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THE PRESENT STATUS OF THE OPERATIVE TREATMENT OF FRACTURES

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THE pioneers of the operative treatment of acute fractures as practiced today are Lambotte of Antwerp and Sir Arbuthnot Lane of London. To these courageous surgeons, who have made such substantial contributions to the surgical armamentarium and technique, we owe a great debt of gratitude.

A recent visitor to our clinic from Australia, who had spent 18 months visiting the various clinics of Great Britain, Europe, and the United States, asserted he was very much confused and in great doubt as to what procedures or practices were best because of the many and divergent methods employed, as well as the claims made for each of them.

The introduction of x-ray films as evidence in Court, with interpretations by the laity, now constitutes a legal threat to force a more accurate anatomical replacement of fractured bones. The patient is frequently under the impression that the "Doctor has set the fracture" only to realize, months or years later, that it had not been reduced. It is, therefore, advisable to show the x-ray films to the patient and to explain the conditions, indications, etc., if operative procedure is necessary. When the patient is confronted with the fact

that he is likely to go through life with a limp, loss of function, or similar disability, he will readily consent to submit to a reasonable and safe recommendation. A surgeon would not permit a fracture to remain uncorrected either in himself or members of his family. Why should not the same consideration be extended to his patients?

For the past 30 years severe criticism has been leveled at those who have used steel bone plates, screws, nails, etc. Many of the leading critics in personal interviews have admitted to me that they never had had any experience whatsoever with steel plates, screws, or nails in the treatment of acute fractures and that their opinion was based entirely on the poor end-results which they have seen in cases in which the operation was imperfectly or poorly done. In the medical schools certain of the professors, when discussing the operative treatment of fractures, stated, "We merely mention steel plates, screws, and nails in order to condemn or decry their use."

In July, 1929, the author attended a meeting of British and American bone and joint surgeons in London. One morning of the program was devoted to the discussion of the treatment of intracapsular fractures of the hip joint. Royal Whitman made a valiant

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stand for the anatomical reduction and physiological treatment by the abduction method, plaster, and rest. A group of 14 cases was presented in which the Thomas splint had been used and was advocated as the method of treatment with traction and immobilization. There was a questionable reduction in all of the cases and the end functional results were anything but satisfactory. There was no criticism made, however, of the use of the Thomas splint. Philip Wilson made a brief preliminary verbal report of 23 cases in which patients had been treated by the operative method by Smith-Petersen. Mere mention of the operative treatment was severely condemned, notwithstanding the fact that those making the condemnation had little or no knowledge of the operative technique. Much credit is due Smith-Petersen for his contribution to this subject. The technique now has been refined so that with the assistance of the x-ray as a guide, only an incision over the trochanter is necessary to insert steel fixation in the form of nails or screws. The results reported by Smith-Petersen, Watson Jones, Sven Johansson, Brewster, Moore, and Cubbins and his group, are very encouraging, and while it is too early to evaluate the end functional results, there is ample justification for this technique at the present time in the hands of those trained and competent.

The high mortality and large percentage of non-unions as a result of the abduction method make it imperative that something be done to shorten the convalescent period and improve end functional results; hence it is obvious that such operations should be done only by those exceptionally well trained and equipped.

It is certainly desirable to make these patients ambulatory in from 5 days to 2 weeks as against the patient remaining in a "coffin of plaster of paris" for a period of 3 to 5 months.

Since the World War there has been "mass production" of bone and joint specialists, many of whom lack general surgical training. A surgeon who requires 3 hours to do an operation that should be done in 45 minutes, should not attempt it.

VANADIUM STEEL BONE PLATES AND SCREWS

In 1909, following Sir Arbuthnot Lane's advocacy in America of the use of steel plates and screws, the author adopted this technique when operation was indicated, and in 1912 he reported 72 operative cases. It was soon found that the screws were too soft and the plates too hard, with the result that the screws pulled out and the plates broke. This led to the redesigning and patenting of vanadium plates and screws in 1911, with the idea of securing plates having maximum strength with a minimum amount of foreign material. If the plates and screws are made according to specifications they will not break, but quantity production during the World War resulted in the market being flooded with plates and screws which had never been inspected either from a physical or metallurgical standpoint. The havoc produced by the breaking of these plates and by the pulling out of these screws, brought a storm of protest to the American College of Surgeons from surgeons throughout the country. The author presented his patents to the College and the Fracture Committee took up the matter with the United States Bureau of Standards. After a thorough, joint investigation, they adopted and approved as standard, the same designs of the plates and screws as advocated in 1909, as well as the metallurgical specifications as set forth in the patent.

The undesirability of beef bone, ivory, gold, silver, and metals containing copper, chromium, and nickel, after the great claims made for them, is a matter of common knowledge.

"Cat and dog" experimenters have strenuously objected to the use of steel in the fixation of fractures, quite unmindful of the fact that as a result of the high explosives used in the World War, millions of individuals carry iron and steel about in their bodies without localizing or irritating symptoms. There are also many thousands of individuals who have been operated upon during the past 30 to 40 years in whom the plates have remained *in situ* without deleterious effects. We take strong exception to the teaching that plates and screws should be removed, unless there are specific indications for their removal.

If the proper technique is followed in applying plates, 95 per cent will remain permanently in simple fractures without any necessity for removal, whereas 48 per cent *are* removed in compound fractures. The results of animal experiments in which steel plates and screws have been used and condemned, are not of great value because of the difficulty in carrying out the meticulous, non-touch technique so necessary.

Non-ferrous substances are being advocated but they are not comparable to the steel alloys in their physical characteristics. The objection to them is, they are too bulky and hard and, therefore, liable to fracture. The objection to stainless steel is that it contains chromium and is rather difficult to temper. Ductility, and not extreme hardness, is the quality most desired.

Electrolysis is not a factor when plates and screws are made of the same steel. In cases in which plates have been removed, the staining of periosteum has been noted. This staining is due to an oxidation of the iron, ferric oxide, and is not in the least objectionable as it is non-irritating as proved by the fact that many thousands of patients operated upon in whom steel plates and screws have remained *in situ* from 5 to 28 years, are entirely unconscious of their presence, as there never have been any objective or subjective symptoms.

It is only reasonable to assume that at some time in the future an alloy may be produced which will have greater physical properties than vanadium steel, but it is doubtful if such an alloy will be of a non-ferrous nature.

CARREL TECHNIQUE

Carrel technique with sodium hypochlorite—0.5 per cent sodium hypochlorite and 0.9 and 0.10 per cent sodium chloride—is a prophylactic against infection as well as of great value in the treatment of suppuration.

The objection to Dakin's solution as made from bleaching lime is that it is unstable and caustic, necessitating the making and testing of a new supply every few days. For the past 18 years we have used to the exclusion of all other antiseptics and chlorines, a concentrated, electrolytically prepared sodium hypo-

chlorite of 4.05 per cent and sodium chloride 3.25 per cent, bearing the trade name "*Hypochlorite*," which has the approval of the Council of Pharmacy of the American Medical Association. Its great advantage is that it is stable and of low alkalinity and can readily be made available for use by the dilution of 1 part of the concentrate to 6½ or 7 parts of water. It is an ideal physiological antiseptic as it destroys nitrogenous bacteria and necrotic tissue by the process of oxidation without inhibiting or in any way destroying viable cells or tissues, and I believe it would have met with the full approval of Lister.

Within a few years the antiseptics used today in the treatment of wounds—phenols, synthetic coal tar compounds, bichloride of mercury, potassium permanganate, peroxide of hydrogen, etc.—will be obsolete and many of the beautifully colored and attractively bottled proprietary antiseptics, whose chief value is confined to the test tube (not unlike iodoform gauze whose greatest virtue was its color and stench), will fall into disuse. It is interesting to note that of the hundreds of antiseptics which have been advocated during the past 50 years, very few have withstood the test of time—a rather sad, but true, commentary.

Those who decry the use of the Carrel technique, stating the same end-results can be secured with saline or other antiseptics, have little fundamental understanding or experience either with the method or of the chemical action of aqueous sodium hypochlorite. There is little or no opportunity for infection to take place in a compound fracture if an early débridement is done, and the Carrel technique is instituted at the time of operation.

The surgeon should be held responsible for postoperative infection if he fails to utilize the equivalent of a specific in the treatment of compound fractures—the Carrel technique—and he is open to fair and just criticism in view of the end-results which were secured by its use in the World War as well as in those clinics where it is used thoroughly and intelligently today.

The use of vaseline gauze packs or maggots has no place in the scientific treatment of compound fractures or their postoperative

complications, despite the enthusiastic advocacy of those measures. We are advised by the etymologists that the active principle of the maggot is an enzyme and to this property is ascribed the justification for the use of maggots in surgery.

We should not be hypersensitive to constructive criticism. There has been more or less hysteria associated with many of our very questionable practices. Criticism of other cults should be restrained until such time as we have "cleaned house."

COMPOUND FRACTURES

It has been the general opinion that steel plates and screws should never be used in the treatment of compound fractures. This opinion is based entirely upon theory and not on actual experience.

In 1933, George V. Foster, the author's associate, reported 304 consecutive compound fractures of the long bones treated by débridement, Carrel technique, open reduction, and plating when indicated. In this series over a 15 year period (1917 to 1932), 129 compound fractures were plated; there were no frank infections, and 1 amputation at the end of 3 weeks was necessary on account of the great loss of substance, bone, and soft parts. There were 2 fatalities—one 4 weeks and the other 6 months after secondary operation. In the plated series, the incidence of non-union was 1.5 per cent, while in the unplated cases, it was 4.0 per cent. The difference in the percentage ratio was most likely due to the extensive comminution found in the unplated series.

In our clinic we employ the following principles in all compound fractures regardless of their severity and have had but one frank infection since 1917:

1. A thorough cleansing of the wound and surrounding skin.
2. A conservative, but thorough, débridement.
3. Reduction of the fracture—manipulation with or without internal fixation or skeletal traction.
4. The Carrel technique instituted immediately following operation, as a prophylactic measure.

5. Immobilization of fracture, preferably with molded plaster of Paris, involving the proximal and distal joints.

6. Unsupported weight-bearing not permitted until a strong bony union has taken place.

7. Plastic reconstruction, if indicated, after cicatrization has been completed.

8. Physiotherapy—Morton Smart method of electrically graduated muscle contraction to restore muscle tone; active exercises.

INDIRECT OPERATIVE TECHNIQUE (Skeletal Traction)

Skeletal traction with ice tongs, Steinmann pin, Kirschner wire, etc., has been used in many clinics to the exclusion of other procedures. This is due either to the lack of knowledge of the non-operative technique and timidity or to the lack of confidence and inexperience in the direct operative attack. There is no question but that skeletal traction has an important place in the treatment of fractures, especially in extensive comminuted fractures. The percentage of infection (7 to 10 per cent) in 2 of the leading hospitals in the same city in this country, is sufficient evidence that it is not without its dangers and complications. At best, skeletal traction is a "bastard" form of the operative treatment. It must be used with discretion and only in those cases in which it is indicated. The "robots" which have recently made their appearance, are of value in selected cases. It is an error of judgment, however, to expect to correct all displacements with this one procedure. A simple fracture is always more desirable than an incomplete compound fracture such as is produced in skeletal traction.

The literature abounds in reports of small groups of cases in which patients were treated by skeletal traction but contains very few reports of unsuccessful cases in which the complications, dangers, failures, etc., have been evaluated. In one case of skeletal traction of the femur in which ice tongs were employed, we encountered a serious secondary hemorrhage. Like the operative attack, skeletal traction is not without its dangers and it will eventually find its proper place in the treatment of fractures but not to the

extent that it is being used today in many clinics to the exclusion of every other method.

DIRECT OPERATIVE TECHNIQUE

The time-consuming, elaborate pre-operative preparation of the operative field, is unnecessary. Thorough cleansing of the skin with soap, water, and alcohol the evening of the day preceding operation, is sufficient. The operative field is prepared with either a 5 per cent picric acid or a 3 per cent tincture of iodine solution, is carefully draped, and the towels affixed. *At no time* are the fingers, instruments, gauze, catgut, etc., permitted to contact the skin. In other words, the non-contact technique of Lane is scrupulously carried out.

TECHNIQUE OF OPERATION

Simple fracture of the femur. An external incision is made with a sharp scalpel through the skin and fat, after which this instrument is discarded. A tissue forcep and clean scalpel are used to undermine the skin and fat to permit of an ample exposure. Turkish towels are then carefully affixed to the cut skin edges with either Michel clips, Lane or Moynihan towel clamps, and the ends of the towels are fastened with Backhaus towel clips. The skin should not be exposed to the slightest degree as it is considered a source of contamination. The fascia lata is then incised and reflected. The vastus externus is incised and the cruræus muscle reflected and the fractured ends exposed. The proximal and distal fragments are not eviscerated into the wound or stripped free of their periosteal and muscular attachment any more than is absolutely necessary. A Lane or Lambotte clamp grasps the proximal or distal fragment and any intervening periosteum, muscle, or fascia is removed by curettage. The fracture is then reduced within the wound by traction and manipulation.

Immediately following the reduction, which is usually of a hair-line nature, a Lambotte or Lowman clamp is affixed to the site of fracture and a 6-screw plate is clamped to the external surface of the femur. The overall measurement, including the plate, is taken by a caliper in order to determine the exact

length of the screw necessary to engage the proximal and distal cortex and, at the same time, not to extend beyond the distal cortex. The bone is drilled through the proximal and distal cortex and a transfixion screw inserted. After a transfixion screw has been applied to both fragments, screws involving only the proximal cortex can be inserted. The drill can be either a hand or a motor-driven one, preferably of the twist type.

Great care should be taken to remove any periosteum at the site of the drill hole. Failure to do so causes the screw to twist about the periosteum and interfere with the proper cutting or tapping of the bone. After all screws have been inserted, the bone clamps are removed and all bleeding points carefully ligated as an absolutely dry wound is desired. The cruræus and vastus externus muscles are sutured with a figure-of-eight double No. 1 catgut; the fascia lata is closed with a double continuous chromic No. 00 catgut. Wherever possible, such as in the tibia, the periosteum should be gently reflected and sutured over the bone plate and screws with figure-of-eight catgut sutures. The skin is closed with Michel clips or with a vertical mattress silk suture and the fracture is splinted in a Thomas splint with Pierson flexion attachment; in fractures of the lower leg and forearm, molded plaster splints are used and are worn until firm bony union has occurred. Drainage is never used.

Recently we have had 2 non-unions due to too early weight-bearing after the patient's discharge from the hospital at which time bony union had been present.

If the technique, as described, is carefully followed, wound infection is no greater than in any other elective type of operation such as goiter, hernia, or chronic appendicitis. Bone plates and screws are not the source of infection as has been so frequently stated. Should infection occur, it is usually due to faulty technique or lack of operative skill on the part of the surgeon. If positive evidence of infection arises, with elevation of temperature, redness, swelling, or other symptoms, the wound should be thoroughly opened at once, all sutures removed, the bone plate exposed but allowed to remain *in situ*, and the Carrel technique instituted.

Those who have decried the use of steel bone plates have had little or no experience in their use. It is rather unfortunate that this criticism of those who have successfully used steel plates in the operative treatment of fractures, has retarded, at least 25 years, the general scientific acceptance of the direct operative treatment where indicated.

BONE GRAFTING—PSEUDARTHROSIS

In a small percentage of cases non-union will result whether steel plates and screws are used, or whether no operation has been done. Sufficient time should elapse before grafting is considered. This operation is not indicated in the treatment of acute fractures or for delayed union but for pseudarthrosis. Absolute fixation of the bone graft to the host, with 2 or more vanadium tap screws, has greatly improved the immobilization of the bone graft and this is a very important and desirable factor. Fixation of fractures without motion is imperative until such time as bony union has occurred. There is little or no divergence of opinion as to the indications or technique where bone-grafting is indicated. Massive grafts are preferable. The step-cut procedure is usually practiced with transfixion screws in the arm and forearm. The inlay in the tibia is the operation of choice and either an inlay or an onlay in fractures of the humerus and femur. In several cases, 2 grafting operations were necessary and in one case, 3 operations were done. In all cases, bony union was eventually secured.

FACTORS CAUSING INFECTION

1. Too early operation. Simple fractures should not be operated upon until the swelling and blebs have subsided and the temperature becomes normal, which is, usually, 10 to 14 days. The trauma caused by operation, in addition to the already existing trauma, tends to produce necrosis of the tissues with resultant sloughing and infection. If operation is deferred 10 to 12 days, it is usually bloodless and the postoperative reaction, nil. We feel that this delay is of great importance and a large factor in combating infection and necrosis of tissue; obviously, compound fractures should be operated upon immediately.

2. Failure to carry out the non-touch, aseptic technique.

3. Excessive trauma caused by the rough handling of tissues and failure to carry out sharp dissection.

4. Lack of proper surgical armamentarium to facilitate operation. Most operations of this character should be completed in 35 to 45 minutes. The surgeon who procrastinates or prolongs the operation to 2 or 3 hours, should either improve his technique or not attempt the operation.

5. Lack of an organized surgical team—that is, assistants and nurses. Failure to plan in advance and practice the meticulous technique, thereby causing many errors in the procedure and subsequent wound contamination. This failure of organization and team work is frequently the alibi of those who find it difficult to adjust themselves to such an exacting technique. With practice, the non-touch technique soon becomes "almost automatic."

SUMMARY AND CONCLUSIONS

Frequently we have been accused of being guilty of operating on all fractures regardless of their nature. Nothing could be further from the truth. Those who have taken the time to inspect our records and x-ray films and note the end functional results in the patients operated upon, have been convinced not only of the necessity for the operation but are cognizant of the excellent end functional results secured. There is no legitimate excuse for neglect in the reduction of fractures any more than there is a legitimate excuse for anyone starving to death in a time of plenty. The vast majority of fractures can be satisfactorily reduced:

1. By the closed method, that is, by manipulation, traction and similar procedures.

2. By direct or indirect operative treatment, when indicated, and in clinics where conditions make such practice a safe procedure.

One of the large bone and joint clinics reports 33 per cent of the patients admitted have malunion or other complications following fractures. The same ratio exists in many

other clinics. This is certainly not very complimentary to the initial treatment rendered and is evidence of the fact that much remains to be done to improve the methods of treatment and end-results.

The government of Australia and The Seamen's Hospital Society of Greenwich, England, have organized and instituted a study of this subject and are making constructive suggestions to correct conditions as they now exist. If the medical profession fails to meet its responsibilities, the public undoubtedly will take the matter into its own hands and attempt to improve conditions through governmental or other agencies. Such a situation would be a deplorable one, indeed, and the general practitioner and surgeon cannot evade this challenge. The co-operation of the Council of Industrial Health recently created by the American Medical Association, together with the American College of Surgeons, can do much to improve present unsatisfactory conditions.

During the past 28 years the author and his associates have carried out the practices and

principles as herein outlined in more than 8,000 compound fractures and in cases in which osteosynthesis has been done. At first thought this large series would give one the impression of unnecessary operations. However, when it is taken into consideration that a great majority of those injuries originated in an industrial army employing some 150,000 men engaged in the manufacture and fabrication of iron and steel, and the transportation of 200,000,000 tons annually of raw and finished materials, it is evident that despite all safety precautions, the handling of such great tonnage is certain to cause serious trauma.

The principles and technique which we have routinely practiced over these many years with such satisfactory end functional results, both from a humane and economic standpoint to the employee, employer, and surgeons, will be continued until such time as better methods are evolved which will improve the end functional results over the shortest period of time and with the greatest safety and comfort to the patient.

