Thus there are two vaginas, the septum between which is removed in ten days or two weeks by clamp pressure. In addition to the four cases reported by Baldwin the small intestine has been employed in six instances to form an artificial vagina, thus making ten in all. Stoeckel (1912) and Abadie (1912) each proceeded in substantially the same manner as Baldwin. Mori (1909), Mueller (1910), and Halbans (1912) isolated a segment of ileum, closed the upper (oral) end, and dragged the other (cæcal) end down to the vulva, re-establishing, of course, the intestinal canal by anastomosis. It is difficult to understand how, without dangerous cutting or tearing of the mesentery, this dragging down of one end of the isolated segment could be accomplished, unless the site of anastomosis also was dragged down into the pelvis and kinked. In order to avoid this traction on the site of anastomosis, without compromising the nutrition of the bowel, and desiring to construct a single vagina, instead of a double vagina as in the Baldwin operation, we removed a portion of the bowel, as described above. If the uterus had been present we should have sutured the upper end of the transplanted bowel around the cervix.

Of the ten patients thus far operated upon all recovered and secured an excellent result. Stoeckel found that in his case the mucous membrane of the transplant continued to elaborate intestinal juices, and that the amount varied with the character of the food taken into the stomach; thus on an albuminous diet the total quantity of secretions in 24 hours was 6.2 c.c., on carbohydrates 3.7 c.c., and on fats 2.1 c.c. Stoeckel calls attention also to the increased danger of absorption and poisoning if corrosive sublimate, carbolic acid, lysol, or other strong antiseptic is employed as a vaginal douche.

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STATED MEETING HELD DECEMBER 2, 1912

DR. GWILYM G. DAVIS, President, in the Chair.

INFECTIONS OF THE HAND.

A REVIEW OF 90 CASES.

BY LEROY W. HOON, M.D.,
AND
GEORGE G. ROSS, M.D.,
OF PHILADELPHIA.

THIS study is based upon all the cases of infection of the hand treated in the German Hospital Surgical Dispensary from April 1, 1912, to October 1, 1912. Ninety cases in all were treated during these six months, and it is of incidental interest to note that during this period only five cases of infection of the foot presented themselves for treatment.

In the main we followed closely the anatomy, diagnosis, and treatment as urged by Allen B. Kanavel, of Chicago, in his most excellent book, "Infections of the Hand." This line of treatment was a radical departure in several respects from our former treatment, but as the first few cases so treated gave such splendid results, we have been using Kanavel's method or a modification ever since.

The less severe cases will be taken up first, as we wish to reserve the deep infections for more emphatic discussion. Under the less severe infections come felons, paronychiæ, carbuncles, furuncles, infected blisters and cuts, and other superficial infections.

Felons (*Nine Cases*).—By "felon" we mean an infection occurring within the closed connective-tissue space which exists in the pad over the palmar surface of the distal phalanx of the thumb and fingers. Seven of these cases were seen before pressure had shut off the vessels supplying the diaphysis of the distal phalanx and thereby caused osteoperiostitis. These cases were at once arrested, and made rapid and complete recovery by making a deep lateral incision, opening the perios-

teum to evacuate the pus, and dressing the part with hot, wet 4 per cent. boric dressings for a day or two. Two of the cases already had osteoperiostitis of the diaphysis of the phalanx when first seen. The epiphysis was not involved in either case and immediate and complete removal of the diaphysis was practised. Both cases recovered with the joint intact and had a functionating stump. The Klapp suction cup and baking hastened the cure in one case. Nitrous oxide anæsthesia was used in all cases.

Paronychiæ (*Four Cases*).—These cases were all treated as advised by Kanavel, *i.e.*, under nitrous oxide anæsthesia a longitudinal incision was made along the lateral edge of the nail, going back as far as the sulcus and being especially careful not to cut the nail bed or overhanging cuticle. The eponychium was then pushed back, point of scissors inserted beneath the detached edge of the nail, and as much of the nail as had been lifted from the nail bed by pus was snipped off. Subsequent dressings of hot, wet boric for two or three days, followed by dry dressings, rapidly cleared up all four cases.

Carbuncles, Furuncles, Infected Blisters and Cuts, with other Superficial Infections (*Fifty-four Cases*).—Carbuncles and furuncles were treated under nitrous oxide anæsthesia by crucial incisions extending beyond the indurated area, followed by thorough undercutting of all four flaps. Squeezing of pus outward was avoided, and for two or three days following wet boric dressings were used. Recovery was hastened by the suction cup in several cases. Necrosis of the flaps was conspicuously absent and thereby less scarring resulted. Perfect drainage occurred. The infected blisters and cuts were opened where needed, and hot, wet boric dressings applied until the discharge began to thin, when iodine and dry dressings were used.

Every one of these 54 cases was saved from becoming a deeper infection by these simple means.

Having disposed of these less serious cases, we now approach the deep infections of the hand—those hidden struggles between microbe and body protoplasm deep in fascial space or

tendon sheath, the prize of battle being a pliant, useful hand, or the pathetically twisted "claw hand" so often seen.

Twenty-three cases of this nature were treated, and in comparison with the usual outcome in such cases the end results were most gratifying. An outline of the anatomy and operative incisions advocated by Kanavel should precede any discussion of these cases.

ANATOMY.

The anatomical knowledge needed is not so much a knowledge of the attachments of the palmar fascia and superficial transverse ligament, palmar arterial arches, and anterior annular ligament as it is an understanding of the fascial spaces and flexor tendon sheaths.

Pus may collect in the following six fascial spaces:

1. Dorsal subcutaneous, an extensive area of loose tissue over the extensor tendons of the back of the hand.

2. Dorsal subaponeurotic space, lying between the extensor tendons and the metacarpal bones.

3. The hypothenar space, an unimportant intermuscular space occupying the hypothenar eminence. Pus located here would not burrow into deeper spaces, but would spread to the surface.

4. The thenar space, an important space in the thenar eminence. It lies entirely to the radial side of the middle metacarpal and upon the palmar side of the adductor transversus muscle.

5. The middle palmar space, another important space, lying between the metacarpals and deep flexor tendons and extending from the middle metacarpal bone to the fifth metacarpal, and having extensions along the three outer lumbricals into the webs.

6. The web space, a subcutaneous space in the finger webs.

Besides these fascial spaces, the following flexor tendon sheaths are of the utmost importance:

1. The tendon sheaths of the index, middle, and ring fingers, extending from the middle of the distal phalanx to a line joining the ulnar end of the distal palmar crease and the

radial end of the proximal palmar crease (Kanavel's line).

2. The tendon sheath of the flexor longus pollicus and radial bursa. This extends from the base of the distal phalanx and when connected to the radial bursa (as it is in 19 out of 20 cases, Poirier) it extends to the lower end of the radius.

3. The tendon sheath of the little finger and the ulnar bursa, when connected (as in 50 per cent. of cases) extends from the distal phalanx of the little finger to the lower end of the ulna.

INCISIONS USED IN OPENING FASCIAL SPACES AND TENDON SHEATHS.

These incisions offer the most intelligent approach to deep pus pockets with the best drainage and least amount of after-scarring:

1. The tendon sheaths along the fingers are opened laterally along the proximal and middle phalanges; if sufficient drainage is not gained by these incisions, we may open laterally opposite the proximal interphalangeal joint as well.

2. The thenar tendon sheath may be split up to a thumb's breadth distal to the anterior annular ligament so as to avoid cutting the motor nerve going to the thenar eminence and thereby destroying apposition of the thumb.

3. The hypothenar tendon sheath may be cut from the base of the little finger up to the anterior annular ligament.

4. The ulnar or radial bursæ above the wrist. One incision is made on the ulnar side 1½ inches above the tip of the ulna and extending down to and across the flexor surface of the ulna. A closed hæmostat is now thrust across both ulna and radius and pronator quadratus, and a counter-incision made upon the radial side of the wrist, where the hæmostat shows beneath the skin. These incisions should both be enlarged to 1½ inches up the forearm.

5. The middle palmar space. This is opened by cutting into the lumbrical canals, preferably choosing the one between the middle and ring fingers. This incision may be carried 1½ thumb breadths up the palm and a hæmostat thrust beneath the deep flexors into the middle palmar space (Besley).

6. Combined opening of the middle palmar and thenar space. A hæmostat is pushed through the incision just described for opening the middle palmar space, pushed across the middle metacarpal bone through the thin partition between this space and the thenar space, and on across the adductor transversus muscle to the dorsum between the first and second metacarpals at about the middle of the second metacarpal. A counter-incision is made here and a rubber dam drain left in for about 18 hours as a rule.

7. Combined opening of the middle palmar space and subaponeurotic space. In the space between the middle and ring metacarpals where the middle palmar crease crosses, an incision is made and a hæmostat thrust through to the dorsum, where a counter-incision is made.

8. The thenar space. This may be opened by one incision through the dorsum on the radial side of the second metacarpal opposite the middle of that bone and on a level with its flexor surface. A hæmostat is then thrust through into the thenar space, being careful not to go beyond the middle metacarpal. No counter-opening on the palm is needed.

9. The subaponeurotic space is drained by adequate incision upon the dorsum over the interosseous spaces.

10. The hypothenar space is opened as any minor localized infection by direct incision.

DISCUSSION OF THE CASES OF DEEP INFECTION TREATED.

During the six months' period, 23 cases of this nature presented themselves for treatment, having infections classified as follows:

Tendon sheath infections	10
Middle palmar space infections	14
Thenar space infections	4
Collar button abscess at web	4
Dorsal subcutaneous infections	2
Dorsal subaponeurotic infections	2
Hypothenar space infections	1

The average age of these cases was 28 years, 19 were male and 4 female. Regarding cause, 9 arose from infected

cuts, etc., 5 from infected blisters, 1 from a bruise, and 8 from unknown cause. Six days was the average elapsed time between onset and first visit to the dispensary. The most prominent symptoms were pain, disability, and loss of sleep. Constitutional symptoms as chill, fever, and loss of appetite were present in about one-half of cases.

In diagnosing the location of pus, the most valuable aids were as follows:

1. In the frog felons or collar button abscess, web tenderness and redness, and a semiflexed position of the adjacent fingers.

2. In the tendon sheath infections, exquisite and unmistakable tenderness over the course of the sheath, a flexed position of the finger, and great pain upon attempting to passively extend the finger, were the three cardinal signs. Necrosis of tendon had already occurred in five cases, and necrosis of bone in three cases.

3. In the fascial space infections, the chief signs were localized tenderness over the thenar or middle palmar space, induration, flexion of the fingers with painful extension, loss of concavity of the palm with slight convexity in middle palmar infection, and ballooning of the thenar eminence with pushing outward of the first metacarpal in thenar space infections. Œdema and redness of the back of the hand was an ever-present feature, but tenderness was much less than that of the palmar surface, and in only three cases was pus present in the dorsum, this being diagnosed chiefly by induration.

As to treatment of these 23 cases, the incisions recommended by Kanavel were faithfully followed, with one exception, which will be discussed later. Nitrous oxide and oxygen anæsthesia was sufficient in 18 cases, ether being used in five cases. Preliminary bandaging of the forearm and arm above the operative field with elastic rubber bandages was tried in the first two cases. Kanavel advises this procedure in order to render the operative area bloodless and by subsequent gradual loosening over a period of about 18 hours to gradually allow the newly liberated toxins to enter the circulation, and thereby give the system a chance to form defensive products. After

carefully observing the effect upon these two cases, this procedure was abandoned as an unnecessary elaboration of technic, no deterioration of results being noted in the other cases. Irrigation of the infected areas after incision was also abandoned after using it in eight cases, and a rigid avoidance of any forcible squeezing or attempts to milk pus out of deep areas was practised in all cases. If adequate incision was made and wet hot boric dressings applied until the parts were draining freely, we found that the subsequent profuse and at first almost alarming discharge of thick clotted pus so moistened the edges of the incisions leading to the pus pockets as to preclude any danger of these incisions glueing shut.

In cases where tendon sheaths had been incised, the hand and fingers were dressed in extension with a wooden dorsal splint until all danger of tendon prolapse was past.

Passive motion of the fingers and hand was started on an average upon the second day after operation, and no extension of infection occurred from this practice. Exploratory incisions into areas which proved to be free from infection were made in seven of the cases, only one of these subsequently becoming infected—this case cleared up long before the original infection and did no ultimate harm.

Hot boric dressings were kept up on an average three days after operation, and were then discarded for dry dressing. Secondary operation was required in nine cases and secondary arterial hemorrhage (from a digital artery) occurred in only one case. Perfect restoration of function was secured in 18 cases and partial restoration in five cases, these latter cases already having developed bone or tendon necrosis before applying for treatment.

RÉSUMÉ.

In the 90 cases studied we wish to emphasize these points:

1. The 67 cases of simpler infection were all saved from becoming serious infections by the simple treatment outlined above.

2. The beautifully simple anatomy of the hand and forearm in relation to infective processes as emphasized by Kana-

vel forms an amply sufficient foundation upon which can be successfully built up treatment for simple or grave infections of these parts.

3. For the 23 cases of deep infection, the incisions recommended by Kanavel resulted in the most perfect restoration of function with the least after-scarring.

4. An utter disregard of the so-called danger of opening up uninfected areas in the hunt for pus did not result in harm. Incisions into doubtful areas were always made before opening into obviously pus-filled areas. In our future cases we intend to open up areas in which we cannot say definitely whether there is or is not pus, using the same incision as should be employed for opening up obviously infected pockets.

5. Rendering the operative field bloodless before operation and subsequent gradual release of the bandage is an unnecessary procedure.

6. Conservative irrigation did no harm, but just as good or better results were obtained by merely washing off what pus could be brought out by very gentle pressure.

7. Bending or extending of the fingers in a day or so after operation was found to be entirely free from danger of spreading the infection and of paramount value to the patient in securing for him an afterwards useful hand.

8. Incisions upon the back of the hand are rarely needed. The redness and œdema commonly present upon the dorsum in these cases is extremely dangerous because it often leads the uncertain practitioner to cut into pus-free areas, and then, finding no pus, to adopt one of the fatal policies of poulticing or waiting until the abscess shall "come to a head." Meanwhile the increasing infection may cause bone or tendon necrosis with crippling, that no amount of carefully made incision or faithful post-operative massage will wipe out.

9. Hot boric dressings, the dorsal splint, and flat rubber dam drains (never tubing) as used above form an indispensable trio.

10. All cases treated as we have described recovered perfect function excepting those few cases where necrosis of bone or tendon was present when the patient was first seen.

TREATMENT OF VOLKMANN'S CONTRACTURE.

A REPORT OF TWO CASES WITH DESCRIPTION OF APPARATUS.

BY EMORY G. ALEXANDER, M.D.,

OF PHILADELPHIA,

Surgeon to St. Christopher's Hospital, Out-patient Department of the Episcopal Hospital, and the Mary J. Drexel Home.

NEARLY forty years have elapsed since Volkmann first described a peculiar contracture of the hand, which he believed due to an ischæmia of the muscles from a cutting off of the arterial blood supply. He believed that the usual cause was too tight bandaging in the treatment of fractures, but also stated that the condition might follow injury to the blood-vessels, compression, or cold.

Volkmann thought the condition to be the result of a myositis and not to a primary nerve involvement, basing his belief on the fact that the paralysis and contractures appeared almost simultaneously, while the contractures following nerve injury were delayed.

Many articles on this interesting subject have been written, but little, excepting the treatment, has been added to the causes, clinical description, and pathology, as described by Volkmann.

The pathology of Volkmann's contracture is still a mooted question. Many follow Volkmann and believe the condition to be a contracture myositis; others, that it is primarily muscular in origin, but that there is a secondary nerve involvement, and still others believe that the nerves are primarily at fault.

Thomas, of Boston, in an excellent article on this subject, read before the American Neurological Society, says that if the nerves are involved in producing the muscle changes it is in the terminal muscle branches and that this is of secondary importance, and that "the involvement of part of a muscle only by the connective-tissue formation with a good response

to the remaining portion of the muscle to electrical stimulation," shows "that the nerve involvement in the primary process is not a necessary factor." The same author also calls attention to the frequent secondary involvement of nerve trunks in connective-tissue overgrowth. To this involvement Thomas thinks are due the disturbance of sensation, the reaction of degeneration and the atrophy of the hand muscles, as are seen in some cases of Volkmann's contracture.

The treatment for the contracture first recommended by Volkmann consisted in stretching the contracted muscles under an anæsthetic. The other methods that have been recommended consist in the gradual stretching of the muscles by means of a splint and by operation.

The operations devised are, freeing the nerves from connective-tissue formation, myotomy, and tendon lengthening, either by operating directly upon the tendons, or indirectly, by removing a portion of the bones of the forearm.

Volkmann believed his method applicable to recent cases, but in old cases with marked cicatricial changes there was danger of fracturing the bones or rupturing the tendons. In direct tendon lengthening, the disadvantages are the danger of infection, the length of time required to perform the operation, and the adhesions that sometimes form around the tendons. The deformity it produces, the weakening of the extensor muscles, and the liability of infection or non-union must be thought of before undertaking bone resection. Freeing the nerves and myotomy have both been practised with some success. Jones has discarded all operative measures and relies entirely upon "mechanical and manipulation routine." His reasons for so doing are that operative measures are "hazardous and inadequate," as any open operation must be performed through tissues deficient in circulation and usually cicatricial. He also states that after operation "almost immediate mechanical strain" is necessary to correct the deformity.

The following two cases were treated by mechanical means,

electricity, and massage. One case was of short duration, the other had existed for several months.

CASE I.—A. W., female, age six years, was admitted to the Children's Hospital of the Mary J. Drexel Home in February, 1912, with the following history:

In June, 1911, the patient fell down a flight of stairs and sustained a T fracture of her right elbow. The fracture was treated with an anterior right-angle splint. The splint was too small, and when first applied was tightly bandaged to the arm and forearm. This caused so much pain that the bandages had to be loosened. The fracture was treated with this splint for six weeks, and on its removal, besides having a stiff elbow, it was noticed that the patient had a Volkmann's contracture. The limitation of motion of the elbow rapidly improved, but the Volkmann's contracture grew steadily worse. When seen by us the child showed a well-marked Volkmann's contracture of the right hand with atrophy of the muscles of the forearm, especially the flexors. The small muscles of the hand also showed atrophy. No accurate tests were made, but there was diminution of sensation in the hand. The muscles were not tested for degeneration. The circulation of the hand was impaired. If the hand was flexed to a right angle the patient could extend the fingers.

The case was treated on a splint, which I shall describe later, electricity and massage were given every other day, and the splint gradually extended. At the end of twelve weeks the case was discharged from the hospital cured, with good supination and pronation of the forearm, flexion and extension of the wrist and fingers. We heard from the patient a few days ago and no contractures have recurred.

CASE II.—H. S., male, age ten years, came to the Children's Hospital of the Mary J. Drexel Home from a neighboring city with the following history:

Five days before admission sustained a fracture in the neighborhood of the elbow-joint. Reduction was attempted and an anterior right-angle splint applied. The patient stated that the splint was tightly bandaged to his arm. As a result of the tight bandaging the fingers became blue, cold, and numb. The patient suffered intensely the first night following the accident and gained no relief until the dressings were removed. On admission

to the Drexel Home, five days after the accident, the arm and forearm were greatly swollen. The forearm was dusky, cold, and showed numerous blebs. On the flexor surface of the forearm, just below the elbow, was a large superficial ulcer. An X-ray examination showed an unreduced supracondylar fracture of the left humerus with the usual displacement of the fragments. All dressings were removed, the arm elevated and placed on a pillow, and hot antiseptic dressings applied. The circulation gradually improved, and at the end of a week, all fear of gangrene having passed, an anæsthetic was administered and an attempt made to reduce the fracture and the arm placed in the Jones position.

The patient remained in the hospital one month and was then discharged and referred to the dispensary. At the time of discharge he showed no sign of a contracture. About two weeks after leaving the hospital, and six weeks after the injury, it was noticed that he had a Volkmann's contracture. As the patient was not under my care when first treated in the dispensary, I do not know the muscle and nerve condition at that time other than the nerve involvement was very marked, as the patient told me that he accidentally placed his hand on a hot stove and received a severe burn without feeling any pain.

This case was treated as Case I, and in about three months' time was able to flex and extend the fingers and wrist. Although the patient has good wrist and finger motion, he still shows atrophy of the muscles of the forearm and hand. Sensation in the hand is apparently normal. (Figs. 1 and 2.)

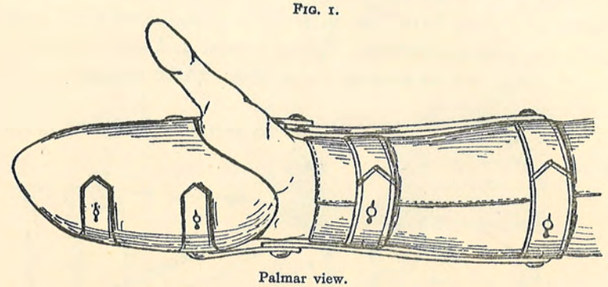
The only difficulty encountered in the treatment of these two cases was superficial pressure ulceration of the finger tips. This, I am sure, was due to faulty management and trying to produce too rapid an extension of the fingers. This difficulty we overcame by placing pads under the finger tips and "making haste slowly" with the extension.

Jones has noticed that, when the contracture has improved to such a degree as to permit hyperextension of the hand without a tendency to recurrence, the circulation will be found, as a rule, to have improved. He also claims that when the nerves are involved relaxation of the contracture is frequently accompanied by nerve improvement.

The apparatus used in treating the two cases reported consists of two parts.

Part 1 consists of a leather casing encircling the lower half of the forearm. The casing is reinforced on each side (radial

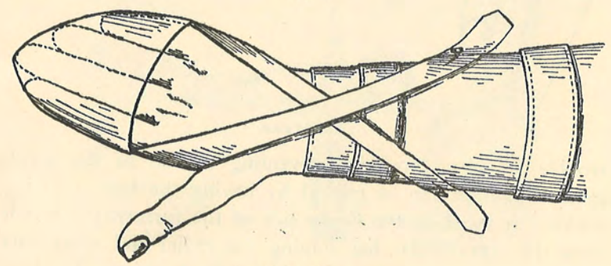
FIG. 1.



Palmar view.

and ulnar) by a steel bar. A semicircular bar at the upper end extends around the flexor surface from the radial to the ulnar bar. The casing is buckled on the extensor side of the forearm.

FIG. 2.



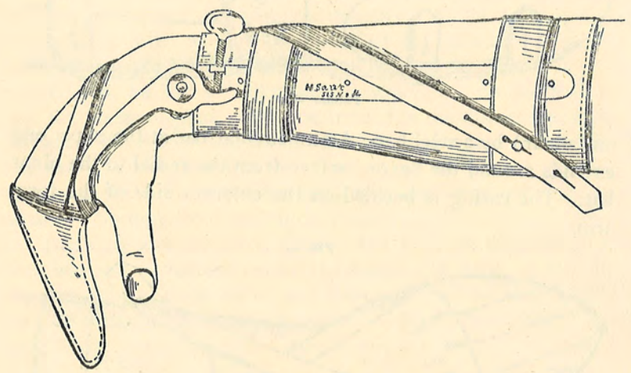
Dorsal view.

Part 2: A plate covered with leather is fitted to the palm of the hand and fingers. Extending from one side of the plate to the other, on the dorsal aspect, is a wide leather strap to hold the fingers straight and in position. Two bars attached in front on either side of the plate pass backward, the one on the radial side arching much more than the ulnar one, to join

at the wrist the radial and ulnar bars described in Part I. The joint formed by the union of these bars is provided with a lever and quick screw. Two long leather straps, attached in front at the junction of the plate and bars, pass backward, crossing on the dorsum of the wrist, and are attached to the radial and ulnar bars, just in front of junction of these bars with the semicircular one. These straps, and also the broad finger strap, are so arranged that they can be adjusted to fit the case.

The apparatus can be varied to suit the case. If much

FIG. 3.

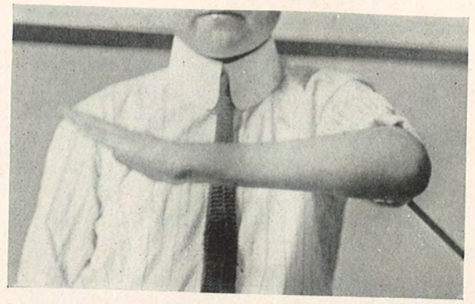


Lateral view.

trouble is encountered in preventing flexion of the wrist, greater fixation can be gained by having the leather casing buckled or laced on the flexor side of the forearm; if this is done the semicircular bar joining the radial and ulnar bars had best pass over the extensor side of the forearm. The long leather straps were not used in the first case, but in the second case they were found necessary to prevent the wrist from riding upward when extension was made on the fingers.

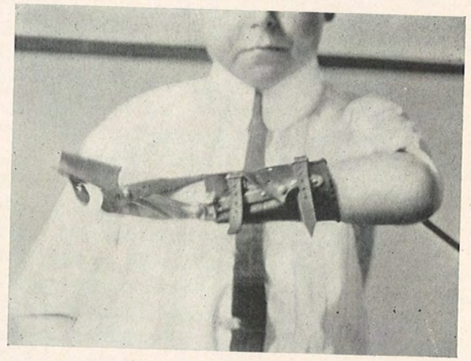
The apparatus is applied with the hand strongly flexed and the fingers extended as much as possible. By turning the screws the plate is elevated and the hand and fingers extended.

FIG. 4.



Case II. End result.

FIG. 5.



Case II. End result—apparatus applied.

Dr. Gwilym G. Davis reported two cases to illustrate the method of treatment adopted. He stated in preliminary that as to the etiology, the relative part played by the nerves and muscles is a matter of dispute. In his opinion the muscles are probably more affected than the nerves, although both may be involved. In many of these cases, the site of probable lesion is indicated by a scar on the forearm; both cases here reported had such scars. They are usually situated lower than the point of entrance of the nerve into the muscle, hence the latter escaped injury. The involvement of the nerves in these cases is not before they enter the forearm muscle, but of those nerves which lie between the muscles and tendons, and muscular disturbances due to such involvement are shown by atrophy and paralysis of the intrinsic muscles of the hand and not of those muscles which arise high up in the forearm. The nerves are apt to be involved only when all the adjacent muscles and tendons are matted together.

Injuries to the nerves in the region of the elbow will however produce muscular contractions which bear some resemblance to that produced by Volkmann's palsy, but the nerve lesion is more likely to manifest itself in the claw hand of Duchenne, while the muscular lesion exhibits a flexed wrist and contraction of most of the flexors of the fingers. The difference in the appearance of the hand and fingers in the two conditions is characteristic and is evidence of a nerve lesion as being the cause of one and the muscle lesion as being the cause of the other. As has, however, been stated there is undoubted nerve involvement in some of the true ischæmic cases.

In the treatment of these cases, Mr. Jones, of Liverpool, strongly advises persistent stretching, and his results show that very much can be accomplished by that method of treatment. It is a long and tedious undertaking, which is not always feasible to carry out. The cases here given will show what has been accomplished by tendon lengthening. Even resection of both bones of the forearm will in some cases add greatly to the use of the member.

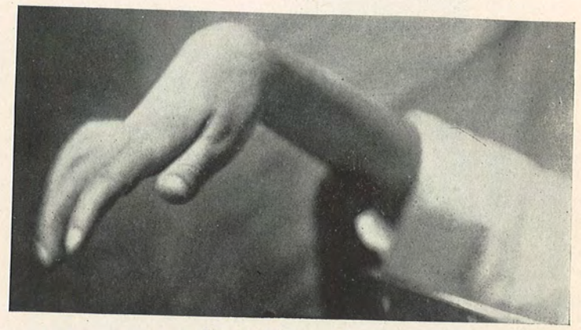
Case I.—A boy, aged 11 years, had fractured his forearm five years previously. On the second day after the injury the bones came through the skin and were replaced under ether and the arm put up in splints. The contraction of the hand and fingers was said to have begun while the splints were still on, and now the contraction of the hand and fingers is very marked

and they are almost entirely useless. This boy was treated persistently for two or three years with splints and apparatus made by his father, who is a skilful instrument maker.

An incision about three inches long was made down the ulnar side of the forearm, extending just above the pisiform bone. To this was added a transverse one directly across the wrist to the radial side. This flap was then raised and the tendons exposed. The palmaris longus, flexor carpi radialis, and the superficial and deep flexor tendons of the four fingers, ten tendons in all, were then cut and lengthened about half an inch, enough to allow the finger to be straightened. The median and ulnar nerves were not much involved. The tendons were then separated as much as possible by means of the adjacent fat and connective tissue, and the wound closed without drainage. Healing was uneventful, It is now five years since the operation and the patient is working in a grocery store and uses his hand quite well. When last seen, about a year after the operation, the result was almost perfect. Now, after the lapse of four years, there seems to be a small amount of contraction again present, but still the hand is a very good and useful one.

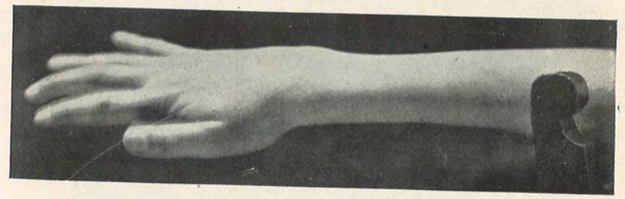
CASE II.—This was a boy aged 7 years. He broke his forearm twice, two months apart, and the contraction was noticed after the second break as soon as the splints were removed. He had marked deformity with the hand firmly flexed on the forearm at a right angle and the fingers strongly contracted. He applied for treatment about five months after the last injury. This boy came from a distance and it was practically impossible to give him the necessary attention if simply stretching was to be employed, and in view of the satisfactory result of the previous case and the difficulties experienced in carrying out the stretching treatment it was decided to operate. In this case a median incision was made and the sublime and deep flexor tendons of the index, middle, and ring fingers were divided and lengthened sufficiently to allow them to come out straight. Fine silk was used to unite the divided tendons. In two weeks the plaster cast was removed and a sinus was found in the line of the incision which had been made through a scar which was present. A couple of pieces of fine silk came out and the wound after several weeks finally closed. Despite this occurrence the result was almost a perfect one, and now, one year after the operation, extension is perfect, but the fingers when voluntarily flexed do not quite touch

FIG. 1.



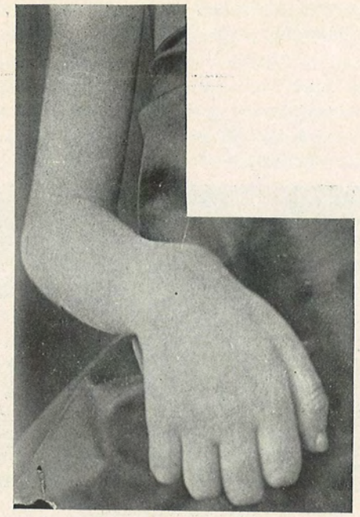
Case I. Before operation.

FIG. 2.



Case I. After operation.

FIG. 3.

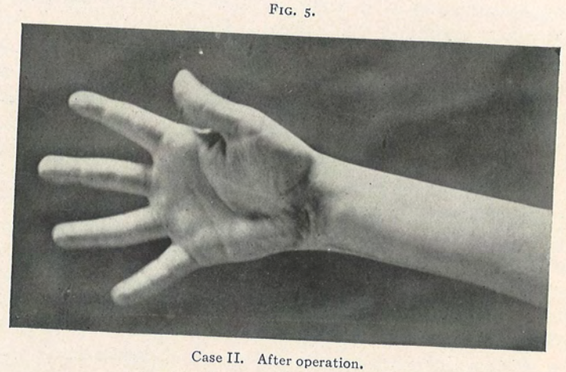


Case II. Before operation.

FIG. 4.

Case II. After operation.

FIG. 5.



Case II. After operation.

the palm. He is using the hand well and is learning to write with it.

In both of these cases, when the proximal and middle phalanges are held firmly, the distal phalanges of each of the fingers operated on can be individually flexed, thus showing that adhesion between the superficial and deep flexor tendons is not present. Operation is not advised in all cases, but only in those in which for any reason the conservative methods of treatment are considered unsuitable.

Dr. Francis T. Stewart said that he had treated one case of this condition like Dr. Davis, and although he secured vast improvement it was not nearly so great as in the cases reported by Dr. Davis. There is one objection to an apparatus of the kind which Dr. Alexander has shown: it provides the very condition that, in the first place, originated the contracture, that is, constant pressure. In one case he had ulceration as a result of this pressure. The pathology of Volkmann's contracture is not by any means clear. It is of some importance from a medicolegal standpoint to know that a few cases do not follow the application of a bandage, but result from a simple contusion. These contractures have more than one point in common with the contractures of the sternomastoid, where a bandage is almost never applied. The ischæmic theory has always seemed to him to be unsatisfactory. It may be that the condition is due to infiltration of the muscle with blood, and that this induces inflammation and subsequently fibrous overgrowth. This condition occurs almost entirely in children; very few patients are more than 12 or 15 years of age. Perhaps it is because the muscular tissue of adults is tougher than that of children.

Dr. John H. Jopson referred to a case reported here a year or two ago, in which he operated by lengthening the tendons of the muscles, but improvement has not been very marked. The condition was a very advanced one, the degeneration of the muscles amounting to complete alteration of the normal appearance of the muscle tissue. The muscles were yellow and brittle in appearance, and it seemed impossible to get any recovery of contractile joints. The nerves also showed marked alteration. They looked as if pinched between the contracting muscle fibres and were markedly atrophied for two or three inches.

Dr. John H. Gibbon said that he had seen a case of Volkmann's contracture following the placing of the arm in Jones's position

where no bandage whatever was applied about the arm. He saw the patient when the accident occurred and placed the arm in this position, and did not see it again for some time. A number of weeks later the child had a Volkmann's contracture. It was due to swelling, the arm not being brought down as it should have been.

Dr. Davis remarked, apropos of the cause as to whether it is nervous or muscular, that in a good many of these cases there is an injury visible on the forearm, and the cicatrix in most of those that he had seen had been below the entrance of the nerve into the muscle; if, however, the nerves have been injured at the site of the injury of soft parts, the injury will show itself lower down, not only in disturbance in sensation but in the paralysis and atrophy of the intrinsic hand muscles. In a good many of these cases the hand-muscles do not appear to be atrophied, and the affection of the nerves may be due to their inclusion in the inflammatory process and the exudate which occurs after the injury. An interesting question is as to the treatment which shall be adopted in these cases in which a trial by stretching has been made and has failed. What shall be done after that? and on that point his two cases show what may be accomplished by tendon lengthening. In the small boy the result is almost perfect. In the older boy who had the deformity for five years, although he has not an absolutely perfect result, yet the hand is very useful and shows that a great deal can be done by operative means. Not much has been said about resection of the bones for this condition, but even that at times will be much better than leaving the cases alone.

Dr. Emory G. Alexander (in closing) remarked, as to Dr. Stewart's criticism, that the apparatus is apt to produce the same conditions that cause a Volkmann's contracture. The pressure exerted by the apparatus is not constricting, therefore it does not cut off the circulation. The worst that can happen by improper use of the splint is superficial ulceration of the finger tips. There is no constriction of the forearm and the slight pressure exerted by the semicircular bar is not sufficient to do any harm.

As to the cause of the contracture, Volkmann thought that venous stasis played some part in causing or hastening the contracture. The fact that the condition has followed injury to blood-vessel, embolism, and constriction by an Esmarch band seems to prove that it is ischæmic in origin. Although attempts to produce the condition experimentally have not been successful, it may be possible that other causes than ischæmia, either combined with or the result of circulatory disturbances, are associated in producing the contracture.

It is of interest to note that all of the cases reported at this meeting give a history of too tight bandaging. A very famous American surgeon claims that Volkmann's contracture is a "surgeon's lesion." While he did not agree with such a broad assertion, certainly in the majority of instances the contracture could be prevented if proper care were exercised in the application of constricting dressings in the treatment of fractures in the neighborhood of elbow-joints.

A very important advantage gained by mechanical treatment, according to Jones, is that the structures are stretched in the order of their tension, and that the deep structures which are impossible to divide at operations may thus be elongated.

ARTERIOVENOUS ANEURISM TREATED BY ANGEIORRHAPHY.

Dr. Francis T. Stewart presented a boy, aged 7 years, who was admitted to the Pennsylvania Hospital, Nov. 27, 1911. Four years before this date he was circumcised by his physician. During the operation the knife was laid on the left groin, and as the patient was not completely relaxed by the anæsthetic he suddenly flexed his left thigh, impaling it on the knife. This was followed by a furious hemorrhage, which was controlled by enlarging the wound and applying ligatures. It was thought at the time that the femoral artery had been included in one of these ligatures. About one month after the injury a soft systolic murmur was noticed over the right heart, and later distinct enlargement of the heart was detected.

On admission to the hospital there was a scar about the middle of the anterior surface of the left thigh, and over this point a continuous thrill could be felt and a continuous bruit heard, the latter being transmitted down the femoral vessels as far as the knee and up as far as Poupart's ligament. Both thrill and bruit were reinforced at each arterial systole, and both ceased when firm compression was made over the scar, or over the artery above the scar, but this compression did not seem to

have any influence on the cardiac murmur. There was no appreciable difference between the pulsations in the right and the left tibial arteries. The entire lower extremity was bluish in appearance, owing to the large number of dilated venules that ramified through and beneath the skin. In none of these venules could pulsation be demonstrated; there were no large veins. The left leg was one inch longer than the right and one-half inch greater in circumference, but there was no œdema.

Under ether anæsthesia the femoral vessels were exposed above the scar and then traced downward. No tourniquet was applied, and many ligatures were needed to check the bleeding from the dilated veins. The vessels were adherent for about one-half inch, and there was no sign of a sac between them. After an assistant had grasped the artery and the vein on each side of the adherent point the vessels were separated with a sharp knife and the opening in each, which measured about one-eighth of an inch in diameter, closed with sutures of fine silk. A flap of the vastus internus was then passed around the artery so as to form a canal for it and separate it from the vein. The muscles, the fascia, and the skin were next closed, without drainage, the limb placed on a splint, and a tourniquet applied loosely to the root of the thigh, so that if bleeding should occur the nurse could at once control it. The pulse in the foot reappeared, full volume, as soon as the blood current was turned on, and continued undiminished as long as the patient was under observation. The murmur over the right heart could no longer be heard after the operation, and the heart diminished considerably in size before the patient was discharged, Dec. 8, 1911, 10 days after the operation. The only unpleasant feature in the case was a small stitch abscess at the upper angle of the wound.

Dr. Stewart remarked that, as far as he was aware, attention had not been directed to the possible influence of an arteriovenous aneurism on the cardiac muscle, although one can readily understand how the right heart might dilate under the strain of the large amount of blood delivered to it under high pressure and with increased velocity, the strain being proportionate to the size of the involved vessels, to their proximity to the heart, and to the size and directness of the orifice of communication between the artery and the vein. In a case of arteriovenous aneurism of the subclavian vessels which he had the opportunity of examining recently, thanks to Dr. Gibbon, under whose care

the patient was admitted to the Pennsylvania Hospital, another factor increasing the strain on the heart was found. The veins of the upper extremity were thrombosed, and almost all the blood from the artery was turned back into the right heart, which was dilated. The aneurismal bruit was transmitted to the heart and along the pulmonary arteries, but when the aneurism was compressed no murmur could be heard over the heart. In the present case the cardiac murmur was apparently due to dilatation, since it subsided promptly after operation. If it had been transmitted from the aneurism it would have been heard over the abdomen, would have ceased when compression was made over the aneurism, and would not have been punctually systolic, but post-systolic, because of the time necessarily elapsing between the contraction of the heart, the production of the murmur in the aneurism, and its propagation back to the heart. That it might have been intermittent and still due solely to the aneurism may be possible, since the weaker portion of the murmur might have been lost in the journey from the middle of the thigh to the heart.

Increase in the length of the limb has occurred in other cases (Franz, Cordonnier), and appears easy to explain, until one reads, as in Brindejone's case, that the limbs may be shorter and thinner than normal. Perhaps the size of the orifice of communication may have some influence on the growth of the limb. If it is small, as in this case, the arterial current is not diverted completely, hence the arteries below the fistula do not atrophy, but continue to irrigate the extremity with almost a normal quantity of pure blood. Further, the amount of arterial blood diverted may be just enough to enrich the venous current without seriously obstructing it. In such an event, which is well illustrated by this case, the circulation would remain active and there would be little or no œdema. If, on the contrary, the abnormal opening were very large, practically all of the arterial blood would pass into the vein, because of the lower pressure on the venous side of the circulatory apparatus, and most of this blood would be hurried directly back to the heart through the central segment of the vein, while the rest would distend the peripheral segment and prevent the return flow of the venous current; in addition the arteries distal to the aneurism would shrink and there would be passive congestion, œdema, and atrophy. In some cases, of course, the malnutrition may be aug-

mented by atheroma, thrombosis, injury to the nerves, destruction of the collateral vessels, cardiac disease, or some debilitating malady of a general nature.

As to the treatment separation of the vessels, with excision of the sac, if such there be, and suture of the opening in the artery and in the vein is the ideal method in all cases in which the major vessels are involved and in which this operation is possible. Extirpation of the aneurism, after ligation of both artery and vein above and below, is the only rival of angeiorrhaphy, and it must be confessed is a formidable rival, since it precludes recurrence, and, contrary to what one would expect from a study of the statistics of ligation, is rarely followed by gangrene. Ligation of the subclavian artery causes gangrene in 2 per cent. of the cases (von Bergmann), of the axillary in 6.6 per cent., of the brachial in 18.75 per cent., of the common femoral in from 19 to 21 per cent. (Raabe), of both femoral artery and vein in from 48.3 per cent. (Ziegler) to 60 per cent. (von Bergmann), of the popliteal in 54.5 per cent., of both popliteal artery and vein in all. In 105 extirpations for arteriovenous aneurism, taken from the tables of Delbet and Monod and Vanverts, 99 were followed by recovery, 4 by death, and 3 by gangrene, one case of gangrene being due to ligation for secondary hemorrhage. These cases, among which are not included extirpations of arteriovenous aneurisms of the head, face, neck, and foot, in which there is no danger of gangrene or other serious disturbance in the parts supplied by the artery, are distributed as follows: common carotid 3, with 3 recoveries; external carotid 3, with 3 recoveries; subclavian 2, with 1 recovery, and 1 death within a few hours; axillary 6, with 6 recoveries; brachial 12, with 1 death from erysipelas; common femoral 12, with 12 recoveries; superficial femoral 24, with 23 recoveries, and 1 death within a few hours; deep femoral 1, with 1 recovery; popliteal 28, with 25 recoveries, 1 death on the second day, one gangrene followed by amputation, and 1 partial gangrene of the foot and permanent œdema; tibials and peroneal 14, with 13 recoveries, and 1 death (anterior tibial). In the last case extirpation was followed by sepsis and secondary hemorrhage, necessitating ligation of the popliteal, then of the femoral, and finally amputation for gangrene. Extirpation we would reserve for arteriovenous aneurism involving vessels of the second class,

i.e., vessels whose removal would not cause gangrene or other grave nutritional changes in the parts irrigated by the artery, and for most cases in which angeiorrhaphy is not feasible.

The ligation methods cannot be wholly discarded however, for in some instances neither angeiorrhaphy nor extirpation can be performed, either because of the relations of the aneurism or because of the condition of the patient. Quadruple ligation, *i.e.*, ligation of the artery and the vein above and below the aneurism, is the best of these methods, but so far as gangrene is concerned is no safer than extirpation, and, owing to the presence of collateral vessels that sometimes empty into the sac, is more likely to be followed by recurrence.

With angeiorrhaphy the aneurism can be dealt with radically and the vessels conservatively, thus effecting cure without interrupting the blood stream and without producing gangrene. Unfortunately suture of the vessels is not always possible. In a number of instances the surgeon has attacked the aneurism with vascular suture in mind but was forced to abandon the idea because of hemorrhage (Delanglade), friability of the artery (Thompson), the large size of the opening (Mignon), or because of dense adhesions (Cranwell, J. C. Stewart). Cestan found, after suturing the brachial artery and vein, that the vessels at the sutured point had been obliterated, hence proceeded with resection. Furthermore, in a number of cases the operator, owing to unforeseen difficulties, was compelled to alter his original plan, so that numerous modifications of the typical and ideal method have been adopted. Instead of analyzing these modifications we have considered it best to include them in the subjoined table, in which these cases are grouped according to the vessels affected. It will be noticed that in the 23 cases there was no fatal result and only one recurrence (Case 18). This list, it must be explained, does not contain the cases of arteriovenous wounds that were sutured soon after the accident, of which there are about 10 on record (Matas, Murphy, Lund, Perugniez, Lissjanski, Oliver, Rost, Sonnenberg, Körte, Stewart). Such cases we believe should be classed, not with arteriovenous aneurism, but with vascular wounds, since in the latter instead of dense adhesions there is a hæmatoma (false traumatic aneurism), and additional factors, *e.g.*, pre-operative hemorrhage, shock, and infection, come into play.

TABLE OF CONSERVATIVE OPERATIONS FOR ARTERIOVENOUS ANEURISM.

Name of operator.	Date of operation.	Vessels.	Age of patient.	Cause.	Time between accident and operation.	Operation.	Result.	Pulse.
1. Vean.....	1906	Axillary	15	Stab	2 months	Double ligation of artery, suture of vein.	Cure	?
2. Marchant...	1898	Brachial	?	Stab	2 months	Suture of artery and vein.	Cure	Reappeared in ¾ of hour then grew fainter.
3. Van Imschoot	1903	Brachial	26	Stab	?	Ligation of canal between artery and vein, ligation of vein.	Cure	?
4. Protherat....	1907	Brachial	19	Stab	?	Suture of artery and vein.	Cure	?
5. Doyen.....	1908	Brachial	11	?	?	Suture of artery and vein.	Cure	?
6. Auvray.....	1909	Common femoral	15	Stab	1 month	Suture of artery, lateral ligature of vein.	Cure	Persistent.
7. Montaz.....	1893	Superficial femoral	16	?	?	Double ligation of artery, lateral ligature of vein.	Cure	?
8. Garrè.....	1904	Superficial femoral	16	Stab	10 years	Suture of artery, double ligation of vein.	Cure	?
9. Gessner.....	1906	Superficial femoral	22	Gunshot	12 years	Intrasaccular suture of opening into artery and both ends of vein (restorative endo-aneurysmorrhaphy)	Cure	Persistent.
10. Westergard..	1907	Superficial femoral	19	Stab	3 years	Double ligation of artery, lateral ligature of vein.	Cure	?
11. Abalos.....	1909	Superficial femoral	19	Gunshot	?	Suture of artery and vein.	Cure	?
12. Zeidler.....	1910	Superficial femoral	18	Gunshot	2 months	Suture of artery and vein.	Cure	Persistent.
13. LeConte and Stewart	1912	Superficial femoral	7	Stab	4 years	Suture of artery and vein.	Cure	Persistent.
14. Bramann....	1906	Superficial femoral vein, deep femoral artery	17	Stab	?	Double ligation of artery, lateral ligature of vein.	Cure	?
15. Manteuffel...	1895	Deep femoral	18	Gunshot	?	Suture of artery, resection of vein.	Cure	?
16. Wiesinger....	1904	Popliteal	18	Gunshot	?	Suture of artery and vein.	Cure	Persistent.
17. Cranwell....	1906	Popliteal	21	Stab	?	Lateral ligature of artery and vein.	Cure	?
18. VanEiselberg	1906	Popliteal	38	?	?	Ligation of canal between artery and vein.	Recurrence in 3 weeks; extirpation.	?
19. Lexer.....	1907	Popliteal	34	Stab	?	Resection and anastomosis of artery and vein.	Cure	Persistent.
20. Sabadini....	1908	Popliteal	19	Stab	?	Lateral ligature of artery and vein.	Cure	?
21. Garrè.....	1908	Popliteal	16	Explosion	1½ years	Resection, anastomosis of artery, double ligation of vein.	Cure	Persistent.
22. Aubert.....	1910	Popliteal	?	Gunshot	?	Double ligation of artery, suture of vein.	Cure	?
23. DaCosta....	1912	Popliteal	29	Gunshot	3 months	Longitudinal incision of vein, suture of opening in artery from within the vein, division of vein on each side of the opening, with utilization of the flap of vein to reinforce the arterial suture, anastomosis of the vein.	Cure	Persistent.

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DR. JOHN H. GIBBON remarked as to the case referred to by Dr. Stewart which recently was under his care at the Pennsylvania Hospital and in which he did not operate. This man had a gunshot wound, the bullet passing between the subclavian vessels and lodging in the trapezius. He was laid up for two weeks, went back to work, then developed a weakness in the left arm and suffered pain. With this condition he was admitted to the hospital; there was a marked thrill and evident arteriovenous aneurism. Dr. Gibbon was quite keen to operate on him, but waited a few days and in that time he showed a great deal of improvement, the pain got very much less, and finally disappeared altogether, the weakness in his arm disappeared until his grip was as good as in the other, and he was finally allowed to go home. He had an arteriovenous fistula, no aneurismal sac, and notwithstanding the heart changes which Dr. Stewart refers to it was the wiser thing to let this man go and operate later if his heart condition became so bad as to demand operation. If the heart condition which Dr. Stewart found in the boy, which had lasted four years, disappeared within ten days, there was no reason in this case not to wait and watch the progess. Another reason why he did not operate on him was that one is not always as successful in arteriorrhaphy as Dr. Stewart was in his case. In a great many of these cases, unless done by such men as Carrel or Sweet, one will get a thrombosis of the vessel and if this man got a thrombosis of his subclavian he would be in a great deal worse condition than he is now.

THE EFFECT OF THE REMOVAL OF THE HYPOPHYSIS IN THE DOG.

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AND
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OF THE UNIVERSITY OF PENNSYLVANIA.

THE problem of the physiology and pathology of the hypophysis represents one of the curious instances in medical science of such contradictory observations, often additionally deflected by speculative fancy, that the answer to any given question concerning the function of the gland in health or disease is even yet not certainly established. The apparently simple proposition—is the organ essential to life?—has divided all workers into two almost evenly balanced groups: those who maintain that the gland is essential to life, and those who hold it to be non-essential.

A detailed review of the literature is here unnecessary, since the appearance of the excellent paper by Aschner (*Pfluger's Archiv.*, 1912, cxlvi, p. 1). Aschner reports extensive experiments made chiefly upon young dogs, discusses the various functions and supposed functions of the hypophysis, and gives a very complete bibliography, covering both the experimental and clinical literature of the subject. We wish in this paper to briefly discuss our own findings, and to leave aside for the present the consideration of results which we have not been able to corroborate.

The work on which this report is based began over a year ago, when the question of the essential character of the hypophysis was perhaps of more importance from the stand-point of experimental medicine than it is to-day. It is evidently a question of prime importance to the surgeon, for if it be really essential to life, the limit of safety in partial removal

must be determined. The results in 22 dogs are as follows: 4 died after an average of three days of evident traumatic encephalitis; 1 died of acute lobar pneumonia after two days; 3 died after an average of 23 days of distemper pneumonia; 4 died after an average of 15 days of basal meningitis; 1 died after 38 days, showing at necropsy a thrombosis affecting the hemisphere opposite the field of operation, with a large abscess of the base; 2 died after an average of ten and a half days, the cause of death being uncertain; 2 met accidental deaths after an average of 23½ days; 5 lived for months. None of these dogs showed any immediate symptoms peculiar to the operation, no peculiar gait, nor position, no tremors, nor any other clinical symptom; recovery was prompt and without complications.

The method of approach is through an incision about 2 inches in length, perpendicularly over the centre of the zygoma —the zygoma forming, as it were, a base line with the two-inch incision extending perpendicularly to such a base line. The zygomatic arch is removed, the coronoid process of the mandible resected, and the base of the skull approached in a direct line. The skull is trephined and the hole somewhat enlarged, and after opening the dura, the brain is carefully elevated by a suitable retractor. The hypophysis is then removed by a special loop forceps (Fig. 1) which enables the operator to grasp the gland and generally remove it in two pieces, the anterior lobe in one piece and the posterior lobe separately. The wound is closed without drainage. With a strong light the field of operation is ample and no difficulty is encountered. This approach, which has been used before, was chosen because the Paulesco-Cushing incision with its extensive removal of the skull seems unnecessary and in our opinion exposes too large an area of the brain to the compressive action of the large masseter muscles. In several instances the operation has failed because of an atypical course of a large branch of the pterygopalatine artery. This branch, ordinarily not in the field of operation, has now and

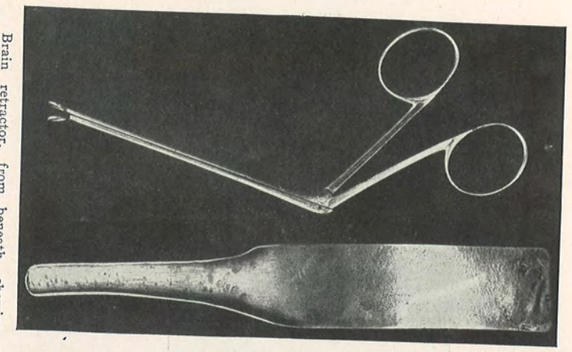


Fig. 1.

Brain retractor, from beneath, showing rounded edges. Loop forceps, for grasping the hypophysis.

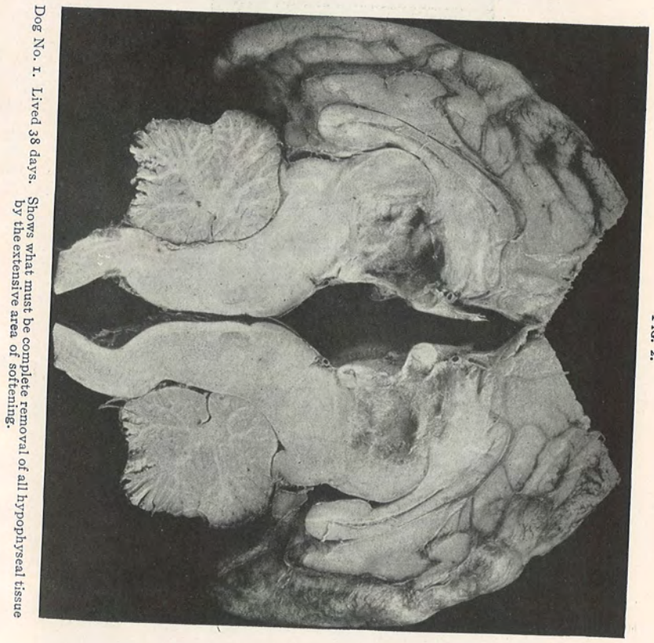
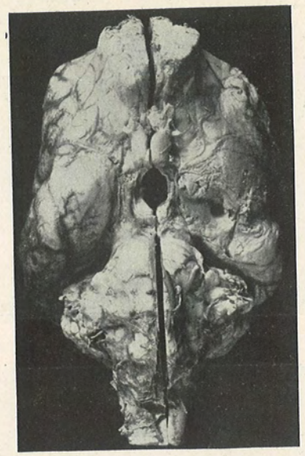


Fig. 2.

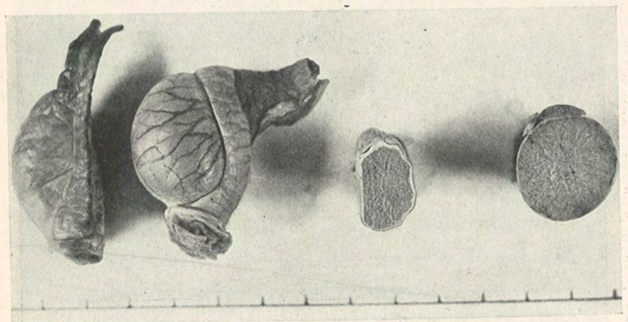
Dog No. 1. Lived 38 days. Shows what must be complete removal of all hypophyseal tissue by the extensive area of softening.

FIG. 3.



Dog No. 1. Area of softening.

FIG. 4.



Dog 19. Atrophy of testicles. On the right, testicle removed at time of hypophysectomy. On the left, companion organ, fifteen days later.

FIG. 5.

Dog No. 15. Eight months after operation.

FIG. 6.

Dog No. 13. Eight months after operation.

then been unexpectedly cut, with a resulting hemorrhage very difficult of control.

The first point which we sought to determine is whether the entire gland can be removed by this or any other method. Two points must here be recognized: Are we justified in speaking of a complete physiological extirpation when either macroscopically or microscopically some portion of the gland can be recognized after the operation? The anatomy of the gland in the dog is such that it is probably impossible to completely remove all the cells of the pars intermedia. These cells extend for a considerable distance forward toward the chiasm and backward toward the corpora mammillaria. Such a condition makes total removal from a microscopical point of view impossible, but can the gland be physiologically removed? The point is perhaps well illustrated by the history of the work upon the relation of the complete removal of the pancreas to diabetes. It is doubtless impossible to remove completely every cell of the pancreas, and because of this fact the relation of the pancreas to diabetes was for a time in dispute, the explanation being offered that the diabetes was due to the nervous shock incident to the operation. Nevertheless there can be no doubt to-day that enough of the pancreas can be removed to ensure physiological results. It is the same with the parathyroids and with the thyroid, so that a limit of safety has been established by surgeons beyond which it is not safe to remove thyroid tissue. We believe that it is possible to remove the hypophysis physiologically, that is, to remove enough so that certain characteristic changes will follow. Dog No. 1 (Figs. 2 and 3) lived for 38 days, showing no peculiar symptoms until shortly before death, when symptoms of meningeal irritation developed. The autopsy showed an extensive area of softening in the infundibular region, which, as shown in the accompanying plates, must certainly have removed all hypophyseal tissue. Concerning the extent of removal of the hypophysis we have taken the following means of ascertaining whether we have been successful in completely removing it: At the autopsy of several animals which died early, and of all

those which lived for months, a block of tissue was removed which included the optic chiasm anteriorly and the corpora mammilaria posteriorly, with about 4 mm. of tissue each side of the medial sagittal plane. This block was mounted in paraffin and serial sections prepared. Careful examination of this material revealed that in only two dogs, dogs Nos. 11 and 22, can it be said that there is no evidence of either pars intermedia or pars anterior. The remnant of the gland found in dog No. 12 was functionally very active, if one may judge by the extensive colloid-like formation and the same appearance of the cells of the pars intermedia which one sees in the normal gland; this dog presents complete atrophy of the testicles.

In the work reported by Aschner with young animals he notes that, in his experience, no marked changes occur after the removal of the gland from the adult dog. The dogs in our series were all full grown. We have no means of judging their exact age except by the fact that they all possessed at the time of operation a complete second set of teeth; in fact, dogs Nos. 19, 20, and 22 were noted as old, their front teeth being worn down almost to the gums.

In this series the first change to be noted was an indetermined effect upon the pancreas. At the autopsy of the dogs in the latter part of the series, that is, in those dogs in which we regularly made note of the condition of the pancreas, it is recorded that the organ presented a striking red coloration, having at autopsy the appearance of the gland seen at the height of digestion. Ordinarily at autopsy the pancreas presents the usual picture of a pale, even whitish, organ, the lobules at the edge being rather hard to differentiate from the neighboring fat tissue. In these animals the pancreas was evidently much congested and yet the microscopical study of sections of these organs did not reveal any very marked changes. The changes seen were perhaps identical with those to be found in a pancreas at the height of digestion. The second change in point of time, which we have noted, has been the atrophy of the genital apparatus, particularly of the testicles. From dog No. 19, at the time of the operation (Fig. 4) upon the hypophysis, the left testicle was removed; 15 days later the dog choked to death in an endeavor to swallow a whole cold boiled potato. The autopsy showed that the remaining testicle had undergone a very marked atrophy, due microscopically to a complete loss of the spermatogenetic cells. Dog No. 20, likewise an old dog, showed the same condition of striking atrophy after three weeks. Dog No. 21, dying on the thirteenth day from an undetermined cause, shows no clusters of young spermatozoa in Sertoli cells nor spermatozoa free in the lumen. Spermatids of first and second order are present in moderate quantity. The epididymis is crowded with spermatozoa. Just how soon after the removal of the hypophysis this atrophy commences we are unable to state, but from the three cases cited it is evidently very early. The third change which we have noted has been the increase in weight. This change in our experience does not begin until some time after the operation. For example, Dog No. 15 (Fig. 5), operated on February 7, 1912, weighing about 17 kilos, showed no particular change until the middle of the following June; the dog then weighed 18 kilos. On October 4 the dog weighed 27 kilos. The same may be said of the other dogs in our series (Fig. 6), so that the question has arisen in our minds whether this tendency to obesity is due to a loss of the hypophysis or to a loss of some other function of the body which is controlled by the hypophysis.

The change in the pancreas has been a constant finding; the testicular atrophy apparently is quite constant. Dog No. 16 showed what seemed to be a decided atrophy on palpation some weeks after operation, but at autopsy 7 months after the testicles were normal; this dog showed quite a large rest of pars anterior and pars intermedia, but dog No. 12 showed an equally large rest, with complete atrophy of the testicles, and dog No. 22 showed no demonstrable gland substance, yet had normal testicles. The increase in weight is apparently constant if the dog lives long enough. Perhaps the most important question to-day in connection with the ductless glands is

the matter of their interaction; are we to consider the hypophysis, for instance, as a link in a chain, which link, if broken, breaks the chain, or as members of a family, where if one member drops out, he can never be replaced, but the other members of his family can take up his work to a greater or less extent?

In three of the dogs which we have autopsied after several months' time, the thyroid presented a change, the significance of which is hard to interpret. There is an evident increase in the amount of colloid with a flattening of the cells of the alveoli. In summing up our experience with these 22 cases, it is evident that the hypophysis is not essential to life; there are undoubtedly three well-marked changes which follow hypophysectomy; the first change concerns the pancreas. We have not worked very extensively with the question of sugar tolerance and therefore have nothing to say. It is evident that such a study can only be made by determining the individual sugar tolerance before operation and obtaining an index by this means as to the normal carbohydrate tolerance of the individual animal. The second change is the atrophy of the testicles, which is of very early appearance, being extremely marked by the end of the second week after operation. Whether or not this atrophy can be compensated for by the function of some part left behind or of some glandular rests which have been described by Cushing in the floor of the sella turcica, we cannot say. Increase in weight is of late appearance, and whether it be due to the loss of the hypophysis primarily or due to the secondary atrophy of the testicle is not at all clear in our minds.

Our results agree with the most recent work on the subject reported by Aschner, except perhaps in two particulars. He worked almost exclusively with young animals, and inclines to the belief that the removal of the hypophysis from the adult dog is without effect. In the second place he ascribes the atrophy of the testicles to injury of the tuber cinereum. This point of view seems to us a purely academic one. There can

be no agreement as to where tuber cinereum ends and infundibulum begins. We have found no evidence whatever in our work which would incline us to agree with him in this particular.

We are presenting this paper at the present time for two reasons: First, we believe that the question of the essential or non-essential nature of the hypophysis is an important surgical matter, and from the results of our work we believe that the entire gland can be removed without danger to life. In the second place, from our work we believe that there is but one surgical indication for operating, namely, intracranial pressure. If such experimental experience is of any value when applied to clinical questions it is our further belief that the intracranial method of approach is to be preferred to any other method, and that the method of operation in human cases which has been elaborated by Frazier is undoubtedly the most correct from the point of view of anatomy and of surgical technic.

DR. CHARLES H. FRAZIER remarked, with regard to the conflicting testimony as to whether the pituitary body is essential to life, that it seemed to him as time goes on that the evidence is accumulating in favor of the position which he has taken. Dr. Sweet will remember a rather crude technic which together they employed five years ago for the removal of the hypophysis. An incision was made through the pharynx exposing the vault; by removing a button of bone with a small conical trephine the sella turcica was opened and the pituitary body exposed; the opportunities for infection were so great and the exposure so limited that complete and satisfactory removal of the pituitary body was not practicable.

OPERATIVE FIXATION AS A CAUSE OF DELAY IN UNION OF FRACTURES.*

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THE great activity, developed in recent years, in the operative treatment of closed fractures, makes it desirable to report any instances of operative fixation that have been followed by unsatisfying symptoms or disastrous results. Many of us have for years been opening recent, closed fractures for the discovery of complicating lesions, for operative reduction, or for satisfactory fixation. My own advocacy of such measures began about 1885. Hence I should not be considered an unduly prejudiced critic of the present furore for operative uncovering of the ordinarily severe closed fractures of the tubular or long bones.

It seems to me, however, that the earnest advocacy of such radical procedure by especially expert and experienced operators has a tendency to do harm to surgical science and to encourage the assumption of unnecessary risks by the public. The situation resembles that of the period when hundreds of women were unnecessarily rendered sterile by oöphorectomy for the so-called sclerotic ovary, others subjected to needless nephrorrhaphy for loose kidneys, and both sexes deprived of useful thyroid glands; because these operations were found to be comparatively free from fatal issue and because neither the docile patients nor the hasty surgeons knew the true physiological worth of the organs thus subjected to surgical insult. A similar illogical following of brilliant operative masters is now occurring in the domain of tonsillar pathology, and is fast approaching, one may fear, in the treatment of closed fractures of the bones of the extremities.

* Read before the Philadelphia Academy of Surgery, Dec. 2, 1912.

Operative surgery has a brilliant career, but its activities must be controlled by a logical mind, not too much given to dwelling on the conservatism of the past or so flushed with victory that it encourages running amuck through hospital wards.

I recently reported [1] two deaths following fixation of closed fractures of the femoral shaft with plates and screws. Dr. Joseph Ransohoff,[2] of Cincinnati, says that Babler in a late report of the St. Louis City Hospital mentions two deaths occurring out of 13 cases of simple (closed) fractures of the femur treated by plating. He himself knows of two other deaths after operative treatment of this injury. I, myself, have heard of one death other than mine occurring in Philadelphia under similar circumstances. This shows that operative fixation of fractures of the femur at least is not as innocuous a proceeding as some medical men seem willing to assume.

My present purpose is to seek information on the comparative rapidity of bony consolidation of fractures under non-operative and operative treatment. It will be conceded at once that to obtain a mathematical determination of this question, it would be necessary to apply both methods to the same number of fractures of the same character and severity, occurring in the same part of the skeleton, and treated under the same circumstances by the same surgeon. These conditions are manifestly unobtainable. I must, therefore, be content to give the statements, which I have obtained from recent surgical literature, bearing on the length of time required for the union of broken bones under these dissimilar methods of treatment.

My attention was called to the possibility of plating being a cause of delay in union by having under my care a young man in whom this contingency seemed to take place.

Mr. D. S. B., aged twenty-nine years, sustained on April 13, 1912, a closed fracture of the right tibia, a little below the middle of its shaft, and a double fracture of the fibular shaft of the same

leg, which also was closed. The injuries were due to striking his leg against that of another player in a game of baseball. His general health was good. A surgeon endeavored to set the fractured leg without anæsthesia, but was not successful. Then 15 pounds extension, made with an anklet and a pulley, was employed for several days. Ten days after the receipt of injury, an X-ray picture was taken showing a fracture of the tibia, which was almost transverse, and two adjacent fractures of the fibula. At this time an attempt was made under chloroform anæsthesia to reduce the fragments. This was unsuccessful.

Fourteen days after the accident the tibia was exposed by a longitudinal incision under ether anæsthesia, and a Lane plate about four inches long was applied with screws to the fibular aspect of the tibia. The reduction of the fracture was perfect. No fixation apparatus was used for the fibular breaks. A gypsum encasement was put upon the leg for external support. It covered the ankle-joint. I do not know whether it went above the knee. The external wound healed by first intention and without pain. The gypsum splint was split two weeks after its application.

Ten weeks and two days after the receipt of the fracture (June 24, 1912) he came to me walking on crutches, and with the leg still protected with the gypsum splint. The fibula had apparently united, but there still was marked anteroposterior mobility at the seat of the fracture of the tibia. There was no swelling as of tibial callus on the subcutaneous surface of the shin bone; and the apposition of its fragments was perfect. I treated him with calcium carbonate, gr. v., and calcium lactophosphate, gr. v., internally three times daily before meals, used the rubber bandage around his thigh for congesting the seat of fracture, supported the broken bone with a gypsum encasement, and had him walk on crutches and stay a good deal in the open air. This line of treatment I continued for six weeks (until August 5, 1912) without producing any special effect on the ununited tibia. He was quite anxious about his useless leg, but seemed in good health except for this worry. He was a rather free user of tobacco.

As sixteen weeks and two days had by this time elapsed without union of the major bone occurring, I advised removal of the Lane plate and inspection of the site of fracture. I expected to find muscle or fascia between the ends of the fragments, or that the tibia was held apart at the break by the plate or by the already united companion bone. My suggestion to the patient was that I would remove the plate and then perhaps refracture the fibula to gain close contact of the tibial fragments or insert a bone graft cut from the crest of the same tibia in the gap between its fragments.

The tibia was exposed by an incision in the old scar, the plate was found hidden, under fibrous tissue and a small boss of callus, on the fibular aspect of the tibia. The subcutaneous or inner surface of the tibia was smooth, showing no deformity and no elevation of callus under the periosteum where the line of fracture was situated. The screws were imbedded in the bone, but were readily removed. There was no pus about the plate or screws. There was, however, a slight darkening of the tissues and some softening of the structures in a few places where they were in contact with the metal. The plate was removed, as were all the screws. A few drill punctures were made into the bone ends and into the tissue between them. The wound was closed without drainage, and it healed promptly.

The leg was dressed with a gypsum encasement and in a few days the man was allowed to be up on crutches. The rubber bandage for engorging the limb was used for longer periods of the day than before, lime salts and tonics were given, he was sent to the seashore, and much was done to encourage him. His tobacco was limited.

When seen on November 30, 1912, which was exactly 33 weeks after the fracture occurred, he still had a slight anteroposterior movement of the tibia at the seat of the fracture. At this point there is a slight mound of callus, and the bone is nearly solid. The gypsum splint has been discarded for three weeks and he has not used the rubber bandage for a short time past. He still takes small doses of calcium carbonate and calcium lactophosphate. He uses a cane for walking outside his home, but in the house uses the leg without any support. He has been attending to his scholastic duties for about two months. He was ordered to wear the rubber bandage for an hour a day and to take a small amount of lime salts. He evidently soon will have firm and satisfactory cure of the fracture without deformity.

In looking for a cause of delayed union in this patient I came to the conclusion that it was not unlikely that the opening of the tissues to apply the fixation plate had something to do with the delay in solidification of the fracture of the larger bone. Slow union or non-union of a fracture from interposition of muscle or fascia is not unusual, but here my exploratory observation at the time I removed the plate showed that this was not the cause of the trouble in this instance. It is true that the patient was very much worried over his condition and was away from his family at the time the accident took place. He also was very anxious to obtain a rapid cure because of the necessary resumption of his teaching in the fall. All these facts have seemed to me scarcely a sufficient reason for the want of callus formation at the seat of the fracture of the tibia in a man so young and apparently so healthy. It is true that there were three fractures, the two in the fibula and the one in the tibia, to be united, the existence of which threw a little more responsibility upon the bone-making powers of the blood.

Upon looking over recent surgical literature, I have been struck with the number of surgeons who believe that the opening of a closed fracture, for the purpose of establishing an anatomical correction of a deformity, has a tendency, not to shorten but to lengthen the time of consolidation of the broken bone.

Some of the advocates of the operative treatment of fractures, and particularly, I think, Mr. Arbuthnot Lane, believe that opening the tissues to gain access to the seat of fracture does not delay the union of the broken bone. Mr. Lane, I think, states that anatomical reposition in the manner advocated by him is almost never followed by delayed union or non-union.

Dr. Thomas W. Huntington, of San Francisco, says that it is interesting to note that in practically all cases where anatomical reposition has been attempted, three things have been accomplished: rapid bony union, absence of deformity, and absence of pain.[3]

Huntington in another article printed in 1908[4] in speaking of fractures of the femoral shaft states that approximate anatomical reposition is essential to quick repair and ideal result. He also believes that a very large percentage of all cases of delayed or non-union can be attributed to faulty adjustment. These two writers represent, I think, the opinion which most of us held when, within recent years, the unusual activity in operative treatment of these lesions began. That broken bones should unite by first intention when the fragments were properly adjusted seemed in accord with what happened in wounds of the soft parts and was, therefore, accepted. Perhaps due weight was not given to the possible physiological differences in the repair of tissue in which the deposition of inorganic salts is required to complete the restitution of physiological function. It is also possible that our reasoning was faulty, because the proper distinction was not made between bad open fractures which notoriously require a long period of time for proper cure, and uncomplicated closed fractures.

Dr. William Darrach, of Roosevelt Hospital, New York, has had a wide experience in the operative treatment of fractures, and is an earnest advocate of the method in a large range of cases. He says in his paper[5] read before the American Medical Association and published in August of this year that his experience has been that firm union comes a little more slowly in fractures that have been opened.

Another similar opinion is given by Dr. Astley P. C. Ashhurst[6] in his article on the treatment of fractures of the forearm, in which he gives the notes of 52 cases treated without operation. He states that if in treating these fractures the surgeon will use "the eyes in the ends of his fingers, he will secure by conservative means quite as good, and in many cases a much better result than by operation, and in a shorter time." In another part of his paper he gives as his opinion that after operation the process of union often is slower than it would have been if no operation had been employed.

One of the advocates of the rather frequent necessity for direct fixation of fractures is Dr. Leonard Freeman, of Colorado. His statement is that it is certain that delayed union is more common after operation than when fractures are treated by ordinary means.[7]

In a later article published in 1911,[8] when discussing the operative procedure, Dr. Freeman makes this statement: "All this gives rise to two dangers—infection and delayed or non-union." In the same article, he continues: "The tibia is one of the most frequent sites of delayed or non-union, and particularly is this true of fractures that have been operated upon and perhaps united by wires or bone plates. Fritz Koenig asserts that this is due to the removal of blood clots and tissue fragments, which are supposed to stimulate bony union, while others place the blame upon the foreign bodies introduced by the surgeons; but whatever the explanation may be, the fact remains." In the earlier article Dr. Freeman says that this delay in union may occur when the periosteum has not been disturbed and when no wires are employed. This seems to indicate that he attributes the slowness of bony repair to the operative intervention itself without reference to foreign bodies being used or the periosteum being unduly disturbed. In another part of his earlier article he speaks of the delayed union after operative intervention being more frequent when fractures of the femur are so treated than those of the tibia, and attributes this more frequently delayed union to the necessary disturbance of the tissues in a deeper wound.

Probably this experience of Dr. Freeman has something to do with his advocacy of subcutaneous fixation with long screws and an external clamp.

In an article in the *Journal of the American Medical Association* of October 21, 1911, Dr. Edward Martin, of Philadelphia, asserts that: "It is noteworthy that union is usually delayed, that the time of treatment is not materially shortened, that the results are not uniformly good. But taken as a whole, they are infinitely better than could possibly have been secured by other than operative means." He thinks: "There

has seemed to be a relation between the size of the internal splint and the promptness of final union. In other words, we have felt that the less foreign matter we put into the wound the quicker it got well." The same writer in an article on the open treatment of transverse fracture of the femoral shaft printed last year[9] makes the statement that union is nearly always delayed, the delay being proportionate to the amount of stripping of the bone ends and trauma of the soft parts at the time of operation. He thinks that we have no evidence that the period of after-treatment, before complete, or what we call complete, restoration of function is accomplished, is materially shortened by plating.

These opinions of Dr. Martin are confirmed by his statement made in September of this year[10] that as a rule the presence of a plate (Lane plate), instead of stimulating osteogenesis between the broken bone ends, retards it.

This statement of Martin is quoted by Dr. F. H. Albee[11] in his paper on bone transplantation in the treatment of Pott's disease, club-feet and ununited fracture as a reason for advocating the use of bone grafts in non-union of fractures.

These writers are not alone in the belief that direct fixation may be a cause of delay in union. William Hessert[12] has written that it has been his experience to see union delayed weeks, even months, though he has never had a case of infection.

S. C. Plummer, of Chicago,[13] states that he has heard Dr. John B. Murphy express the opinion that union was slower when a Lane plate had been applied. Plummer says that this has also been his experience in some cases. Plummer, therefore, does not agree with the opinion of Mr. Lane, whom he quotes[14] as making the statement that operative treatment "shortens the duration of the period during which he (the patient) is incapacitated for work, since union is practically by first intention, and, consequently, very rapid and perfect."

I finally give the opinion of Joseph A. Blake,[15] of New York, on this subject, which is valuable, because Dr. Blake has been greatly interested in the operative treatment of fractures and

has written a good deal in its favor. In speaking of non-union after the operative treatment of broken bones, he says: "The occurrence of non-union is not so very rare, even when the fragments have been maintained in end-to-end position by ordinary external splints. I have seen such results notably in the femur. I have also seen non-union occur when the femur had been wired. In these cases non-union has usually been attributed to the presence of the wire. When, however, the wire was changed for a plate which kept the fragments rigidly fixed, union resulted in spite of the presence of much more foreign material."

Many surgeons have probably seen this occurrence. I, myself, a good many years ago was unable to get union of an ununited fracture of the humerus by wiring, which another surgeon subsequently cured, I understood, by the insertion of a plate.

Blake further says that he has had three cases of mild infection after operations upon the femur in which there was a rather excessive production of callus. In these instances "union did not seem to be delayed, but even seemed to be accentuated." He makes the assertion that "mild infections apparently do not interfere with union, but, on the other hand, seem to stimulate the formation of callus." He maintains, however, that: "Infections severe enough to cause necrosis of tissue manifestly will prevent union." He calls attention to the fact that he does not look upon infection of such operative wounds with satisfaction, for infection must be considered, he says, "the worst misfortune that can happen in operations for fractures."

Plummer, in commenting upon the fact that slight degrees of sepsis seem to hasten union of the broken bone, truly says that all agree that the one chief and overwhelming cause of failure in the operative fixation of broken bones is sepsis.

I have reported my own case of apparent interference with union by operative fixation with a plate to maintain coaptation of the fragments after a difficult reduction. I have also gone over the recently expressed opinions of surgeons doing

this kind of work. My intention has not been to discourage the election of direct fixation in fractures, which are difficult to reduce or hard to maintain in position after reduction. This contribution is rather a plea for caution against the enthusiastic adoption of this method of treatment as a routine means of dealing with closed fractures. The profession and the public should know that while it is a necessity in some cases and its adoption a question of judgment in other cases, there are many instances of subcutaneous or closed fracture in which it is not needed. Good results can often be obtained, both as to anatomical restoration of the parts, good function and rapid cure, by external dressings guided by a thoughtful, careful surgeon, who has a mechanical mind and anatomical knowledge. The operative treatment is particularly dangerous when adopted by novices in aseptic surgery, or in places where complete aseptic surroundings cannot be obtained.

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*Read Feb. 5, 1912; by error this paper was bound up in Vol. xiv of the Transactions of the Philadelphia Academy of Surgery (1911–1912, pp. 32–33). Authors, Dr. Astley P. C. Ashhurst and Dr. Rutherford L. John.