### TREATMENT OF FRACTURE OF THE FEMUR\*

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## SERIES OF FRACTURES OF THE FEMUR REPORTED IN RECENT AMERICAN LITERATURE

Nis reported 575 cases of simple fracture of the femur occurring in the Charity Hospital at New Orleans during ten and one-half years. Of these fractures, ninety-six, or 16.7 per cent., were of the neck of the femur. He found that fractures of the neck were rare in negroes only fourteen of the ninety-six patients being of this race. There were fifty-six males and forty females. The age incidence in ninety-four cases of fracture of the neck of the femur in this series is recorded in Table 1.

TABLE 1.—Age Incidence in Fractures of the Neck of the Femur

Age	Number of Cases
1- 10,	0
10-20	7
20- 30	1
30-40	6
40-50	7
50-60	15
60- 70	29
70- 80	
80-90	-8
90-100	ĭ

No two surgeons of the hospital agreed as to the method of treatment of these fractures. There was not one attempt at complete reduction and restoration of normal function. If patients survived and left the hospital, the usefulness and function of the leg was not investigated. Only two or three patients were given anesthesia and placed in plasterof-Paris casts, with the limb in abduction. Most of the casts applied were removed within a few days, probably on account of pain, and Buck's extension was thereafter used as the method of treatment. The methods of treatment employed were: Buck's extension in 35.2 per cent. of the cases; plaster of Paris in 29.8 per cent.; extension, cast six weeks, 10 per cent.; Liston's splint, 9 per cent.; Hodgen's splint, 8 per cent., and sand bags, 8 per cent. The mortality in ninety-six fractures of the neck was 15.6 per cent.; and of the fifteen patients who died, fourteen were more than 60 years of age.

Martin published the end-results of 242 cases of simple fracture of the femoral shaft, collected from the hospitals of the city of Philadel-

<sup>\*</sup> Based on a report made before the Société Internationale de Chirurgie, Paris, July, 1920.

phia. Most of these fractures were treated by Buck's extension. Two of his conclusions were:

No. 12.—The unsatisfactory results following the weight extension treatment of simple fracture of the femoral shaft in adults suggest that this method is either inadequate in itself or is unskilfully applied.

No. 13.—Efforts to obtain better results should be directed to (a) employment of more weight to entirely overcome the deformity; (b) early resort to open operation if extension seems insufficient; (c) systematic use of massage and passive motion continued for months; (d) longer use of crutches than is now customary, and (e) education of the patient.

Estes analyzes the reports of 739 cases of fracture of the femur. The age distribution in fractures of the shaft of the femur in this series is given in Table 2.

TABLE 2. — Age Distribution in Fractures of the Shaft of the Femur

Age	Number of Cases
0-10	. 90
10-20	. 65
20-50	. 122
50-70.	. 55
70–90.	. 12
4	
Total	. 344

TABLE 3.—Age Distribution in Fractures of the Femur

Age	Number of Case
0-10	125
11-20	48
21- 30	26
31-40	23
41- 50	53
51-60	73
61-70	77
71- 80	69
81-90	26
91-100	5
101-110	1

He concluded that during the period of hard active labor there was the greatest number of fractures of the shaft of the femur in America. Speaking of fractures of the middle third, he says: "Except in selected cases I have quite lost my preference for traction methods of treating these fractures, since skiagrams so frequently showed me overlapped fragments, inaccurate apposition and nearly always a little angulation as a part of the result."

In 1890, the fracture committee of the American Surgical Association agreed that if the end-results after fracture of the femur should be considered good there must be: (a) firm bony union; (b) correct axial relations of fragments; (c) maintenance of correct relations of

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the anterior planes of upper and lower fragments; (d) no shortening to exceed  $\frac{1}{8}$  to 1 inch; (e) no lameness occurring as a result of shortening over 1 inch, and (f) an understanding that conditions attending the treatment may prevent these satisfactory results. At that time, this committee reviewed 364 nonoperated cases, in 67 per cent. of which there were good anatomic and functional results.

# FRACTURES OF THE FEMUR AT THE COOK COUNTY HOSPITAL, CHICAGO

From the records of the Cook County Hospital, Chicago, for the last three years, I have collected the reports of 526 cases of fracture of the femur, which were observed long enough to warrant their inclusion in this article. Four of the series were compound fractures. The age distribution is given in Table 3.

There were 328 males and 198 females. The right femur was affected in 271 cases; the left in 255. The incidence according to the part of the femur affected is given in Table 4.

Site of Injury	Number of Cases	Per Cent
Neck	124	24
Intertrochanteric	118	22
Greater trochanter	10	2
Subtrochanteric	14	2.5
(upper	39)	
Shaft{middle	157 249	47
lower	53	
Supracondylar	5	1
Condyles	2	1
Intercondylar	1	0.3

TABLE 4.—INCIDENCE OF INJURY IN VARIOUS PARTS OF FEMUR

Mortality of Fractures of the Femur.—The total deaths of the series were fifty-six, 11 per cent. Twenty-two deaths were attributed to pneumonia complicating the fracture. Other causes of death were multiple fracture, nephritis, myocarditis, infection and lung abscess. The number of deaths occurring in the different fractures is given in Table 5.

TABLE 5.—Number of	DEATHS	OCCURRING IN	Different	FRACTURES
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Site of Injury	Number of Cases	Per Cent.
Intertrochanteric	22 20	18.6 of all intertrochanteric fractures 16.1 of all neck fractures
Shaft middle 4	7	
Subtrochanteric Supracondylar	3 1	
Greater trochanter Not stated	1 2	
Total	53	

Methods of Treatment.—The methods of treatment for the whole series of 526 cases were: rest in bed, sand bags, sitting up in bed supported by pillows, etc., in 35 cases; Thomas splint with suspension traction in 25 cases; vertical extension in children in 56; Buck's extension, sometimes combined with Liston's splint, double inclined plane and molded plaster-of-Paris splints in 97; fracture table, extension and cast in 113, or 21 per cent.; splints of plaster and wood in 8, and treatment not stated in 192, or 36 per cent.

Discharge Results.—The results on discharge from the hospital were: shortening,  $\frac{1}{2}$  to  $\frac{21}{2}$  inches, in 101 cases; left hospital on crutches, 189; left hospital in cast, 39; able to walk, 51; nonunion (questionable), 6, and discharge condition not stated, 240, or 47 per cent.

Operations on Fractures of the Femur.—The total number of operations performed to reduce these fractures was fifty-one. divided as in Table 6.

	Operation	Number	Results		
Site	Туре	Kumber [	Good	Bad	
leck	. Bone peg	5	2	3	
leck	. Steel screws	6	2	4	
nart	Intromodullary hone page	15	5	9	
12116	Metal serews	11	(	4	
haft	Simple replacement.	3		1	
haft	Calipers	7	5	2	
haft	. Nail extension	2	ĩ	1	
naft	. Parham's band	1	1	. –	

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Mortality Following Operation.—The total deaths following operative interference were 4, or about 8 per cent.: neck, metal screws, 2; shaft, intramedullary bone peg, 1, and shaft, nail extension, 1.

#### SUGGESTIONS FOR STANDARD TREATMENT

The results tabulated here are not good. In an attempt to improve the results I make the following suggestions:

Indications for Fixation and Traction.—In the general consideration of treatment it is acknowledged that the femur is richly supplied with strong muscular attachments, and consequently a reduction of fracture in any part of its continuity cannot be obtained by simple fixation of the thigh. In addition to fixation, there must be traction to obtain relaxation of the muscles which have become infiltrated with blood to a certain degree, following the trauma. The infiltration causes muscle shortening and pull on the bone, holding it out of normal alinement, once it is broken. Traction in the axis of normal muscle action and weight-bearing overcomes muscular contraction and puts the muscles at rest, just as fixation puts the broken ends of the bone at rest. When these two indications are met, we are treating the fracture properly, but an effort must be made to obtain the best ultimate function of the limb. Hence we must restore the bone to its normal physiologic axis and secure bony union and bone integrity to assure both a structural and functional restoration. Consequently, proper methods of treatment demand precision and system. The patient with a fractured femur should be hospitalized. Roentgen-ray examination with reduction and splinting should be made at once, so that a maximum muscle infiltration and contraction will not occur and so that bone fragments may be approximated and immobilized.

General Law of Fracture Treatment.—The distal bone fragment over which the surgeon has control must be brought into a plane of normal relation with the proximal fragment. When this practice becomes general, both the suffering and mortality incident to fractures of the femur will be greatly lessened. In aged patients, some of the mortality is the result of the so-called conservative methods of treatment which lead to pain and which wear out the patients' strength and resistance, so that they succumb easily.

Treatment of the Fracture of Different Parts of the Femur.—Suggestions for standard specific treatment of fractures of the femur may be divided according to the site of fracture, thus—neck, intertrochanteric, subtrochanteric, shaft, supracondylar, epiphyseal separation, and condylar.

## FRACTURES OF THE NECK

Of the 124 cases of fracture of the neck in our series, seventy-two were in females and fifty-two in males. Among the twenty deaths after fracture of the neck, only six were in males. This would make it appear that the probability of fatal issue in females was greater than in males after fractures of the neck. The average age of the six males who died was 68; of the fourteen females, 61 years. Only five of the deaths occurred in patients under 60 years of age. Distribution of the neck fractures according to age is given in Table 7.

TABLE	7.—Distribution	OF	FRACTURES	OF	THE	Neck	OF	THE	Femur
		Ac	CORDING TO	Age	C				

Age	Number of Case
1- 10.	
11- 20	0
21- 30	
31-40,	
41- 50	
51-60	
61-70,	
71-80	
81-90	
91–100	1

Fractures of the Neck in Childhood.—Fracture of the neck occurs in childhood frequently, and was first thoroughly described in America by Royal Whitman in 1890. An early diagnosis is highly desirable because reduction should be made at once. Many of the fractures of the neck in adolescents are epiphyseal separations with little displace-



Fig. 1.—Healed neck fracture, with coxa vara from too early unsupported weight-bearing. This illustration and Figures 4, 7, 8, 10, 12 to 25, 32, and 37 to 42 are adapted from the author's textbook, "Fractures and Dislocations," Lea & Febiger, Philadelphia, 1916.



Fig. 2.—The usual type of neck fracture of the femur with a minimum amount of shortening, foot rotated outward. When this fracture was reduced the roentgenogram revealed almost perfect neck angulation and apposition of fragments. ment. The causative trauma may be overlooked. The child, unlike an adult, may walk away from the scene of the accident, and the gradual displacement accompanying the change in the angle of the femoral neck with shortening frequently follows, as the patient bears weight on the injured leg (Fig. 1). Some process of repair accompanies the gradual displacement of the shaft upward. If the diagnosis is not made early, the neck may be molded, after several weeks, into a firm bony mass, which then requires open operation to effect a perfect reduction.

Technic of Reduction.—If the fresh fracture has resulted in complete separation, either through the epiphyseal line of the neck or at



Fig. 3.—Fracture of the neck of the femur involving the head, the usual displacement. It is perfectly evident that there is shortening, rotation outward of the foot and change of the normal axis (130 degrees) of the femoral neck, and that extension, internal rotation followed by complete abduction of the thigh are necessary to effect a proper relation of fragments.

the base of the neck, the shaft usually is moved upward, backward and outward (Fig. 2). Hence to appose the fractured surfaces, the distal portion of the limb over which the surgeon has control must be lifted forward, rotated inward and then must be drawn down to normal length (Fig. 3). This is followed by *abduction to the limit*, so that the greater trochanter is apposed to the rim of the acetabulum and the side of the pelvis and the neck is brought into alinement and contact with the head, aided partly by the capsular ligament and the resistance of the head against the acetabulum. The angle of the neck is thus restored (Fig. 4).

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Result of Restoration of Angle of the Neck.—In this position of extreme abduction, the security of the reduction is assured by the capsule, the bony contact and the muscular impotence incidental to the position. Because the range of abduction in the human hip depends on the normal angle of the femoral neck to the shaft, this reduction in a position of extreme abduction looks toward a perfect reestablishment of the angle of the neck. If that is secured, there is no insecure support of the hip later, no shortening and no compensatory distortion of the pelvis is required to accommodate for a changed angle of the neck. "Body Casts and Hip Spicas of Plaster of Paris.—While the leg is

in extreme abduction, the patient is placed in a plaster-of-Paris cast



Fig. 4.—Attempted reduction by extension in a straight line. Some length has been regained, but the neck angle is still about 90 degrees and can be corrected by complete abduction. Healing in the position shown would lead to an adducted leg and some shortening.

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(Fig. 5), extending from the nipples to the toes, for from eight to twelve weeks, and is not allowed to bear weight for from three to six months thereafter. He must use a walking caliper fitted into the shoe during this period to avoid subsequent development of coxa vara.

The technic of application of the body cast requires that all bony points should be completely padded to avoid pressure necrosis and that the plaster should be well reinforced at the weak points, namely, at the groin and outer aspect of the thigh up to the waist. For padding purposes, I have found that saddler's felt is the best material. The usual cotton or stockinet wadding is used to cover the patient, and the saddler's felt padding is applied in addition. Nine pieces, each about 6 inches square, are required. One is placed over each anterior superior

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iliac spine, one over the sacrum between the sacrum and the sacral support, one on each lateral aspect of the knee to be included in the cast and one on each side of both ankles to soften the force used in extension and traction on the fracture table. Multiple layers of plaster bandage are applied longitudinally over the front of the groin and the lateral aspect of the thigh to give strength. This additional strength makes tipping of the patient in the cast, for hygicnic purposes and necessary change of position, safe. A fairly large sized pad is placed over the epigastrium (dinner pad) before the cast is applied. This allows room for distention after eating, without unpleasant pressure,



Fig. 5.—Woman, aged 52 years, with fracture of the neck of the femur in body cast. Both legs abducted. The feet are off the edge of the bed on either side, and a more than half sitting posture is possible. She can be turned on her side or even onto her face safely. The cast reaches down to the knee on the uninjured leg. By the pole above the bed, she can move the upper part of the body at will.

After-Treatment—the Walking Caliper.—The walking caliper is made like a Thomas leg splint with a snug fitting thigh ring. The lower ends of the iron side-bars are turned in at right angles and fitted into the heel of the boot, the hole in the boot being of such length that in walking the patient's weight is supported largely by ring pressure against the tuberosity of the ischium. Calipers can be made with adjustable side rods, and they are strapped to the leg by broad canvas bands (Fig. 6). When the patient goes to bed, the calipers are removed, because the soft callus does not have to support weight.

Treatment of Fractures of the Neck in Adults.—The same treatment is applicable in fractures of the neck of the femur in adults, whether impacted or not, unless the physical condition of the patient precludes any active treatment. It should give a high average of successful results. There is little doubt that nonunion will seldom occur if this careful approximation of fragments is attained. The capacity for



Fig. 6.—Patient in walking caliper after cure of fracture of neck of the femur. Straps hold the leg firmly and the leather ring presses against the ischial tuberosity when the patient bears weight. The length is adjustable by means of the threaded bar and lock nuts.

repair in bony tissues in adults is not so great as it is in children; but still it is active, as evidenced by bony union following open operation on ununited fracture of the femoral neck, where simple freshening and fixation of fragments in apposition is the only operative work performed. The cast is most frequently applied with the patient anesthetized, lying on a fracture table. Rationale of Abduction Treatment for Fractures of the Neck.—The position of extreme abduction offers the best chance for mechanical apposition of fragments, and that appears to be more important than the blood supply of the head fragment, when ultimate bony union is considered. In this position, the greater trochanter and neck come into close relation with the upper border of the acetabular rim. The Y ligament also assumes a position where it exercises its greatest strength and function, being used as a suspensory fulcrum, on which the major fragment (shaft) is swung outward and into direct contact with the head fragment, on which a direct hold cannot be obtained. After recent fracture of the neck, whether through its narrow or broad portions, this method of treatment approximates satisfactorily the fractured surfaces, and immobilization in the abduction position results in bony union (Fig. 7).



Fig. 7.—The pelvis may be broken along with the femoral neck fracture. The neck angle is less than 90 degrees.

Treatment of Old Fractures in Adults.—In old fractures, however, even where the head fragment is levered into position, it may be difficult to maintain bony contact (Fig. 8). Shortening of the neck, caused by bone absorption from the irritation of motion and use and incomplete reduction, becomes so great that the trochanter impinges on the acetabular rim during abduction and hyperabduction; it may cause a separation of the fragments, rather than a forced contact. Consequently, in old fractures, in order to secure a bony union, it has been considered best to introduce a bone peg through the trochanteric region into the head, while the limb is in a position of extreme abduction. I have treated a few patients, whose cases are classed under this head, in whom simple freshening of the fragment surfaces near the hip joint, without the introduction of a bone splint, followed by a sufficient period of immobilization in abduction, resulted in bony union. If the head and neck are so much absorbed that a fragment of only from 1 to 1.5 cm. in thickness remains, certain operative methods are necessary if a weight-bearing, painless hip is secured. Either an autogenous bone peg can be driven clear through the head into the acetabulum making a bony ankylosis, fulfilling the conditions mentioned, or the head may be excised and the freshened neck and acetabulum placed in apposition with the thigh in abduction, a bony union being desired (Fig. 9). Tilting of the pelvis will accommodate for much of the shortening, and the bony union will be painless. The necessary factor after operation is the firm



Fig. 8.—Fracture of the femoral neck which had gone untreated for some time. Absorption of the neck and head fragment, adduction of the leg and shortening and rotation of the foot outward are apparent. The abduction position in this type may lead to bony union; more often operation is indicated.

body cast applied while the patient is on a fracture table, with the *thigh in complete abduction*, with the foot rotated inward. If the patient cannot tolerate rest in bed even in the half sitting position that such a cast permits, abduction and extension by the Thomas or Hodgen splint, with rotation of the thigh inward, will also be impossible. If these methods are not applicable, the patient must then be placed in a wheel chair or set up in bed. The result will be a fibrous union of the shaft to the pelvis, which will permit the maximum of shortening when weight is borne on the limb. The pain in such a hip may eventually become bearable, but usually the function is very poor.

Results in Fractures of the Neck.—Probably not more than 15 per cent. of fractures of the neck in adults result in bony union, unless the

patients are treated by extreme abduction (Fig. 10). Originally impacted neck fractures, let alone and not broken up nor brought into reduction and abduction, result, if union obtains, in a short, adducted and outwardly rotated leg. To avoid the bed confinement in a supine position, Moore advised a modification of the Whitman method by the application of the cast with the thigh in abduction, while the patient is in a sitting position. He treated sixteen patients thus, nine of whom were more than 70 years of age; seven had good functional results, one died, two had nonunion, two were not traced and three were still under treat-



Fig. 9.—Bone transplant into the pelvis through the femur and broken off head. This patient was more than 50 years old and had had this fracture of the neck of the femur for two years. The neck angle has been well restored, the hip is in maximum abduction and the patient now has a weight-bearing, painless, stiff hip joint.

ment. When the ordinary body cast is properly applied the patient can easily assume a half sitting posture (Fig. 5).

Extension Without Abduction in Neck Fractures.—Buck's extension and extension by a Thomas or Hodgen splint with traction and suspension fail to consider the degree of abduction necessary to restore the angle after fracture of the neck. If one leg is drawn into abduction in these suspended splints, the angulation is not steady because the patient's pelvis is not fixed. The patient consequently can, and does, tip the pelvis to overcome the abduction. Putting both legs in extreme abduction in a suspended Thomas splint or Sinclair's net bed will secure the necessary abduction, but the bed confinement is as severe as that induced by a cast. The same arguments apply to caliper extension (Fig. 11).

*Résumé of Treatment of Fractures of the Neck.*—The best treatment of fractures in youth or other age is immediate reduction and use of the position of extreme abduction in a plaster-of-Paris body cast. After the patient is etherized, the trochanter is lifted up, the foot is rotated inward, and the leg is drawn down to the fullest extent. Then it is swung out into extreme abduction while still under traction. This procedure is most easily carried out while the patient is on a fracture



Fig. 10.—Fracture of the femoral neck with impaction. Shortening, adduction of the leg and change of the neck angle are all present. Abduction treatment in a plaster spica would promise a much better result than a "leave impaction alone" treatment.

table. It is almost impossible to secure permanent, proper abduction with restoration of the angle of the neck by any other means. If the patient's health will not permit the use of a plaster cast, it will also preclude the use of any traction which requires bed confinement. Therefore, since no half-hearted method of traction will secure bony apposition and lead to bony union, the only other treatment, which is really no treatment, is sitting up in bed or in a wheel chair supported by pillows.

Impacted Fractures of the Aged.—In the aged, who cannot tolerate the cast abduction treatment, any impaction of fragments should be let alone. The fragments usually slip apart in a few days after rest in bed.

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Patients Suffering from Delayed Treatment.—If the patient is not seen for many days after a fracture and a maximum of shortening, combined with some bone absorption in the neck has followed, the abduction and cast method should also be used. Should neck absorption be great enough to lead the surgeon to fear delayed or nonunion, the patient should be subjected to immediate operation, an autogenous bone peg being passed through the trochanter up into the head with the neck angle



Fig. 11.—Double suspension traction in abduction. By this means abduction of the thigh can be maintained. For fractures of the neck of the femur we prefer the plaster spica or cast, allowing the patient to sit up.

restored. Exogenous bone and metal screws or nails should never be used in the neck of the femur. Any successful cases that have been reported following the insertion of nails or screws in the femoral neck for fracture may be attributed to the immobilization and to a position of abduction maintained during the healing, and occurred *in spite* of the foreign body present. Vicious Union—Coxa Vara.—The most common deformity requiring treatment after vicious union of fractures of the neck of the femur is coxa vara. The neck is shortened, thickened and painful when weight is borne; its angle with the shaft has been reduced to 90 degrees or less, and the shortened adducted leg gives evidence of deformity. For these patients, an osteotomy alone promises a better result. If the thickened neck still permits free hip motion, one may cut across the neck and swing the leg out into extreme abduction and inward rotation under strong traction, hoping to gain a better neck angle and better function. If there is bony union between the neck and head and the pelvis with an adducted leg, one can improve the function by



Fig. 12.—Impacted fracture healed with adduction and limited motion. Exostosis at acetabular border.

performing a subtrochanteric osteotomy, swinging the leg into abduction and letting it unite in this position (Fig. 12).

## UNUNITED FRACTURES OF THE NECK

Ununited fractures of the neck of the femur demand treatment when the patient desires to be relieved of the disability, usually shown by shortening, adduction of the leg, lameness, the necessity of using a crutch or cane and pain.

Some Causes of Nonunion.—There is no doubt that most instances of nonunion or malunion could be avoided if the adequate primary treatment of extension and abduction outlined were applied after an early correct diagnosis. When true nonunion has occurred no manipu-

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lation method will cure; surgical operation alone can give bony union. Some patients treated by the proper method are allowed to bear weight too soon; coxa vara or even a breaking down of the soft callus may result with all the findings of a nonunion. No patient after fracture of the neck of the femur should bear weight on the bone for six months; he should wear a walking caliper.

Treatment of Ununited Fractures of the Neck.—A series of 120 cases of nonunion of hip fractures was reviewed by Henderson. There were sixty-eight males and fifty-two females. Twenty-six were operated on with no deaths, ninety-four were dismissed without treatment. Nails or screws were used in eight cases; bone transplants in eighteen cases. Only two operative wounds were infected. The fibula was used as the graft, and every care was taken to restore the angle of the neck.



Fig. 13.—Old fracture of femoral neck treated by nailing. Because the nails projected into the acetabular cartilage and caused pain, they were removed eighteen months later. The neck had not united.

Full exposure was made by a U-shaped incision with removal of the greater trochanter. All patients were on a fracture table, and after operation were placed in plaster-of-Paris casts. The end-results in seven cases were not known; ten operations were successful; eight were failures. The percentage of good operative results was 38, but of the entire series of 120 patients only 8.3 per cent. were improved. It was concluded that any means, in suitable cases, which will freshen the fractured surfaces and maintain them in apposition (abduction and traction) are sufficient. I agree with that conclusion, and believe that the value of the autogenous bone peg inserted through the neck into

the head has been overrated. Some operators use two incisions, one over the trochanter through which to insert the peg, another over the femoral neck just outside the great vessels, to freshen the fragments and give a proper guide to the bone peg as it is inserted. Traction and extreme abduction are required on a fracture table during the operation.

A series of eight cases of nonunion of the neck of the femur treated by the insertion of nails was reported by Swett. He made a lateral incision only, making no attempt to freshen the fragments. The results were not satisfactory (Fig. 13).

Absorption of the Femoral Neck.—When the neck fragment has been absorbed by use and improper treatment and when the head is



Fig. 14.—Intertrochanteric fracture. The changed neck angle and the large surface of cancellous tissue which insures bony union may be noted. Abduction plainly indicated.

atrophied so that only the articular portion, which does not project beyond the acetabular margin, remains, it is difficult to bring the fragments in apposition.

Viability of the Head of the Femur.—It has always been asserted that the state of nutrition of the head fragment is also a point to be decided. Even if it does not bleed when scraped, it may be viable and conditions favorable to full return of life must be established. A head which has thus been long separated from the shaft is somewhat softened, yellow and contains little holding substance into which a bone transplant can be driven. In the old cases, the use of the graft as a carrier of osteogenetic stimulus is futile unless there is also firm apposition of fragments. It is hardly reasonable to expect

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the transplant, which must first be partly renourished by the shaft portion, to save the life of the soft head fragment. Bone regeneration must be developed in the bridge of the transplant and by it carried into bone partly dead. Consequently, some operations for nonunion of the neck by means of a bone transplant will not succeed. If the head in these old cases is considered as a sequestrum, it may become vitalized if grafted on living cancellous bone.

Brackett and New have advised placing the head of the femur on the inner, upper side of the sawed off and freshened trochanter, which is abducted enough to come into contact. After the leg had been in a plaster-of-Paris cast for ten weeks they obtained seven good results in nine cases in which this operation had been performed. The unions



Fig. 15.—Intertrochanteric fracture with separation of the lesser trochanter and tearing of the acetabular rim. Abduction is plainly indicated in the treatment.

were strong and bore weight well; the amount of motion in the hip was not complete but was practical.

Operative Treatment.---My treatment has been as follows:

If there has not been great absorption of the neck, the fragments are freshened through an anterior incision and an autogenous bone peg is then inserted from the trochanter into the head, while traction is maintained and the extremity is abducted and rotated inward. In patients over 50 years of age in whom the hope of bony union of the head to the neck is diminished, it may be better practice to produce an ankylosed hip by driving the bone peg clear on into the pelvis. This promises a stiff hip which bears weight painlessly, which demands a

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shorter bed and cast confinement. This bone transplant ankylosis operation is more quickly performed than excision of the head, and it is less of a shock to the patient. However, as stated, I am beginning to doubt the value of the bone transplant. When the head is largely absorbed and fragmented, the best treatment is its excision with freshening of



Fig. 16.—Intertrochanteric fracture with shortening and changed neck angle, indicating extension followed by abduction to restore normal position.



Fig. 17.—Intertrochanteric fracture with little displacement, but one which requires abduction.

the bony surfaces, so that when the limb is drawn down and completely abducted, bony ankylosis in that position results. Brackett's operation is more extensive; it must be reserved for younger and more active patients for whom length of limb and hip joint motion are very essential.

#### INTERTROCHANTERIC FRACTURE

Intertrochanteric fractures mostly result from direct violence. The plane of fracture runs diagonally from one trochanter to another, and either or both trochanters may be broken off and separated. The great proportion of these fractures makes their treatment important. Many occur in patients who lead an active life and have need of good leg function. The displacements vary—usually there is little shortening,  $\frac{1}{2}$  to 1 inch; but the neck angle is reduced from 130 degrees to about 90 degrees in most instances (Figs. 14 and 15). Traction will easily restore full length, and the swinging out to full abduction restores the neck angle. A body plaster-of-Paris cast applied while the patient is on the fracture table in this position gives excellent



Fig. 18.—Intertrochanteric fracture involving both trochanters. The changed angle between the shaft and neck fragments may be noted.

results. If there is impaction and the patient cannot be confined to bed, sand bags or pillows and a sitting position will frequently give a satisfactory result but with some shortening (Figs. 16 and 17). Nonunion of this portion of the bone is rare, because of the large cancellous surfaces which come in contact. Bony union results even when no mobilizing treatment is employed (Fig. 18).

However, our statistics show a higher mortality from this fracture than from fractures of the neck, and we advise great care of the heart and lungs of these patients. Many are very fat, with corresponding cardiac weakness. Prolonged anesthesia should be avoided. If union should fail, an autogenous bone peg or a simple freshening of the bone surfaces is all that is needed operatively before a cast is applied. A walking caliper is required for six months to avoid coxa vara.

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#### TROCHANTERIC FRACTURES

Fractures of the trochanters alone do not often demand unusual treatment. If the greater trochanter is widely separated by the attached muscles, it may be pegged onto the rest of the bone and the leg immobilized in abduction. Usually abduction or rest in bed for two or three weeks gives a useful leg (Fig. 19). Fracture of the lesser trochanter alone is rare. Because the separated fragment is pulled up and inward, it is sufficient to treat the patient by setting him up in bed, with the thigh flexed on the body, for three weeks. Casts are rarely required to maintain this position (Fig. 20).



Fig. 19.—Fracture of the greater trochanter.

#### SUBTROCHANTERIC FRACTURES

Subtrochanteric fractures are not frequently encountered; but they are very important inasmuch as the relative angle of the neck is lessened and shortening occurs. The distal or shaft fragment may be displaced above the level of the acetabulum. These fractures are often short spirals or oblique. It is often most difficult to reduce the deformity and to maintain the fragments in apposition. The two fragments are of unequal lengths: the proximal or upper fragment which is very short contains the head, neck, trochanters and a varying length of shaft up to 2 inches. It is strongly flexed and abducted by attached muscles (Figs. 21 and 22). The distal fragment consists of the remainder of the femur pulled on by all the strong thigh muscles including the quadriceps extensor. The proximal fragment has varying displacement depending on the type of fracture, the cause—direct or indirect violence-and the pull of the glutei, ilio-psoas and pelvic muscles.

Treatment of Subtrochanteric Fractures.—The best method of treatment is continuous suspension traction with the Hodgen or



Fig. 20.-Fracture of the lesser trochanter.



Fig. 21.—Spiral subtrochanteric fracture. Shaft fragment drawn in and up; trochanter rotated outward.

Thomas splint bent at the knee. The large fragment is swung out and up to meet the prolonged axis of the short upper fragment, and at the same time strong traction in that axis must be made to pull the end of the lower fragment into proper relation with the upper. Because the long fragment tends to be adducted, it may be necessary to apply direct outward push against its upper end by means of a pad on a threaded bar attached to the side of the main splint. Lateral traction by adhesive is often used. All these methods may fail to give complete reduction. Thomas splints with attachment for knee movement are very useful.



Fig. 22.—Subtrochanteric fracture with triangular fragment. A reduction of this type is difficult to obtain and hold. Extension and abduction of the lower fragment is indicated.

Operation for Subtrochanteric Fracture.—Should reduction fail after six or seven days' effort, as shown by roentgenographic control, operation is indicated. An operative reduction may be difficult, and it may be even more difficult to maintain the reduction during the applica-

## SPEED-FRACTURE OF FEMUR

tion of an internal splint. The upper fragment is so short that a metal or other plate cannot be attached. When there are spiral fractures, a band or an ivory screw may maintain the reduction. Intramedullary splints do not hold well (Fig. 23). When the deformity tends strongly to reproduce itself, the muscular insertions into the greater trochanter may be loosened by a sharp chisel, or the tendons may be severed so that the upper fragment does not tend to rotate outward so strongly. Reduction may then be accomplished easily.



Fig. 23.—Attempted reduction of subtrochanteric fracture by an intramedullary bone peg according to Hey Groves method (*The Journal A. M. A.*, Sept. 6, 1919, p. 742). Little reduction obtained anatomically. The peg was too short and the lower fragment was not sufficiently extended and abducted. A fair functional result followed this repair.

#### FRACTURES OF THE SHAFT OF THE FEMUR

These occur in any part of the diaphysis, the limits being from just below the lesser trochanter proximally to a plane just above the condyles distally. There are the usual types of transverse or oblique fractures caused by direct violence, resulting frequently in comminution or the freeing of a triangular shaped piece of bone, and the spiral fracture caused by the twists or indirect violence (Figs. 24 and 25). In children, incomplete fractures involving only part of the cortex, and green stick fractures may be encountered. The commonest site at all ages is the middle third of the diaphysis. Treatment aims to restore length by approximating the ends of the fragments, and

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to maintain a normal limb axis in both a horizontal and longitudinal plane. Every effort is made to bring the limb's long axis into the proper line for weight-bearing, a straight line from anterior iliac spine through the middle of the patella and on to the second toe. The horizontal axial relation of fragments must also be normal. When



Fig. 24.—Transverse shaft fracture. Very difficult to reduce for end-to-end apposition and axial alinement.



Fig. 25.—Transverse shaft fracture with interlocked fragments—not difficult to reduce.

these axes are not restored, the patient later develops static troubles in the neighboring joints, especially in the knee, and axial rotation may bring on foot troubles when walking is undertaken. Secondary axial deviations from too early weight-bearing on soft callus may cause these troubles.

فتحسرسه

Shortening is a result of shaft fracture that is most difficult to overcome. In transverse fracture, it sometimes becomes impossible by manipulation and extension methods to get the ends into contactshortening as such may be overcome. Consequently, oblique and even long spiral fractures may offer a better prognosis, for reduction may be more easily accomplished and the length of the extremity more nearly restored. If the patient is placed on a fracture table an exact end-to-end contact is seldom obtained, even when considerable traction is applied. In oblique and spiral fractures also after the application of body casts following fracture table reduction, the spastic thigh muscles tend to cause a renewal of the displacement no matter how perfect it may have been as shown by roentgenogram at the time of reduction. The position of a shaft fracture, viewed by roentgenogram shortly after reduction and which may seem satisfactory, very frequently shows the original displacement when examined by the roentgen ray ten days later. When the fragment ends of a transverse fracture interlock by their serrated edges, a bowing is liable to develop later from muscle action within a heavy cast. Oblique and spiral fractures simply tend to slip back into the old displacement. It is practically impossible to maintain any real extension in the longitudinal axis of the leg by means of a plasterof-Paris body cast.

With no hesitation, therefore, I can advise that there is no treatment comparable to continuous traction, best continuous suspension traction. The use of plaster casts for fractures of the shaft, except in instances of children or adults when there is green stick or incomplete fracture and little displacement, should be discarded. The best results in fractures of the shaft in children are obtained by suspension traction treatment. This I have demonstrated in a year's work on sixtyseven shaft fractures which were studied from the standpoint of methods and results of treatment. The extension used was gauze applied with Sinclair's glue to the unshaven limb, attached to a Thomas splint (Figs. 26 and 27). The splint was slung in suspension traction. Children have little trouble with limitation of joint motion after splint traction. Below the age of 4 years, on account of the disproportionate weight of the leg and the body, vertical extension, as usually employed, is advised.

It is not true on the other hand that continuous traction results in an anatomic reduction in all cases, but it assures the restoration of the weight-bearing axis of the leg, an insignificant shortening and a result approaching the normal. Depending on the site of the fracture and the displacement, we can use straight-in-a-line exten-





Fig. 27.-A, end view of Balkan frame; B, overhead frame.

#### ARCHIVES OF SURGERY

sion or the splint can be bent to give semiflexion. Suspension traction is the best method of all as it allows these variations and furnishes one apparatus for the care of all shaft fractures. The rule already expressed concerning traction must be referred to (Fig. 28). Because the extension acts on the lower fragment and does not modify the axial direction of the upper fragment, it is necessary to bring



Fig. 28.—Model frame attached to doll's bed, the foot of which is elevated. The weights at the head of the bed are out of the way. The frame is compact and does not touch the floor, leaving the bed free to be moved about if desired.

the mobile lower fragment, which can be easily controlled, into line with the upper fragment.

Suspension traction of the limb in either a Hodgen or Thomas splint, the very best method of obtaining continuous traction, has not been in wide use. Sporadic attempts to revive the use of the Hodgen splint have been made and yet the method has not been widely adopted. This I believe

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has been because the average American surgeon is not mechanically inclined. He favors plaster-of-Paris casts or some splint application which is put on once and taken off once before the patient is discharged. Any extension apparatus which involves daily attention and adjustment is too irksome to use. In rural districts, with the patient in his own home, a suspension traction method was deemed impractical because the surgeon could not see the patient often enough (Fig. 29). Among hospital patients, too much time was necessary for the attention required to adjust the splints; the nursing staff did not care to have wards



Fig. 29.—Overhead frames in actual operation. The nearest patient is sitting up to watch proceedings, without affecting the traction on his leg.

and beds disfigured by strange wooden frames. However, a certain proportion of active American physicians had an opportunity during the war to study the methods of suspension traction used by the French and English; this nucleus may help spread the use of the system (Fig. 30).

It is really a blow to American surgery that the idea of suspension traction so highly perfected by Hodgen should have fallen into the discard until revived by foreigners in the Balkan war and later in the World War. We now learn from them its great advantages and we wit-

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ness its acceptance by the highest authorities as *the* means of treatment for shaft fractures. Too much is written at this time in the American literature about the use in foreign lands of the Thomas or other leg



Fig. 30.---Suspension traction for an adult. The splint is tied to the post, the extension on the leg is tied to the splint, so that the traction comes from the adult's body-weight.

splint for suspension traction of the thigh. If the writers would consult our own literature and would give credit to the Hodgen splint, America might come into some of the credit due the real inventor (Fig. 31).

#### SPEED—FRACTURE OF FEMUR

#### MASSAGE AND ELECTRICAL STIMULATION

No résumé of the present treatment of femoral fractures can be complete unless attention is drawn to the extreme negligence shown by American surgeons in the way of providing accessory massage and electrical stimulation of muscles. These two adjuvants must, when possible, be applied during the course of repair. When the limb is enveloped in a plaster cast, they cannot be employed, another



Fig. 31.—The foot is held up by gauze and glue, so that foot-drop cannot occur.

argument in favor of open dressing in suspension traction. The daily massage and galvanic stimulation of thigh muscles in fracture of the femur, whether open or closed, operated on or not, should be as much a part of routine ward work as making the patient's bed. It is rather disheartening to see the great amount of care bestowed on patients about to be operated on in hospitals as compared to the trouble taken in caring for fractured thighs. For the operative patient, all the resources of the hospital are called into play: special anesthetist, a large operating room force, the surgeon and his assistants, everything being subordinated to the operation, and later much attention given to the postoperative care. The mortality among operative patients is no higher than among those suffering from fractures of the femur. The average patient after appendectomy is up and walking in eight or ten days—the average patient with a fracture of the femur has months of



Fig. 32.—Portable roentgen-ray machine, the operator making a bedside exposure without interfering with the suspension traction.

waiting before he can walk and then must often carry through life distinct evidence of his mishap. The relative economic loss of two such conditions cannot be compared.

As a result of massage and electrical treatment during healing of the bone, when the patient's splint is removed, the thigh and calf muscles are found prepared to function. There is no atrophy of disuse,

## SPEED—FRACTURE OF FEMUR

no waiting for shrunken thighs to regain size and power, and there is more rapid convalescence, free from fear of falls on account of loss of muscular power. Ambulatory calipers supplement this shortening of disability and insure a stability of the callus while reduction is maintained.

Fractures of the femur are very grave injuries; the supplies needed for caring for these patients, including frames, splints, extensions and dressings, should be as liberally and punctually supplied as those for laparotomy. The facilities for roentgenographic work for bedside diagnosis should be found in every hospital in which these fractures are treated (Fig. 32).



Fig. 33.—Shaft fracture in a child treated by Lane plate which has pulled out because of insufficient external splintage and too early weight-bearing.

#### AFTER-TREATMENT

When the callus has formed and can be felt to be firm by the examining hand (in children after three or four weeks; in adults after eight or ten weeks), the leg is lowered and kept loosely bound in a Thomas splint. The patient remains in bed and the splint protects the soft callus. After another week, a walking caliper having been made in the interim, the patient is fitted with a caliper and allowed to stand with crutches. The patient soon begins to walk, but the wise surgeon will see that the walking caliper fits perfectly and is worn for from four to six months, depending on the type of fracture and the patient's bony reaction. With that security, one knows there will be no disappointments resulting from secondary deformities and short-ening (Figs. 33, 34, 35 and 36).

Nail and Caliper Extension in Suspension Traction.—When ordinary traction fails, on account of damaged skin or slipping adhesive or glue, calipers or nail extension can be substituted. Should these fail to bring apial correction and full lengthening, as so frequently happens when the treatment is delayed too long, open operation offers a chance for anatomic reposition. By persistence and attention to



Fig. 34.—A healed gunshot fracture of the femur treated by suspension traction, showing the length obtained.

details, with inspection of leg, splints, ropes, pulleys and weights twice a day, the percentage of patients requiring nail or caliper extension will not rise over 3. We prefer the nail extension through the femoral condyles, and we employ steel drill rod sharpened at one end like a meat skewer, driven rapidly through the bone at the correct rightangled axis under the restrictions laid down by Steinmann. The nail will not slip as the caliper is inclined to, nor can the patient pull it out. The newer calipers like Schiassi's (Fig. 37) hold quite firmly; but any caliper is objectionable, inasmuch as there is some movement of the points within the skin wounds. This movement leads to a little

## SPEED-FRACTURE OF FEMUR

irritation and to infection which may not be serious, but which adds to the patient's troubles. The nail, on the other hand, does not move; it holds the lower fragment rigidly and permits a nice correction of the deformity. The nail also is cheap. We have had no infections from nails. In adults the nail treatment of femoral fracture must sometimes be used through the os calcis; in children this cannot be done on account of the slow development of this bone. A child up to 12 years of age has very little bone in the os calcis.

Portable Roentgen-Ray Control.—Regardless of the method used to obtain the traction in this suspension treatment, the operator must not trust alone to his eye for complete correction of the deformities. Roentgenographic controls by means of the portable roentgen-ray tube are absolutely necessary. If the patient's limb is removed from traction, and he is carted to a roentgen-ray room for exposure, the true



Fig. 35.—After the fracture has healed, attention is first paid to moving the knee joint while the patient is still confined to bed. The first step is bending the joint over a pillow.

state of reduction as obtained in the traction is lost. Consequently, the plates must be made while the limb is under traction with the patient in bed. When fractures of the shaft of the femur occur, they should be given immediate treatment. If that treatment is suspension traction, the roentgenogram for control must be made in case of a child within forty-eight hours, in case of an adult within four days, so that measures may be taken to vary the weight used in traction, to bend the splint at the proper angle, or to make pressure against one side of the limb or the other to correct axial deviations. There is no other way to insure a maximum correction of length and axis. It may happen that too much weight has been employed and that the fragments are actually separated.

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## SURGICAL TREATMENT

There are many methods of procedure in open operations. Usually the patient lies on the fracture table with the feet bound to the supports, ready for immediate application of a plaster-of-Paris body cast after the operation is finished and while the anesthesia is still effective. The simplest method of open operation is replacement of the fractured ends to the normal axis after correction of overriding and the local pathologic condition. Lane plates of steel, Parham's steel bands and wire are



Fig. 36.—The second step to increase knee joint motion. The patient is his own masseur.

used to hold fragments in position. Ivory or bone plates, with screws of corresponding material are also used. Inlay and intramedullary bone and ivory pegs are used, every internal operation requiring external splinting subsequently, a fact sometimes overlooked by the surgeon. Bone splints may be autogenous, taken from the tibia, fibula, or the femur itself, near the site of fracture. They may also be exogenous, usually beef bone used in the intramedullary fixations when a simple mechanical connection is desired. Numerous modifications of inlay bone fixations are offered, some sliding in character, taken from the

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operative field, some held by bone dowels cut from their own substance, others held by flanged edges made in the sawing. For these operations there is required a special electric outfit. One may well conclude that the best operation is the one which obtains, by the simplest technic, a satisfactory end-to-end approximation which will hold with the aid of external immobilization. The longer the exposure and the greater the local manipulation of bone ends and implanted fragments, the greater the possibility of infection.

A Lane plate should be employed only when the fracture cannot be reduced and maintained in reduction by other means. In children the indication for its use is found in neglected fractures



Fig. 37.—Schiassi's (Bologna) caliper for extension on the calcaneus. This can be modified for use above the malleoli or on the femur itself.

with overriding of from 2 to 3 inches, the fracture being of the transverse or sharp oblique type. When these fractures have not been submitted to suspension traction soon after their occurrence, the shortening soon passes beyond the possibility of being overcome by any traction, and callus forms so rapidly that within from two to three weeks a union is inaugurated. Therefore the ends must be freed, the callus removed, and the steadying plate is applied outside the periosteum. But we remove all such plates within six weeks in children and twelve weeks in adults; then we apply the walking caliper to protect the callus. The patient thus leaves the care of his surgeon with the plate removed: there are no complications. We believe that

the internal splint, especially one of nonabsorbable material such as a steel plate, is merely a means to an end. Its function is to hold the fragments in apposition until the bone wound is sealed by callus. Once that duty is performed, the metal plate should be removed; if that duty has not ended in a normal union in the customary period of time, its



Fig. 38.—Spiral supracondylar fracture with penetration of the knee joint by the sharp upper fragment.

presence for any longer period is not likely to insure union. However, we may modify the time of removal a little in case callus development is slow, though the plate should be removed as promptly as possible.

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#### SUPRACONDYLAR FRACTURES

These do not include separations of the lower epiphysis of the femur, nor true articular fractures. The supracondyloid site is that point of union between the diaphysis and its spreading portion that quickly widens into the massive condylar area. In children, fractures in this area are high up and may be green stick in character or even subperiosteal, but in adults we find the usual transverse or oblique and spiral types.



Fig. 39.—Unreduced bicondylar fracture which operation alone will benefit.

The primary displacement is usually due to a continuation of the force producing the fracture. The upper long fragment may be sharp, may penetrate muscles outward or inward or may be forced downward, lying just beneath the skin, or may penetrate the subcrural pouch of the knee joint to lie in contact with the patella (Fig. 38). The lower fragment is usually drawn backward and downward by the gastrocnemii. Injury of nerves and blood vessels may demand immediate treatment. A large hematoma should excite suspicion of vascular damage, and exploration need not be feared. Very early gangrene may call for amputation; but it is best delayed if possible for a line of demarcation. Old Cases of Supracondylar Fracture.—Should a complete supracondylar fracture heal with shortening, vicious deformity and large callus, operation promises a functional result. Osteophytic outgrowths may greatly restrict knee joint motion or interfere with the vascular and nerve supply of the leg, and it is also common to find that there is restricted joint motion after the hemarthrosis which accompanies the fracture. The greatest part of the partial ankylosis of the knee probably comes from fibrous changes in the periarticular structures, less frequently from intra-articular fibrosis.

Treatment of Supracondylar Fracture.—The treatment of supracondylar fracture must be prompt (Fig. 39). When incomplete, or green stick, or only slightly displaced, extension on a fracture table with pressure of the fragments back into line, followed by a molded plaster



Fig. 40.-Epiphyseal separation with little displacement.

splint for four weeks, will give good results. It may be necessary to put the leg in flexion. If the hemarthrosis is large, the joint can be aspirated, but not until active hemorrhage has ceased.

When there is real displacement of fragments, extension manually or on a fracture table may assist in an easy reduction when pressure is made on the lower fragment. One must take pains not to injure the popliteal vessels. It is too frequently discovered, however, that after a reduction of this kind—especially in oblique and spiral fractures—the fragments immediately slip out of place, once the traction is released. Consequently, continuous traction must often be resorted to. The best position is with the thigh at right angles to the pelvis and the leg at right angles to the thigh, to relax the gastrocnemii. The extension is applied to the leg and the thigh, and the body acting as a counter weight insures reduction. Nail or caliper extension applied to the lower fragment has a real use in these fractures. We can use here the double inclined plane; but we must be sure there is sufficient traction on the leg. If reduction does not follow within five days, open operation should be undertaken. When the thigh is opened (as it would be at first for all nervous or vascular lesions) the faces of



Fig. 41.-Fracture of internal condyle from direct violence.

the fragments may hold when reduction is accomplished. If the fracture is oblique or spiral, it may be held by a cerclage of wire, a Parham's band or an ivory or bone screw. The leg is held in flexion in a molded plaster-of-Paris splint. After three weeks, passive knee motion must be cautiously begun.

Separation of the Lower Epiphysis.—Separation of the lower epiphysis may occur in any direction, forward, backward, inward or outward. The ligaments of the knee joint usually remain intact and the distal

#### ARCHIVES OF SURGERY

fragment retains its normal relationship to the tibia. In these accidents, vasculonervous complications must be searched for; also the stretching or tearing of the skin must be considered. In the treatment an examination for vascular and nervous lesions must first be made. When such are found, immediate operation is indicated (Fig. 40).

Treatment of Epiphyseal Separations.—For incomplete separations of the epiphysis, manual reduction must be performed at once under anesthesia. A plaster-of-Paris molded splint with the leg in extension will suffice for after-treatment. One great difficulty is the hematoma



Fig. 42.—Condylar fracture with displacement.

about the fracture. It spreads from groin to heel. There may develop a tendency to leg flexion after the patient becomes ambulatory—best guarded against by having him wear a walking caliper for three months. Complete displacements in any direction must be immediately reduced. Under anesthesia, usually ether, the knee is flexed acutely, an assistant makes counter traction on the flexed thigh and the surgeon, by traction on the flexed leg, pulls the epiphysis into position. The reduction is usually recognized by the soft cartilaginous rub as the surfaces pass into position.

After reduction, the leg and thigh are immobilized in a plaster-of-Paris gutter which holds the heel against the buttock. Two weeks in that position are sufficient. This position has the advantage of relaxing the hamstrings, of using the tension of the quadriceps as a splint and of preventing the contracting epiphyseal surfaces from lateral displacement, much as the position of flexion of the forearm is used in elbow fractures.

Operative Treatment of Epiphyseal Separation.—If manipulation with extension fails to reduce the fracture, an open operation is necessary. The epiphyseal surfaces should not be roughly handled, likewise the diaphysis should never be shortened for fear of interfering with subsequent growth. If the fracture has healed in malposition, all callus must be removed, the fragment ends must be freshened gently and then completely reduced.



Fig. 43.—Replacement of condylar fracture shown in Figure 42 by means of traction and manipulation.

### KNEE JOINT FRACTURES

Bicondylar fractures, T and Y fractures, are best treated by strong continuous extension in semiflexion. Manual pressure on the fragments can aid a reduction (Fig. 41). When this fails, an open operation must follow, best performed within eight days. These are true articular fractures and the operation is an arthrotomy. Two methods of approach are offered: The best is to saw the patella longitudinally, retract the extensor mass over the femoral condyles, bring them together, maintaining contact by an ivory screw or nail driven in laterally. The joint is then carefully and completely closed. Another method of approach is obtained by a large U-shaped incision extending just below the tibial tubercle, so that the insertion of the patellar tendon can be chiseled free and the joint exposed (Figs. 42 and 43).

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Fig. 44.—Fracture record sheet compiled by the American Surgical Association.

### SPEED—FRACTURE OF FEMUR

*Fracture of a Condyle.*—For condylar fractures, the best treatment is continuous extension in a straight line aided by manual pressure. Some prefer semiflexion, but it has failed in our hands. When reduction cannot be obtained, an operation should be undertaken to restore the articular surface of the knee.

#### CONCLUSIONS

1. Because there is no accepted American standard of results after fracture of the femur, there is no American standard of treatment.

2. A large percentage of the fractured femurs are cared for by the first physician that sees them; specialists are not employed to direct treatment.

3. There is not sufficient effort put forth to use abduction or suspension traction methods, as obtained by the Hodgen or Thomas splint in fractures of the shaft, which may allow knee motion during the course of bone repair without disturbing the extension.

4. Portable roentgen-ray outfits should be furnished in all hospitals treating fractures of the femur, so that results in the course of treatment can be checked as frequently as desired.

5. There have been too many operations performed on fractured femurs by inexperienced operators, and without proper indication.

6. Very little attention is given to massage and electrical stimulation of muscles during bone repair and still less is given to after-treatment, so that many patients are permitted to bear weight on soft callus. Disability results. Walking calipers are little used.

7. The remedies suggested are:

(a) Every patient with fracture of the femur should be directed to a hospital for roentgen-ray examination, correct treatment by any of the accepted methods, and after-treatment when cured. This includes fitting the patient with a walking caliper as soon as he is ambulatory or on his discharge from the hospital.

(b) Because fracture tables offer good means of securing reduction and an easy method of external splinting by plaster of Paris, every hospital receiving cases of fracture of the femur should possess a fracture or orthopedic table. Careful records should be kept in accordance with a fracture record sheet (Fig. 44) such as has been compiled by the American Surgical Association, so that a large number of average results can be grouped, that treatment looking toward the ideal may be worked out.