more to certain facts that will aid in the correct and early localization of intracranial neoplasms. Since the visual fibers, either primary or secondary, extend almost the entire length of the anteroposterior diameter of the cranial vault, it is evident that the interpretation of signs and symptoms resulting from their interruption by a disease process becomes vitally important and affords valuable information from a localizing standpoint. This is especially true in lesions of the temporal lobe.

LOCALIZATION OF INTRACRANIAL NEOPLASMS

The greatest problem in connection with intracranial neoplasms has been not so much the diagnosis itself as the localization of the lesion once the diagnosis is made. This is especially true in those cases in which the so-called silent areas of the brain are involved and it, therefore, behooves us as diagnosticians to call attention to and utilize every possible means at our disposal to make as early and as accurate a diagnosis as is possible.

In 1899, thirty-one years ago, Byron Bramwell,[1] in an article on the localization of brain tumors, made the statement that "tumors of the temporosphenoidal lobe, and more especially those of the right side, were of all tumors the most difficult to diagnose because they involved the most silent areas of the brain." Such a statement was the result of the lack of accurate anatomical knowledge of the structures involved in the temporal lobes, namely, the visual pathways.

The anatomical details of the visual tracts were accurately worked out and described by Niessel, Von Magendorf, Archambault, and other anatomists, but it was Adolf Meyer [2] who in 1907 first realized the clinical significance of these findings. He called attention to defects in the visual fields resulting from lesions affecting the optic radiations during their passage through the temporal lobes where they make a forward and ventral detour around the temporal horn of the lateral ventricle before reaching the calcarine fissure of the occipital cortex (Figs. 1 and 2).

The importance of these anatomical findings was still unrealized as late as 1911, when Foster Kennedy,[3] in a careful symptomatic analysis of nine cases of temporosphenoidal lobe tumors from the records of the National Hospital of Queens Square, London, failed to attach any significance to the value of defects in the visual fields, saying that "an examination of the pathological findings suggests the probability of a hemianopsia having been present during life. Five patients were examined perimetrically and the sole abnormality discovered was the concentric contraction of the visual fields, so often associated with severe and especially protracted papilloedema."

Cushing [4] in 1921, however, in a series of cases with careful perimetric studies, pointed out the early involvement of the visual pathways in temporal lobe tumors. Of thirty-nine cases in which perimetry was possible thirty-three showed homonymous field defects, indicating involvement of the temporal loop of the optic radiation. He also called attention to the partial or quadrantal field defects which may later develop into a complete homonymous hemianopsia as being an early characteristic finding of temporal lobe involvement and urged the use of careful perimetry in all cases where a tumor is suspected.

A further contribution was made in 1925 by Lillie,[5] who found that in one-third of a series of 168 cases of verified cerebral tumors the tumors occurred in the temporal lobe, and that forty-three out of fifty-one of these cases presented homonymous defects in the perimetric fields.

All four cases here presented had temporal lobe pathology and all of them showed characteristic visual field defects that were of localizing value. In three of the cases localization was possible by the perimetric field defects only, the neurologic

* Read before the General Medicine Section of the California Medical Association at the fifty-ninth annual session at Del Monte, April 28 to May 1, 1930.