MODERN METHODS IN THE TREATMENT OF FRACTURES

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IN the early days of the human race, nearly all fractures were caused by falling from a sufficient height, and were usually simple fractures of the long bones. As the centuries rolled by, and warfare became developed to a higher grade than wooden clubs and stone axes, compound fractures became more common and were less easily repaired. With the advent of gunpowder and the hazards of more rapid transportation, fractures occurred with much greater frequency, and began to attract the serious consideration of the physicians and surgeons of those times.

Seventy years ago, a compound fracture of an arm or leg almost invariably required immediate amputation to save the patient's life, but the development of antiseptic and aseptic methods of treatment began to offer more hope of saving these damaged limbs. Forty years ago, the rapidly increasing numbers of automobiles introduced the tremendous risks of high-speed travel on the highways and the byways of the world. Thirty years ago, the first World War produced the enormous dangers of high explosives and fast airplanes, and these dangers were multiplied many times over in the war which ended only last year. Or has it really ended?

What has been learned in the last few decades about the treatment of fractures? Since 1900, forty-six years ago, I have been interested in orthopedic surgery and in fractures. I have seen the rise, and sometimes the fall, of many different methods and ideas in the treatment of broken bones.

The one dominant purpose of treatment is to produce a satisfactory union of the fracture, with re-establishment of the normal function, in the shortest possible time.

In the Fracture Oration of 1935, Paul Magnuson presented briefly and graphically the salient points of fracture treatment from the days of the Egyptians 4500 years ago, the Hippocratic era 2400 years ago, and the works of Galen up to the year 200 Anno Domini. Then came the long centuries of the Dark Ages when no progress was recorded until the Renaissance. In the 14th century, interest in fractures was revived, and from that time the value of many of the almost forgotten old principles began to be recognized. Methods of traction and countertraction, the basic foundation of the treatment of fractures of the long bones, became simplified and improved. Buck's extension, Thomas's splint (which was originally designed for knee disorders) and the Hodgen suspension splint gradually assumed their well deserved importance, together with the improved types of adhesive plaster. Then, in 1895, came Roentgen's discovery of the x-ray, which visualized both the good and the bad results of treatment, and made possible some much needed improvements in the handling of fractures.

Now it became easy to determine accurately whether or not the alinement of a fractured femur was satisfactory, or whether the traction was pulling the bones too far apart.

Next came the development of skeletal traction by Steinmann's pin and Kirschner's wire, in cases in which adhesive plaster could not be used. These devices were not free from the danger of infection and had to be carefully watched.

In 1910 Arbuthnot Lane popularized his method of applying a steel plate, by open operation, screwing it across the fracture-line by four or six or eight screws. This simple and easy way of reducing and securing fractures of the long bones swept the country like a tornado. It seemed so rational and so satisfactory that hundreds of surgeons purchased the plates and the few special instruments, and, without following the meticulous technique perfected by the originator, proceeded to plate many simple fractures of the long bones. I do not know how many times I have been asked

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Fracture Oration, presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16–20, 1946.

to see a boy or a girl with a fractured femur who was about to have a Lane plate applied by an enthusiastic surgeon. In most of these cases, when it was explained that the overriding and the malposition could be corrected by a few days of traction and suspension in a comfortable Thomas splint, and that in 6 or 8 weeks union would be strong enough for a caliper splint or a plaster-of-Paris spica, the doctor and the patient were willing to avoid the operation.

There are two basic reasons, entirely apart from the danger of infection, why a plate of the Lane type, or the Sherman type, or any similar type is not the ideal method of treatment. First, it does not immobilize the fracture completely, because a certain small amount of motion will always be present in rotation and in lateral bending toward the plate. Both of these motions could be avoided by applying a similar plate to the opposite side of the bone, but few surgeons have had the hardihood to attack the bone on both sides. In oblique fractures, a transfixion screw applied at right angles to the line of fracture will prevent most of the mobility, but does not work so well in transverse fractures. Secondly, when a Lane plate is applied, the ends of the fragments undergo a small amount of absorption, so that a definite space is left between the ends. It is true that in many cases enough new bone is formed to obliterate this empty space, and the fracture unites, but it does not unite as rapidly as it would if the bone ends were in firm contact. Moreover, the external callus formation develops upon the opposite side of the fracture, and does not cover the plate, except in children, so that the ultimate ossification of the fibrous tissue between the ends of the bones is greatly delayed. This external callus may become very large when the immobilization of the fracture is inadequate. Even a long plaster-of-Paris cast, from the chest to the toes, does not furnish complete immobilization in most cases of fracture of the shaft of the femur.

I do not deny that in many hospitals and clinics the plating of simple fractures of the long bones has shown excellent results, but such operations should be performed only when a satisfactory result cannot be obtained by conservative mechanical means, and when the surgical standards of the operator and of the hospital are of the very highest grade.

Because of the many disappointments following the widespread use of the early types of the Lane plates, whether from mechanical defects, technical errors, or infections, other investigators have been busily devising different methods. The old and reliable principles of manual reposition, traction, and countertraction, and fixation by plaster of Paris and splints have become less understood and less popular. This, I think, is largely due to the fact that the conservative, mechanical treatment of long bone fractures requires the careful, time consuming attention of the surgeon himself. He cannot safely delegate this attention to anyone else. A leg or an arm in a traction apparatus must be seen every day by the man who is responsible for the ultimate result. Residents and internes do not always notice that the adhesive plaster is cutting into the skin or is losing its pull at important points. Because this constant attention is necessary, and because a day has only so many hours, it is perfectly natural that busy surgeons should welcome any methods which would reduce the time element required for proper results. If such methods are safe, sane and satisfactory, we should use them, but we must always remember that the union of a fracture takes so many weeks or so many months, and that we cannot make broken bones grow together any faster in 1946 than the Egyptians could four thousand years ago.

What are some of these newer methods, and to what extent can they be recommended for general use?

Many years ago various types of nails and screws were employed in attempts to fasten together the broken bones. Considerable success resulted, in many cases, but the ever-present danger of infection made such treatment always a definite hazard. The advent of the sulfa drugs, penicillin and other fungus derivatives has removed some of these dangers, but there is still no substitute for aseptic surgical technique. Stainless steel and vitallium have replaced iron and plain steel, and we can no longer use metals which undergo erosion or cause electrolytic reactions in the body tissues. Metallic fixation of fractures has assumed a very important place in bone surgery, especially in certain kinds of fractures. The neck of the femur, the olecranon process of the ulna, the patella, and the shaft of the tibia may present problems which may legitimately be considered suitable for open operation. Years ago, Kellogg Speed, in one of these Fracture Orations, applied the name "The Unsolved Fracture" to the very dangerous fracture of the neck of the femur. The medical literature has been full of articles about different methods and devices for the treatment of this lesion. When I was a young man, some of the surgeons were using carpenter's screws or nails, with occasional success but with frequent failure. Smith-Petersen's three-flanged nail was an enormous improvement over the earlier types, but even today there are clinics where lag-screws, threaded wires, and other devices are preferred to the flanged nail.

Some of the recent publications do not emphasize sufficiently the enormous necessity of accurate reduction of the fracture before it is nailed or screwed. In many of the articles, roentgenograms are shown which reveal imperfect replacement of the fracture before the nail was inserted. This did not always produce a failure of union, but it is certainly not desirable, and it is usually the result of inadequate x-ray control. Anteroposterior x-ray films cannot be relied upon to show accurate reduction of the fractured ends, and it is extremely difficult to make satisfactory lateral films with the patient's legs fixed firmly in the traction apparatus. No surgeon should attempt to nail a fracture of the neck of the femur unless he can obtain good lateral films on the operating table at all stages of the operation, without disturbing the hip-joint or the operative technique. This means that such patients should be cared for in a hospital with all of the requisite equipment and personnel. It is major surgery of the most difficult type.

The purpose of this lengthy discussion is to emphasize the tremendous importance of developing, in every community, a team of surgeons who will be able to treat properly the cases of fracture of the neck of the femur, and who will have the requisite instruments and x-ray facilities and technicians, without which no one can accurately reduce and nail such fractures. One day in August I examined the x-ray films of 3 cases of this kind which had been nailed in other cities. Not one of these fractures had been properly reduced before the nailing, and all 3 had failed to unite. It is highly probable that these unfortunate results were due to imperfect lateral x-ray films made on the operating table, and I have seen many similar examples, 2 of them occurring in my own practice. Unless the x-ray control is clear and accurate, it will be necessary to open the hip-joint in order to be sure that the reduction is satisfactory and that the nail is put in the proper place. This type of open operation adds greatly to the danger of shock and of infection, and is practically never necessary when good x-ray films are available during the operative procedures.

To make my position perfectly clear, the following plan seems to be the best for the treatment of fractures of the neck of the femur:

The patient is placed upon an orthopedic traction table of the Albee, Hawley, McKenna, or similar type. The displacement is carefully reduced by the Leadbetter maneuver or by traction. X-ray films are made in anteroposterior and lateral planes, one of the two portable tubes being located between the thighs, the other directly over the hip-joint and two or three feet above the field of operation. The perineal post on the sacral support should be of wood or aluminum, so that no manipulation will be necessary for the lateral views. When the reduction is shown to be satisfactory, both legs are securely fastened to the traction apparatus. A 5 inch incision is now made to expose the outer surface of the femur, and a long wire, marked in half inches, is drilled upward and inward from a point well below the trochanter. It is wise to make a hole through the outer cortex with a quarter-inch drill before starting the wire, so that the direction of the wire can more easily be changed without binding or bending in the thick cortex. When the wire has been inserted to a depth of 3 or 3½ inches, new x-ray films are made to check its position. If not satisfactory, the wire is withdrawn and reinserted until it is in proper position. This may require one or two trials, with corresponding x-ray films. A little time may be saved by using another wire, leaving the first in place as a guide. When the position is found to be correct, a cannulated stainless steel or vitallium Smith-Petersen nail is threaded upon the wire and is driven along it into the neck and head of the femur. The length of the nail is estimated by the calibrations of the wire. Again, x-ray films are made in both directions, and, if satisfactory, the wire is pulled out and the wound closed.

You will see, from this description, the enormous importance of the x-ray examinations, and the complete futility of attempting this kind of operation unless such rapid and accurate roentgenographic control can be furnished. Good anteroposterior views can be made with great ease, but the lateral views require special equipment and technique.

I have not mentioned the use of screws, lag-screws, or the various threaded or unthreaded wires, because I believe that the Smith-Petersen-Johansson nail is better than any of them for general use.

A few words about the after-treatment. Over the usual dressings a firm, elastic spica bandage should be applied from the waist to the knee, and a foot-piece or sling should be used to prevent outward rotation of the thigh.

It is important to prevent outward rotation of the thigh as the patient lies in bed, because the weight of the thigh and leg exert a downward and outward pull upon the nail, tending to separate the fragments. It is not wise to allow early sitting and standing without some form of partial immobilization of the affected hip, although some writers encourage it.

We must remember that at least 4 months are required for bony union in these cases, and that union is made by the internal deposit of new bone, and not by external callus formation.

Aseptic or avascular necrosis of the femoral head is a complication of intracapsular fractures seen less frequently than after dislocations of the hip, but nevertheless sufficiently often to influence the ultimate prognosis. The artery in the ligamentum teres supplies only a small portion of the head, and, indeed, is sometimes absent. The main blood supply comes from the arteries of the capsule, and if these arteries are occluded or are too small, the head becomes necrotic. At present, there is no certain means of improving the blood supply, although drilling and bone-grafts offer some hope. Perhaps the best form of treatment is to prevent any weight-bearing on the femoral head, by the use of crutches and a caliper splint, or by long-continued traction, trusting that Nature will provide a new blood supply by the slow ingrowth of small arterioles and by "creeping substitution." This requires a long time, and in some cases fails to occur, in which event the patient has a painful and disabled hip-joint which may need a reconstruction operation, or an arthrodesis to produce an ankylosis of the joint.

Let us now consider the other types of fractures which may usually be considered suitable for operative treatment. The patella and the olecranon process of the ulna, if the fragments are widely separated, will unite more satisfactorily and more rapidly if they are mechanically fastened together by one of the accepted operative methods. Spiral or oblique fractures of the shaft of the tibia may be extremely difficult to retain in good position by conservative treatment, and it may be wise, in such cases, to fix the fragments together by transfixion screws, or even by stainless steel plates. The fibula unites much more rapidly than does the tibia, and sometimes holds the fractured surfaces of the tibia so far apart that they cannot unite. Cases of this kind require operation.

For many years, the surgical literature has been flooded with articles advocating the use of mechanical devices for the reduction and the fixation of fractures of the long bones. The catalogues of the instrument-makers and the published articles of the designers show in fascinating detail the very ingenious devices and the remarkably successful results. The basic principle of all of these contrivances is identical. This principle is to drill two strong pins into the shaft of the bone above the fracture and two more similar pins below the fracture, as far away from the fracture itself as possible, and to connect each pair of pins with a clamp to hold them rigidly together. These two units are then used to manipulate the fractured ends into accurate apposition. In difficult cases an ingenious traction frame has been devised to aid in this manipulation. When good position has been attained, the pin units are connected by rods clamped firmly to them, or by short plaster-of-Paris casts molded around the pins. It is not to be denied that this method is very valuable in certain types of fractures. It furnishes good apposition and good control of nearly all types of fractures, and allows early and free movement of the joints at either end of the broken bone. It is, however, neither so simple nor so safe as the inventors and manufacturers would have us believe. It requires considerable skill and experience to drill the pins into the proper positions, whether the pins go entirely through the limb, or stop after penetrating both cortices of the bone and project only from one side of the limb. It is also not easy to prevent infection from occurring along the track of the pins, as there is always some seeping discharge from the pin holes, but the advocates of the method state that osteomyelitis is very rare.

The best known of these devices are the Stader, the Haynes, the Griswold, and the Roger Anderson types, and of these the Anderson instruments seem to be the most generally satisfactory. They are all modifications and improvements of the old Lambotte ideas, and in a very small proportion of fractures they may be very useful.

Another revival of ancient methods was described by Kuntscher in 1940, who drove a long steel rod into one end of a fractured long bone, down through the medullary canal across the line of fracture. These rods were used chiefly in Germany during the second World War, and have achieved some popularity in the United States. One of the advantages of this method is that the broken ends of the bone are pulled into close apposition by the action of the muscles, so that union is much more rapid than when Lane plates are used. The fact that the medullary canal is plugged up by the rod seems to have no deterrent effect upon the union of the fracture.

About thirty years ago Hey Groves treated a fracture of the upper third of the femur in this way, using an iron rod, but he complained that the rod was not strong enough to resist the muscle-pull, and so the femur became bent at an angle. If he had put the leg up in a Thomas splint or in plain traction apparatus, after the operation, the result might have been better. With the new stainless steels, the method may be useful in selected cases.

It must be admitted, in discussing the various kinds of operative treatment of simple fractures, that the advent of the sulfa drugs and the fungus derivatives has made open surgery much safer than it was a few years ago, but we must not lose sight of the fact that the majority of fractures can be treated successfully by the older conservative methods. We are going through a transitional period at the present time, both surgically and politically, and I do not want our young physicians impressed with the idea that fracture treatment necessarily means a machine-shop full of tools to repair every kind of broken bone.

The best fracture surgeon uses the fewest gadgets.