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THE HISTORY OF THE TREATMENT, BY EXTENSION, OF FRACTURES OF LONG BONES

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INTRODUCTION

The treatment of fractures has mainly come to my interest through the influence of friends in practice. It was so interesting to see the results of some of the modern methods that I thought it might be even more interesting to go into the subject and learn how such injuries were treated before man had his wide knowledge of surgery, asepsis, and mechanics.

Today, more and more men are using methods of traction and counter-traction in which the skeleton is directly used. I have had the privelege of seeing the device designed by Roger Anderson used several times. I have also seen the end results of their cases, and due to the fine results, my interest became aroused. The results were almost spectacular, in one case unbelievable. Thus the question came up ----- What would have been done for these people 50, 100, 1000, or 3000 years ago?

THE HISTORY OF THE TREATMENT, BY EXTENSION, OF FRACTURES OF LONG BONES

For knowledge of the treatment of fractures in the prehistoric period, we have to go to the findings of those who have explored the ancient graveyards and tombs.

"The most ancient records of the treatment of fractures are supplied by bodies found by the Hearst Expedition of the University of California excavating at Naga-el-der, about 100 miles north of Luxor in Egypt. They were described by Sir Grafton Elliot Smith (1) in the British Medical Journal in 1908."

The bodies were found in rock tombs and were buried about the fifth dynasty or 4,500 to 5,000 years ago. Two of the bodies had splints in position over fractured bones. These are the oldest splints ever found, in fact the oldest of surgical or medical appliances with the exception of certain stone knives which are thought to have been used in cercumcision. One of the bodies was that of a girl about 14 years old who had a compound fracture of the right femur. Four splints were used to hold the fragments in position. These extended from just above the fracture to about 16 cm. below the knee. All four splints were made of wood wrapped in linen bandage. From the

fibers of these bandages, it is thought that the bandage was first wound in one direction then in the opposite. Because of blood stains, proven by iron tests, on these bandages it is thought that the wound was compound. In this case there were no signs of calcification or union; so it is believed the girl died soon after the injury .

The other fracture was a compound fracture of both bones of the forearm. Here a very similar type of splinting was used. The wound was packed with some type of grass, and here the splints were made of bark and were fitted to the limb much better than in the first case. This type of fracture seems to have been quite common at this time as many healed fractures are found. The results in most cases were good. The prevalance of this type of fracture is explained by the type of weapon used in fighting and dueling. This is contrasted by the findings of fractured femurs in which the results were not so good, showing much shortening, displacements and other deformities. (2)

In older explorations, 6000 B.C., made in prehistoric graves in Nubia, the remains found show poor results in cases of fractures of bones of the forearm. Many cases of delayed union and non-union were found in these diggings.

It is very interesting to note that the Egyptians

who were a relatively civilized people treated fractures with moderately good results; while in the wilder primitive aborginal Australians, almost no treatment was used.

Due to the nature of fractures, the mechanics, the fact that a solid material is involved, the general principles of treatment have not changed much down through the ages. This makes it a rather easy subject to trace and thus it is one of the oldest known members of the art of healing.

According to Sudhoff, the bones of Neolithic man show attempts at correction of deformities. Enough of these have been found to tabulate the approximate results of their efforts. These statistics show about 53.8% good unions and 46.2% bad ones. (3)

Written works from the early Egyptian period (3000-2500 B.C.) are few, but our knowledge of their methods is great because of their peculiar beliefs. The robbing of tombs was a rather common thing, and in cases where the mummies were disturbed to the degree of fracturing bones, these mummies were given the same treatment as though they were living. Thus when these tombs are explored now, the exact procedure can be found.

In the Edwin Smith Surgical Papyrus reference can be found to the treatment of fractures of the clavicle,

humerus and cervical spines. On the treatment of fractured clavicle, it states, "If thou examinest a man having a break in his collar bone,--- thou shouldest place him prostrate on his back, with something folded between his two shoulder blades; thou shouldest spread out with his two shoulders in order to stretch apart his collar-bone until that break falls into its place. Thou shouldest make for him two splints of linen, (and) thou shouldst apply one of them both on the inside of his upper arm and the other on the under side of his upper arm." (4) The treatment of fractures of the humerus was much the same except that the splints were made to extend to the elbow. Splints similar to these are now used in Sudan, Abyssina and elsewhere.

In the Bible, there is but one reference to a fracture. This is in the Book of Prophet Ezekiel, Chapter XXX, verse 21, as follows: "Sun of man, I have broken the arm of Pharaoh, King of Egypt; and, lo, it shall not be bound up to be healed, to put a roller to bind it, to make it strong to hold the sword." This was written about 600 B.C., but does not tell us much as to how the fracture was managed. (1)

Up to this time fractures, in general, were treated by immobilization with some attempt to correct the de-

formity. We now approach the time in medical history where one might say modern medicine had its beginning, that is, with the work of Hippocrates who lived from 460 - 377 B.C.

Hippocrates was one of the keenest observers that has lived, and by his keen observations and sound logical reasoning, he devised a system of treatment which in principle, at least, is used today. Many of the modern rules are mere restatements of facts that he pointed outcenturies ago. (5)

He described in detail the use of traction and counter-traction in the treatment of fractures and designed a table which was used for this. It was the first orthopedic table and consisted of a system of pullies and windlasses by which both traction and counter-traction could be applied by the turning of one lever. (5)

He stated, "The model by which we judge if the part is properly set is the part which is its pair." This rule is used today. Hippocrates used bandages in these wounds but warned against getting them too tight. Looser but thicker was his rule. He used waxes to make his bandages stick to the skin and as an agent to stiffen them. In the use of bandages, he avoided covering the bony prominences as about the elbow and knee. (5)

He described the specific handling of fractures of the humerus as, "--- having got a piece of wood a cubit or somewhat less in length, like the handles of spades, suspend it by means of a chain fastened to its extremities at both ends; and having seated the man on some high object, the arm is to be brought over, so that the armpit may rest on the piece of wood, and the man can scarcely touch the seat, being almost suspended; then having brought another seat, and placed one or more leather pillows under the armpit, so as to keep it a moderate height while it is bent at a right angle, the best plan is to put round the arm a broad soft skin, or broad shawl, and to hang some great weight to it, so as to produce moderate extension; or otherwise, while the arm is in the position I have described, a strong man is to take hold of it at the elbow and pull downward. But the physician, standing erect, must preform the proper manipulations, having one foot on some pretty high object, and adjusting the bone with the palms of his hands; and it will readily be adjusted, for the extension is good if properly applied." (5)

For fractures of the bones of the leg, Hippocrates used his orthopedic table. With this his results must have been good as he says, "But the best thing is, for

any physician who practices in a large city, to have prepared a proper wooden machine, with all the mechanical powers---either for making extension, or acting as a lever." (5)

For cases where permanent extension was needed, Hippocrates described the use of a special appliance. This consisted of two wooden rings which fitted firmly above and below the site of the fracture. The distance between these was to be about ten inches; then there were to be four pieces of wood just a little longer than the distance between the two rings. These were to be wedged between the rings on four sides and thus to hold them apart; while at the same time to transmit the weight of the individual from the upper ring to the lower without any support from the bone itself. As is shown later, this is one of the main principles in one of the newest methods of treatment. (5)

About this device he states, "If these things be properly contrived they should occasion a proper and equable extension in a straight line, without giving any pain to the wound." To those who were not adept at the applying of these he says, "And all other mechanical contrivances should either be properly done, or not be had recourse to at all, for it is a disgraceful and

awkward thing to use mechanical means in an unmechanical way." (5)

Concerning the use of active and passive movement he says, "Friction can relax, brace, incarnate, attenuate: hard braces, soft relaxes, much attenuates and moderate thickens." This means that soft massages relax muscles, hard vigorous massages cause spasms, while moderate massages help by increasing the volume of the muscle. He also states, "Exercise strengthens, and inactivity wastes." (5)

In cases of compound fractures, Hippocrates did not advocate the use of splints, but bandages were to be used, and there was to be plenty of room for drainage. In cases where it was not possible to put the limb in the proper position he states, "But if it incline to either side, it should rather turn to that of pronation, for there is thus less harm than if it be toward supination." (5)

According to him, it was a disgrace to get shortening in the leg but not so bad when in the arm, as here it could be concealed. In conclusion, he states that one should, if possible, avoid taking care of compound fractures of the humerus and of the femur, as the results were often bad if not fatal. (5)

It is questioned by some as to whether Hippocrates practiced all that he wrote. This is, of course, something that we will never know, but we do know that his principles and observations were very sound and that many are still used. There were no great improvements added to his methods until the time of Ambroise Pare. However, many others wrote of minor differences.

Following Hippocrates, the next era of great work in medical science was that which grew up during the early rise of Rome. However, Rome borrowed her physicians from the Greeks. Pliny said, "For it is a well known fact that those physicians who, without being able to speak Greek, attempted to build up a practice in Rome, failed to gain the confidence of their patients, even of those who were not at all familiar with that Language." (6)

The Romans as a group did not add much to the work of Hippocrates; however one of their leading military physicians, Aurelius Cornelius Celsus did bring out some features which were new. He emphasized early treatment saying, "Therefore, if this (i. e. fracture with shortening of the extremity) has been discovered, it behooves immediately to extend that limb---; if that has been omitted in the first days, inflammation arises." (7)

Celsus noted that fractures of the shaft of long bones gave better results than when the ends of the bones were involved. He mentions therapeutic refracture in, "Sometimes, however, the bones are accustomed to unite in an oblique direction, and the limb becomes shorter and deformed---for this reason the bones ought to be fractured again and again set." (7) In reference to compound or delayed unions he states, "But if at anytime the bones have not united, in consequence of the dressings being frequently removed, and the parts disturbed, the treatment to be adopted is obvious; for union may yet take place. If the fracture be of long standing the limb is extended, in order to produce a fresh injury : the bones must be separated from each other by the hand, that their surfaces may be rendered uneven by the grating against each other; and if there be any fat substance, it may be abroded and the whole reduced to a recent accident; yet great care must be exercised lest the fragments or muscles be injured." (7)

Although Galen (130-200 A,D.) was one of the most famous of the early physicians, he did not add to the method of treatment of fractures. However, he did closely follow the methods used by Hippocrates, and in his writings he reviewed these. This is said to be one of the

reasons that Hippocrates'methods were handed down and used for such a long period of time.

Following Hippocrates, Celsus and Galen comes a period in medical history which might be called the Dark Age. Small contributions were made from all the more important civilized centers of the world, but in general the period was not of great importance. However, during the early part of this period came the first treatise exclusively on treatment of fractures. "The first treatise exclusively dedicated to the treatment of fractures by mechanical means appears to have been the works of Oribasius (325 - 403 A.D.) of the early Byzantine school. The first edition of this book in a modern language (French) was prepared in the 16th Century. The illustrations accompanying this edition present a refinement of detail which is distinctly apocryphal and not consonant with the clinical development of early times. There remains, however, a clear and concise text to establish the importance of this contribution." (8)

Oribasius described a traction apparatus to be used in the treatment of lower limb fractures. This apparatus was used a great deal at the time, but its popularity was only short lived. Ambroise Pare used it many years

later, and it is the basis for recent work done by R. H. Russell.

The Arabian school, which might be limited to the period from about 850 A. D. to 1200, was dominated by Rhazen, Avicenna, Albacasis and Avenzoar. These men worked independently and in the main added but little. Avicenna, however, did practice and advocate the use of open reduction, while both he and Albacasis favored the suturing of compound wounds. Without the use of antiseptic or aseptic methods, however, it is very easy to see why these men did not have the greatest of success. (3)

In the latter part of the 13th Century, Gulielmus de Saleceto (1201-1277) wrote rather extensively on the treatment of fractures. He gave a formula which was used to make a gum which would stick to the skin and thus aid in making traction.

Guy de Chauliac (1295-1368 or 1300-1370) by some is thought to be the same man as Gulielmus de Saleceto, and from the nature of their work, this is highly possible. Both were interested in the use of traction in the treatment of fractures. de Chauliac used weight traction, suspension, an overhead monkey pole, massage and damming for delayed union also coaptation splints, debridment and

and open reduction. As to the use of traction he said, "It is often possible that a fracture may be equalized by softening the callus which Avicenna says, as y ou know; and for this, also, I have often seen a weight with a pully useful.", and "With regard to myself, the thigh being bound with long splints to the feet,I sometimes sustain it with the above mentioned means with straw or some other thing; and I attach to the foot a leaden weight, passing the cord over a pully so that it will keep the leg in its proper length; and if there is some defect in the equalization, by pulling little by little it will be rectified." (9) This method though not invented by de Chauliac, was first recorded by him and is one of the methods in use even today.

Ambroise Pare (1510-1590), the first of the great French surgeons, had much experience and wrote a great deal concerning the treatment of fractures. He did not add much to the methods but in general followed the teachings of Hippocrates. He was a military surgeon, so his experience was wide. He used metal splints that had windows in them for the treatment of compound fractures. He was the first to use the cradle to keep the bedclothes from pressing on the injured member. Pare described fractures of the patella which had not been done up to

that time. (10)

Pare did not advocate permanent extension as did Hippocrates, but with reference to fracture of the shaft of the femur he said, "Instead of this glossocomium, y ou may make use of my pully; for Hippocrates, in this bone when broken, doth approve of extension so great that although by the greatness of the extension the ends of the fragments be somewhat distant asunder, an empty space being left between; yet notwithstanding would hee have ligature made. For it is not here as it is in the extension of other bones, whereas the casting about of ligatures keeps the muscles unmoveable; but, here in the extended thighes, the dèligation is not of such force, as that it may stay and keepe the bones and muscles in that state, wherein the surgeon hath placed them. For seeing that the muscles of the thigh are large and strong, they overcome the ligation and are not kept under by it." (10) This seems a just criticism of the older method.

Pare's book is one of the most interesting of the older books which was translated into English at a very early date.

It is very interesting to note the great contrast between Paré and Hieronymus Brunschwig (1450-1533) who lived just before and during the early part of Pare's

life. Brunschwig, in his works, quoted much from Avicenna and de Chauliac but was not as practical as was Pare. He had great faith in powders and salves. Salves were very important in his treatment of compound wounds. About binding the limb, he said, "pacyent might come in great harme, payne and fire----bynde with clothe depte in oyle of roses." (11)

Giovanni Di Vigo (1460-1520) used splints in his treatment and like Brunschwig advocated many types of oil. He stiffened his bandages by using the whites of eggs and for the reduction used manual extension and the apparatus described by Hippocrates. He said, "The restauratyon of a broken bone---must be done as sone as maybe." He also was one of the earliest to state the exact time it would take the various bones to heal following fracture. (12)

Thomas Gate (1507-1586), an English surgeon, was one of the earliest to classify fractures as simple and compound, but in his classification, he included in compound fractures, "one or more effects to it connected or ioyned", such as gangrene, inflammation, excess callus etc. (3)

Another Englishman, William Clowes, (1540-1604) writes in reference to fracture of the femur, "First I

made two decent towels, and fastened each towel one above the fracture and the other below the fracture. Then I caused two strong men to apprehend and take hold of each towel and I placed myself very neare unto the fracture. Then all things being readie I caused them stronglie to extend or stretch out the member; which being sufficiently preformed I did elevate or lift up that part of the bone which was depressed and agayne I did also depress downe the other part of the fractured bone which was borne by or elevated; which being reduced and counited together and rightly restored as near as I could I according to natures former union, which being then well joyned I did curiously keepe close the dissevered bones together, and then I caused the men which extended the member by little and little to release their hands, whereby the patient found himself greatly eased of his payne--." The thigh was then wrapped in linen cloth and soaked in white of egg and vinegar, then put on a soft bed. (13)

This procedure, although hundreds of years later, is not so different than that used by Hippocrates.

Peter Lowe (or Love) (1550-1612) also used the methods of Hippocrates. He did extensive work on the diagnosis of fractures, noting, "inequalities easily

felt," pain on handling and movement and, "noyse or burite", with movement. (14) Lowe was one of the first to advocate a special diet in treatment of fractures. He put his patients on a high meat diet. In the treatment of cases of fracture with dislocation, he reduced the dislocation first.

Richard Wiseman (1622-1672) was the first Englishman to make an immovable apparatus with which to bind the broken parts. As with all such appliances which were used before, this too was based on the use of the white of eggs. With this method, he was very successful in the treatment of fractured femurs. (1)

Stephan Bradwell, who in 1633 wrote one of the most complete tests on emergency surgery, omitted all concerning fractures. He said, "But, if, in such a fall, any bone be put out of joint or broken, they must get help of such as are skillful in bone-setting, which art is learned by sight and not by writing." (15)

In the 11th chapter of Jean-Louis Petit's book, A Treatise of the Diseases of the Bones, he describes his method of treating oblique fractures of the femur. He applied leather throngs just above the femural dondyles and fastened these to the foot of the bed. Counter traction was obtained by means of a sheet passed through the

crotch and fastened to the head of the bed on each side. In addition, a strap was fastened just above the malleoli to be used alternately for traction when the thigh strap irritated the skin. This is one of the first instances where the whole body was used as counter-traction. Petit also used an overhead strap to help the patient move as well as a perforated mattress to lesson the incident of bed sores.

Petit's major contribution was his double inclined plane which marked the first association of suspension with traction. With this the leg was held at a higher level than the body, and the thigh was held on the inclined plane. Along with this apparatus, he immobolized the whole foot which was a great advancement. In the main, both the inclined apparatus and the immobilization of the foot are used today. (8)

Up to the time of Percivall Pott (1714-1788), all those interested in the treatment of fractures based their methods on the principles of Hippocrates. Sampson Gamgee, in his book, "Fractures of the Limbs" 1871 says, "the honour of protesting against the accumulated blunders of a faulty tradition, of rescuing this branch of surgery from unenlightened empiricism, belongs unquestionably to Pervicall Pott." (16)

Gamgee's statement, no doubt, is or was true to some degree, but modern methods, no doubt have retained many of the rules and principles laid down long before the time of Pott. However, it must be admitted that Pott's work was a definite advancement, and his ideas, when used in conjunction with previous ideas, are the basis of modern methods.

Pott did not mean to criticise the older methods but did wish to show there were newer ways and ways which he deemed better. He states, in the beginning of his work on fractures and dislocations, "the general doctrine relative to fractures is contained under the following heads, as parts of the treatment of them.

Extension
Counter extension
Coaptation or setting
Application of medicaments
Deligation or bandage
Position
Prevention or relief of accidents

This is the general arrangement of the subject by most of the writers on it, and a very just and proper one it is; but notwithstanding the parade of books under these various heads, much less alteration will be met with, since

the time of Hippocrates, Galen and Celsus, than an inquirer might expect, or than the subject is capable of." (17)

"I must desire that what I have said may not be misconstrued. I do not mean that there are not, and have not at all times, been men of particular ingenuity, who have deviated from the common methods, and have greatly improved the art; but still the common methods are the same, and the multitude of practitioner religiously follow them---." (17)

Pott's ideas of treatment was based on the following observation; "By the resistance of the muscles, and of these only, are we prevented from being always able to put the ends of a fractured bone immediately into the most apt contact." (17) Thus it was that Pott advocated position as the main therapy. The position in which the most muscles were in a relaxed state, or when one group was offset by another, was the position used. He reasoned that if one group was not over-pulling, there would be no displacement. By putting the limb in this so called neutral position, then with gentle pressure on the broken fragments, they could be put in their anatomic position. With no muscle group over-pulling, there would be no further displacement.

Pott's ideas became very prominent in England and influenced later English workers, but his ideas were not as well accepted on the continent.

Pierre Joseph Desault (1744-1795), who worked at about the same time as Pott, and who was one of the greatest Frenchmen in the field at the time, did not follow Pott's ideas but brought out a new idea of traction, namely, axis-traction. Said Desault, "All kinds of apparatus for fractures being nothing but resistance opposed by art to be the powers which produce displacement, it follows, that they should all act in directions precisely opposed to the direction of those powers." (18)

Concerning fractures of the femur, he states, "Hence, it follows in general, that coaptation is here a feeble assistant toward reduction; that, if it renders any service, it is only in cases of displacement laterely, or, in the direction ofthe cross diameter of the bone; and, that it is by giving the proper direction to extension, by managing it according to the disposition of the muscles, and by knowing when to augement and when to slacken it, that the fragments are brought into regular contact." (18)

Desault designed a traction apparatus which gave his "axis-traction". This was a machine which was attached at its distal end to the foot by a special foot piece and

at its proximal end set against the ischial tuberosity. Thus the pelvis acted to give counter-traction. Into a groove at the side of the device, there was a windlass which adjusted the amount of traction. This is far different than the ideas of Pott. (18)

Desault's successor, Alexis Boyer (1757-1833) improved the apparatus and laid down four rules or basic laws of extension:

> "I. To apply the extending force on the parts of the members inferior and superior to the fractured bone.
> II. To act on as great a superficies as possible; the effect which external causes have in our bodies is small in proportion to the extent of the surfaces on which they act, because the action is then supported by a greater number of parts.
> III. To give the extending power a direction parallel to the axis of the bone.
> IV. The extending ought to be as gradual as possible, operating slowly, and by degrees." (19)

These rules, in general, are followed today in the treatment with the newest traction and counter-traction machines.

It was Sir Astly Cooper (1768-1841) who brought the method of extension back to England following its banishment by Pott. Cooper used the system which is today known as the "well-leg" method and describes it as follows: "In a third method, the patient has been placed in bed with both legs extended to the utmost possible degree, and then the two feet have been bound together with a roller, passed from the foot on the injured side under the sound foot, so as to make one limb steadily preserve the extension of the other. This may also be effected by an iron plate affixed to the shoe on the sound foot, with a screw passed through a hole in the plate, and having a band fixed to the other foot, which may be lightened by turning the screw, and the foot by this means, be kept constantly extended." (20)

Cooper described this in conjunction with fractures of the neck of the femur, but he used it in all types of fractures of the leg and thigh.

Benjamin Bell, who worked at the same time as Cooper, just after Pott, advocated a well framed case to be stiff and adapted to the shape of the limb. He states that:

"There is more of gentle uniform resistance than could be derived from these torturing machines--- and much greater than can be procured by that cruel extension which Desault has decorated with the fine title of permanent." (21)

We are now coming to the time where the various schools of thought are beginning to come together. Thus, Pott, with his ideas of position, and all of the rest with their devices for extension are slowly working to the point where both will be combined to give the modern method.

It must be remembered that up to the time of the Belgian military surgeon, Antonius Marthiusen (1805-1878), the best method of immobilizing a part was by the use of bandages with the various preparations of egg white, or by the use of wooden or metal splints. It was this surgeon who first had the idea of impregnating bandages with plaster of paris. This type of bandage was used by the Russians during the Crimean War, 1853-1856, and by the Germans during the Franco-Prussian War, 1870-1871, and thus became well known. With this new aid to treatment and with the work of Lister which was soon to follow, there was a great impetus to new work being done

in the field of fractures.

In 1871, Lister (1827-1912) under his antiseptic surgery reduced a broken ulna of some two weeks standing. His results were good. In 1877, he operated on a fracture of the patella, wiring the two fragments together with a silver wire. With the discovery of antiseptic surgery, which was to lead to aseptic surgery, the field of open reduction was greatly enlarged. Men were given a method which heretofore had not been used to any great degree.

At about the same time, the French surgeon, Lucas Championniere, began treating fractures by massage and mobilization. He said, "As soon as there is no fear of displacement, take off all splints." As can be seen, this was a new idea. Another of his ideas was, "A certain degree of movement of the fragments is more helpful to osseous union by formation of callus than treatment by splints." Even though these ideas were based on false premises, they were good and were the first mention made of what is now known fact. He went so far as to say that some shortening was a good thing, and ends his article with, "Massage, like other theraputic measures should be given in measured doses." (22)

In 1895, it was shown that the X-ray could be used as a diagnostic aid in fracture work, and soon after the

fluoroscopic screen was used not only in diagnosis, but bones were actually set while the operator visualized them. This new aid was, of course, one of the greatest in modern orthopedic work. It added another sense to the surgeons equipment; as he could now see as well as feel what had taken place in the bone and the results of his efforts.

Armed with the X-ray and the new idea of aseptic surgery, Lane was able to bring out his treatment of fractures. In cases of non-union, or delayed union, he would open the limb down to the bone, then secure the fragments to each other by one of the metal plates which bear his name. This method gained wide popularity and was used widely during the World War. The method is still used but is not as popular as it was at one time. Lane was also the originator of the "no-touch" method of surgery. This was devised because bone is so easily infected, and is a technique in which the operator at no time touches the operative field with his hands. At all times, an instrument is used. This technique is now used by some operators.

In 1907, Steinmann published his first description of the pin which bears his name. This pin was driven through the distal fragment of the fractured bone and

traction applied to the pin. Thus there was direct traction on the bone. With this new method, again many new advancements in treatment were made possible. Many of the newest methods of traction and counter-traction are based on the use of this type of pin.

In 1912, the British Medical Association, in view of the numerous methods of treatment, decided to review all of them and make a report of their findings. The results were published in the British Medical Journal of Nov. 30, 1912, and in conclusion they say, "An analysis of all the results, non-operative and operative, clearly shows the interdependence of the anatomical and functional results. The total number of cases in which good anatomical result was obtained is 1,736 and in no less than 1,576 of these the functional result was also good. In other words, if the anatomical result is good the functional result is good in 90.7%. If the anatomical result is moderate or bad, the functional result is good 29.7% (i.e. 380 out of 1,279). If the anatomical result is bad, the functional result is bad in 53.3& (176 out of 330)." (23)

Thus, "The most certain way to obtain good functional result is to secure a good anatomical result. No method, whether non-operative or operative, which does not definitely promise a good anatomical result should be accepted

as a matter of choice." (23)

The information gathered by this committee is very interesting in the light of the methods which are to come. As to the obtaining of anatomical results, with the aid of the X-ray, the Steinmann pin and the newer methods, the operator has at his command all that is necessary to get this perfect anatomical result. In fact, his tools make it almost as though he had the broken fragments in his two hands.

In 1916, F. G. Dyas reported on the results of treatment with the Steinmann pin. This was the report of its first use in this country, and as a whole he concluded that its use was very advantageous. His conclusions are:

"Advantages:

1. It is less dangerous than radical operation.
2. It enables the surgeon to exert the maxium amount of traction while using the minium area for the attachment of the traction apparatus.
3. It will bring about a reduction in all cases where other methods have failed.
4. The technique is not difficult and can be mastered by anyone. Therefore, the method is practical and can be used by the entire profession.

5. It gives access to wounds in compound fractures, permits the frequent dressings and does away with the unclean, infected fixation apparatus.

Disadvantages:

1. Apparent brutalityof the procedure. This is not real, however, as the patient suffers no more by this traction than by any other method.
2. Danger of infection. This is less than the danger of an open radical operation.
3. Hemorrhage. This may occur but can always be readily controlled by enlarging the incision and tying off the bleeding points." (24)

Thus we see an early report was very favorable.

The World War gave the medical profession, as a whole, a wide and varied amount of experience, but in particular, it gave those interested in fractures and orthopedics a much greater field of work. This was due to the type of warfare with shrapnel, high explosives etc. There were a great number of broken bones that needed attention. Thus the Thomas splint was devised and used in great numbers. Many men owe their good sound limbs to this rather simple device.

It was during the War that Lorenz Böhler, an Austrian

physician, got his much and varied experience which led to his system of treatment. He devised an apparatus which used the Steinmann pin as its basis of traction, but it also held the leg and thigh in a more or less neutral position. Bohler's work has been the basis of almost all of the modern methods, and his laws are almost fundamental to all types of treatment. His laws are:

> "1. The peripheral fragment must always be placed in the direction where the central one points.
> 2. Every fracture must be reduced by means of traction and counter-traction.
> 3. After reduction the fragments must be continuously in the right position until firm union takes place." (25)

He further states, "The quickest and best way of making a fractured extremity again capable of function, consists in the proper reduction of the dislocated fragments, in prevention of atrophy of the muscles, and in the avoidance of progressive stiffness of joints." (25)

Bohler's method consists of a Steinmann pin through either the os calcis or lower portion of the tibia and fibula or lower portion of the femur. On this pin the traction is applied. The leg is in a semi-flexed posi-

tion, with the leg suspended at a higher level than the body, and the thigh on the incline much as Petit described many years before. Bohler believes in the use of a local anesthesia and in the use of plaster applied directly to the skin. He also advocates that early massage and passive motion are a definite harm rather than help but that active motion is of great help. Bohler says, "By functional treatment we understand the complete uninterrupted fixation of the fragments in good position with the simultaneous active movement of all the joints, or as many as possible, and with the avoidance of any pain." (2$)

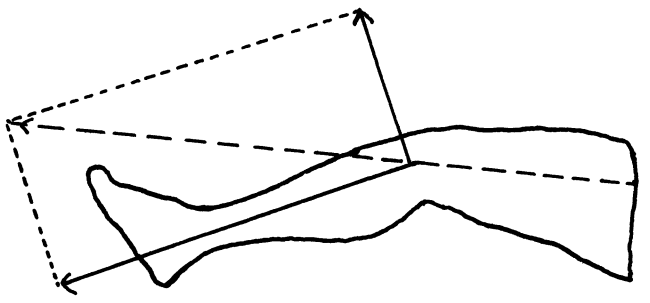
As to treatment when a joint is involved he says, "If we reduce exactly a broken joint and continuously hold it in good position until union takes place, and, at the same time, allow the use of the fractured extremity, we obtain a moveable joint, while on the other hand, if we apply massage and passive movements in the first days after fracture, the joint becomes stiff." (25)

Having Bohler's work as a background, all types of extension machines and devises are mere modifications. R. H. Russell, in 1924, describes his method of treatment which in principle is about the same but does not require the special apparatus nor the Steinmann pin; although the latter can be used. Russell puts the leg in a more or

less neutral position, but he pulls up at the knee as well as extends the leg. The main axis of force is along the axis of the broken femur. His reasons for this method are:

> "1. In a limb previously normal that is rendered perfectly comfortable in a natural position, muscular action is never the cause of displacement of fragments.
> 2. The cause of malposition of fragments are three in number, viz: (a) unnatural position and discomfort; (b) action of gravity; (c) splints." (26)

This method is often modified now by the use of a Steinmann pin in the os calcis. By diagram, he shows his lines of force as:



In 1928, H. E. Conwell reported fifty cases in which the Russell type of treatment, modified by a Steinmann pin through the os calcis, was used. Of these fifty cases the results were forty good, seven fair and only three bad. (27)

The method of treatment in which the "well-leg" is used as a basis of the traction was described early in medical history but is now being used again. It especially is used when the fracture is in the neck of the femur. As described by Roger Anderson in 1931 and 1932, the Steinmann pin is used through the tibia on the injured side; while on the well side, the apparatus is included in a plaster boot. By adjusting the apparatus, the pelvis is tilted both by pulling on the injured leg and pushing on the "well-leg". This tilting of the pelvis corrects the deformity in the neck of the femur. (28) (29)

H. W. Spiers, in 1933, in discussing the various methods of skeletal traction, states that the Steinmann pin is not good because it has a tendency to break in the middle. The use of ice tongs, he says, is not good because it has a tendency to slip and thus tear the tissues. He suggests that steel pins or piano wires are the best materials to use as they give less reaction and do not break. (30)

In all methods heretofore described, one metal pin was used as the basis for traction with the body acting as the counter-traction. Many types of machines have been devised in which two steel pins are used, one pin above the fracture and one pin below. Thus the traction and counter-traction points are, as a rule, within one bone. Several of these devices were described before Anderson devised his.

Ralph M. Carter, in 1933, described a device much like Andersons, but it is not as complete. (31) W. K. West, in 1933, showed good results by the use of a Kirshner wire above and below the fracture without any special device. He reduced the fracture then put his plaster over the leg and wires. (32) Other machines were devised by William H. Bailey (33), R. A. Griswald (34) and J. E. Bittner (35).

In the Anderson method, the patient is prepared as any major surgical patient. All procedures are done with just as much asepsis as in abdominal surgery. The parts are given the same type of cleaning process. Through the distal end of the femur, just above the condyles, a through and through steel pin is driven. When in place, this pin extends for about three inches on each side of the limb. For control of the proximal fragment, two half pins are

used. These are driven into the region of the greater trochanter but are not driven through the bone. Two pins are placed here, being driven in to make about a 45° angle with each other. These two pins are now placed tightly in a solid bar and by movement of this bar, the proximal fragment of the femur is under control. Now the lower pin is cradled in the apparatus, and the upper bar is also fastened in. Thus, both the upper and lower fragments are controlled by the apparatus. By adjustments with thumb screws, traction may be applied as well as rotation to either of the fragments. With the use of the fluoroscope frequently, while the reduction is being done, an almost anatomic result should be obtained.

Following the reduction, a plaster cast is applied incorporating the pin below and the bar above. The cast extends below, just to the knee, and above just enough to securely hold the bar. As soon as the plaster is dry, the machine is removed. In about three days the patient may walk on this leg as the fracture site is not bearing any weight. The weight is transmitted from the upper bar to the lower pin by the cast. Thus active movement is started very early. (36) (37)

The advantages of getting early active motion is shown by the work of Clay Ray Murray. In an extensive

article on the chemistry of the repair of bone, he states that to have early repair there must be:

> "a. The establishment of the early acid pH in local tissue fluids at the site of the fracture.
>
> b. The adequate growth of granulation tissue.
>
> c. The reversion at an early date to a relatively alkaline pH in the local tissue fluids which will allow deposition in the newly formed tissue.
>
> d. The maintenance of a proper interrelationship between local metabolic activity and the circulatory efficiency." (38)

These four principles can only be fulfilled where there is active muscle movement which will give quicker and better blood supply to the part.

Anderson has used the same method in fractures of the bones of the lower leg, humerus (39), fractures of the radius and ulna (40) and in fractures of the patella (41). He has also used this method in bone lengthening operations in which it is so necessary to hold the bones rigidly. (42) In the lower arm and lower leg, the apparatus is modified by using through and through pins both

above and below.

S. L. Haas reports three cases in which wires or pins were used, and there was a latent osteomylites. In all cases there was a history of trauma, and all were in children where osteomylites is more common. Anderson thinks there must have been some error in technique. (43)

Thus we have followed the methods of treatment from the earliest of time. In principle, the changes have not been so great, but the technique of carrying out these principles has greatly changed.

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