*TREATMENT OF UNUNITED FRACTURES.

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We all have troubles, but no man is perplexed more than the surgeon who is called on to correct a large number of ununited fractures, and I personally believe the introduction of the Lane plate is largely responsible for the apparent recent increase in this class of cases.

This plate has unquestionably done a great deal of good, both in a negative and positive manner, for its advent has stimulated an immense amount of research work and doubtless in a number of cases it has served the purpose for which it was intended. On the other hand, however, it has tempted many a surgeon to employ it when far simpler and longer tried methods would have sufficed, and the placing of this foreign body in the wound has either prevented or certainly limited osteogenesis.

So great is the fear of infection by the originator of this plate as for him to insist it should not be touched with the gloved hand, but only with especially devised instruments. This, however, is not in keeping with modern technique, for certainly if a wound is to be aseptic, the gloved hand as well as the instruments must be surgically clean.

Having in mind, first, the dangers of infection in the presence of a foreign body; second, the dangers of infection with an autogenous bone graft; thirdly, the result of a foreign body placed in the epiphyseal line upon the future growth of that bone in its long diameter, and fourthly, the results of an autogenous bone graft placed in the epiphyseal line upon the future growth of that bone in its long diameter, we started a series of experiments on Belgian hares, and the results seem to justify our plea against the indiscriminate

use of the Lane plate or any other foreign material.

Taking up the first two questions, namely, infections, we took a series of thirty-five (35) rabbits. The first five were injected with a culture of colon bacillus mixed with graphite. In this series we only obtained three abscesses but with these three we made an incision through the abscess to the bone and placed a small Vanadium steel screw in the femur. In all three the screws finally came to the surface and were removed in six, ten and forty-one days, respectively. With the rest of this series we gave up the idea of trying to develop a certain type of abscess and decided to simply make an incision in the rabbit's thigh in as dirty a manner as possible, and thus obtain an infected field through which to place our screws, and at the same time we obtained a culture to ascertain the type of organism producing the infection. This was carried out in thirty rabbits, with the following results: Six rabbits died from the anaesthetic (ether), leaving twenty-four which had screws placed in either tibia or femur. In two (Nos. 6 and 12) the screws remained in position after developing sinuses, both of which finally closed, and in the remaining twenty-two all the screws came to the surface and were removed.

This series, according to the type of infection, is as follows:

Bacteria Found in Rabbits Having Screws Inserted.

1. *B. pyocyaneus* and a few gram positive diplococci.
- *6. *B. coli* and a few gram positive diplococci.
7. Staphylococci, streptococci and a gram negative bacillus.
8. *B. pyocyaneus* and streptococcus.
- *12. Staphylococci, streptococci and gram negative bacillus.
13. Staphylococci, streptococci and a few gram negative bacilli, *B. pyocyaneus*.
14. *B. pyocyaneus* and staphylococci.
15. *B. coli* and staphylococci.
16. Staphylococci and a few *B. pyocyaneus*.
17. Gram negative bacilli and a few gram positive bacilli and cocci.
18. *B. coli*.
19. Gram negative bacilli and a few cocci.

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20. *B. pyocyaneus* and a few cocci.
21. Staphylococci, streptococci, a gram negative bacillus, probably *B. coli* and gram positive bacilli.
22. Staphylococci, streptococci and a few *B. pyocyaneus*.
23. Gram negative bacillus, a few cocci and gram positive bacilli.
25. Staphylococci and *B. pyocyaneus*.
27. *B. coli*, *B. pyocyaneus* and a few streptococci.
40. *B. pyocyaneus*.
41. *B. pyocyaneus*.
42. *B. pyocyaneus*.
43. Staphylococci and *B. pyocyaneus*.
44. *B. coli* and *B. pyocyaneus*.
45. *B. pyocyaneus* and a few staphylococci.

We next determined to ascertain the fate of an autogenous graft placed through an infected field in the same manner in which we had inserted our screws. The manner of obtaining the graft was simply to remove a small piece of bone and transfer it to the other leg. In other words, to take from the left and place on the right, and from the right and place on the left.

In this series we employed twenty-five rabbits, three of which died from ether, leaving a series of twenty-two (22) rabbits having forty-four (44) grafts. Five (5) of the bone grafts worked out (Nos. 50-R, 55-L, 60-L, 81-R, and 87-R), while in the remaining thirty-nine (39) the grafts all apparently "took" and were found in place by X-rays and later on autopsies.

The grouping according to bacteria is as follows:

Bacteria Found in Rabbits Having Autogenous Grafts.

49. Right—*B. coli*, *B. pyocyaneus* and a few cocci. Left—*B. coli* and *B. pyocyaneus*.
50. *Right—*B. pyocyaneus*. Left—*B. coli*, *B. pyocyaneus* and streptococci.
51. Right—*B. coli*, *B. pyocyaneus* and a few gram positive bacilli, with metachromatic granules. Left—*B. pyocyaneus*.
52. Right—*B. pyocyaneus*. Left—*B. pyocyaneus*, *B. coli* and staphylococci.
53. Right—*B. pyocyaneus* and staphylococci. Left—*B. coli* and *B. pyocyaneus*.

54. Right—*B. coli* and *B. pyocyaneus*. Left—*B. pyocyaneus* and a gram positive bacillus.

55. Right—Staphylococci and *B. pyocyaneus*. *Left—*B. pyocyaneus* and a few cocci.

56. Right—*B. pyocyaneus* and a few gram positive bacilli. Left—*B. pyocyaneus* and a few gram positive bacilli with metachromatic granules.

57. Right—*B. pyocyaneus*. Left—*B. pyocyaneus* and a few gram positive bacilli with metachromatic granules.

58. Right—*B. pyocyaneus*. Left—*B. pyocyaneus*.

59. Right—*B. pyocyaneus* and a few gram positive bacilli with metachromatic granules. Left—*B. pyocyaneus* and a few staphylococci.

60. Right—*B. pyocyaneus* and a few gram positive bacilli with metachromatic granules. *Left—*B. pyocyaneus* and a few gram positive bacilli with metachromatic granules.

75. Left—*A. gram negative bacillus*. Right—Gram positive and gram negative bacilli and a few cocci.

76. Left—Large gram positive bacillus, gram positive diplococcus and gram negative bacillus. Right—Staphylococci and gram positive and gram negative bacilli.

77. Left—Staphylococci, gram negative diplococci and gram positive bacilli. Right—Gram positive bacillus and staphylococci and gram negative bacillus.

80. Left—*B. coli*, staphylococcus aureus and a gram positive bacillus. Right—Staphylococci, gram negative bacillus and diplococcus and a gram positive bacillus.

81. Left—*B. coli*, gram positive diplococcus and a few gram positive bacilli. *Right—Staphylococcus aureus and gram positive and gram negative bacilli.

87. Left—Staphylococcus aureus and gram positive bacillus. *Right—Staphylococcus and gram positive bacillus.

88. Left—Staphylococcus aureus, gram positive bacillus and gram negative diplococci. Right—Staphylococcus aureus and gram negative diplococcus.

89. Left—Staphylococcus aureus and a small gram positive bacillus. Right—Gram positive bacilli (white and yellow colonies).

90. Left—Gram negative bacillus and gram positive bacilli and diplococci. Right—Little growth, gram negative bacillus.

91. Left—Staphylococcus aureus, gram positive and gram negative bacilli. Right—Staphylococcus aureus and large gram positive bacillus.

In other words, in these infected cases nine-

ty-two per cent (62%) of the screws had to be removed, while eight per cent (8%) remained after developing sinuses. With the autogenous bone grafts only eleven per cent (11%) were removed and eighty-nine per cent (89%) remained in place, as proven by X-ray and on killing the rabbits four months after the insertion of the grafts and finding them apparently continuous with the rest of the bone.

These two series demonstrated experimentally, first, a foreign body is far more apt to give trouble in the presence of infection than an autogenous graft, and second, an autogenous bone graft will "take" in a proportion of cases in the presence of various types of acute and chronic infections. Not for one moment, however, do we want to be understood to advocate any relaxation in aseptic technique, for absolute cleanliness is as essential in this class of work as it is in any other field of surgery.

To illustrate clinically the first of these two deductions we have only to realize almost every surgeon has had to remove Lane's plates, both in infected and non-infected cases—some of

his own, as well as those of some other surgeon. Therefore, it would only be a waste of time to demonstrate our Lane plate failures.

Case No. 1 demonstrates better than any other case we have had the possibility of bone grafts taking in the presence of active infection.

Young man 22 years old, compound comminuted fracture of left tibia and fibula eleven weeks before admission to the hospital. X-ray (Fig. No. 3) showed not only the fracture but a detached piece of bone, and on exposure of fragments pus (smears of which the colon bacillus predominating) was found permeating all the tissues and about 200cc escaped after incision of skin.

It was decided to try an autogenous bone in-

Figure 3. Case No. 1—Infected fracture of tibia and fibula with detached portion of bone.

Figure 5. Infected Fracture—A diagrammatic sketch of operation done in case No. 1.

lar graft in spite of the infection. This was done on Dec. 29, 1913, and as follows: Incision was made and dead bone removed, after which two parallel circular saws were used for making a groove, the pieces removed being utilized for the manufacture of five bone pegs, one of which was inserted as an intramedullary peg in the fibula. The other four were employed to hold in place a graft which had been removed from the upper part of the tibia. This last graft was obtained with two circular saws, but now being separated by a washer the thickness of the "set" of the two saws so as to make the graft fit tightly in the groove prepared for its reception. In other words, the washer allows for the "sawdust." This is illustrated diagrammatically in Fig. 5. Fig. 6 and Fig. 10 show the case in two weeks and ten

months, respectively; and the patient has a perfect functional result without any of the pegs or graft ever coming to the surface, and this in spite of the fact that there was almost constant drainage of pus for about two weeks following the operation.

A small vanadium steel screw was then placed in the epiphyseal line of tibia in a series of ten young rabbits varying in age from 4 to 6 weeks. This was done through as near an aseptic field as possible to obtain, and all rabbits showing any signs of infection were dis-

Figure 6, Case No. 1.—Infected fracture, two weeks after operation.

Figure 10, Case No. 1.—Infected fracture, ten months after operation.

carded. The hair was removed with barium sulphide and starch and the field cleaned up in the usual manner. X-rays were then taken on the following day to ascertain accurately the relative position of the screw, and at the end of six months all the rabbits were killed. In four of these cases there was a shortening of the tibia having the screw, varying between one-half to two cm. There was no ascertainable difference in six. In addition to this series, there were twelve rabbits which had to be discarded because the screw was not in the epiphyseal line and seven on account of sinuses and infections.

An autogenous spicule of bone was placed in the epiphyseal line of the tibia in a series of twelve young rabbits in a manner similar to that in which the screw had been placed, and in none of these cases was there any shortening, rabbits being killed in the same length of time. In other words, with steel screws, 40

per cent of the cases showed shortening in the long diameter, while with the autogenous pegs there was no shortening in any case.

Meissenback, in 1910, injected sterile water, Tr. iodine, alcohol, carbolic acid, formalin, various bacteria, etc., in the epiphyseal lines of a series of hares and found some of these, formalin especially, stimulated osteogenesis, but on the other hand, concluded a "retardation of growth may occur if the zone of provisional calcification is destroyed or if this zone is infiltrated by excessive blood clot or by destructive processes." It is this permanent destruction we feel occurs by the placing of a screw in the epiphyseal line, while with an autogenous peg such destruction is not permanent.

The importance of this part of the work is shown in the case of a small boy, aged 10 years, who had an epiphyseal separation, with rotation outward, of the articular head of humerus to such an extent it was impossible to re-

Figure 12, Case No. 111—An epiphyseal separation returned to normal position and held there by Lane plate.

Figure 13, Case No. 111—Patient 12 years old. Epiphyseal separation of humerus held in position by means of autogenous bone peg. X-ray taken two weeks after operation, and operation on January 2, 1913, three weeks after injury.

duce it without open operation. The fragments were returned to their normal position as shown in Fig. 12 and held in position by means of a Lane's plate. This operation was done on Sept. 1, 1912, and on Oct. 8, 1914, the date on which the plate was removed, there was about three cm. shortening of the right (affected) arm. With this exception the boy obtained a perfect result, and it will be most interesting to watch the future development of the length of the arm without the plate.

Figure No. 13 shows one of three similar cases in which autogenous bone pegs were employed instead of Lane's plate, and while the time has not been as long, as yet there are no signs of shortening, and both results are perfect as regards function. Both of these cases have been done over a year, and the case in which Lane's plate was employed showed shortening in about six months, which at first was thought to be due to disuse of arm, but after return of full use of the arm and increased exercise it failed to develop as rapidly as the other arm.

So far this paper has not dealt directly with the "Treatment of Ununited Fractures," except largely from the standpoint of prevention, and it would require much longer time than we have at our disposal to discuss each special type of fracture; therefore, we will consider some of the general methods now employed.

Before any surgeon undertakes this type of work he should be equipped with an efficient

electric motor. We have found a friction-driven motor with a long, flexible shaft far preferable to the cumbersome gear motor or the heavy hand motors on the market. A foot control of the electric current adds to the comfort and safety of both patient and surgeon. The metal part of the shaft can be boiled in oil while the remainder of the instrument can be covered with sterile cloth. We simply use a long bag about four feet long and three inches wide, with a purse-string at each end.

I believe the most important part in the treatment of these fractures is to have the fragments held in as near normal position as possible by as little foreign material as will serve this purpose without the intervention of any abnormal tissue.

So many surgeons holding this view have produced various operations the basis of each being to utilize autogenous bone grafts.

In the Journal of the A. M. A., April 4, 1914, we described our dowels or reamers, which we had been using then for about a year, and we have found them to be easy to handle and satisfactory in every detail. These, as can be seen in figure 15, are simply three cylinders of different sizes, at one end of which is a sawing edge. This end is placed over the fragment of bone to be fashioned into a peg and then the motor started. It

Figure 15—Reamers or dowels with drills of same size.

Figure 17—Two circular saws with various sized washers, allowing different width grafts to be used. Notice especially the small washer which is width of two saws.

only requires a few seconds to obtain a peg several inches long. The size of peg required depends on the strain to which the peg is to be subjected. We have usually employed the smallest size, though for an intra-medullary peg the largest size is most frequently used. The strength of these pegs is surprising to one unaccustomed to them. In making these pegs it is best to allow a few drops of normal saline solution to play in front of the cutting edge so as to prevent any possibility of heating the bone. Not infrequently one can obtain several pegs from a fractured spicule of bone. In very oblique fractures it is not necessary to use an inlay graft but just simply to nail the fragments together with several of these pegs. Of course, the drills correspond in size to the pegs.

If one wants to manufacture an autogenous bone screw this is easily done by placing a peg in a mold and screwing down the "lugs." This impresses us as being a useless refinement and not possessing sufficient advantages to justify the waste of time.

The grafts can be held in place by catgut, but this requires about as much time to thread in place as it does to make and insert the pegs, and certainly a graft held by catgut is not as firm as one anchored with the pegs.

We have found the parallel saws (figure No. 17) easy and quick to operate, and are sure having this little washer to place in between the two blades to allow for the "saw-dust" makes a far more satisfactory and certainly a more accurate operation.

It is occasionally necessary to remove bone from parts remote to the fracture, and for this purpose we have always employed the crest of the tibia. This should never be done except when absolutely necessary, for such practically means two operations. If one is prepared to do these operations and has practiced on fresh animal bone sufficiently to handle the instruments, there is no reason why they should not be done quickly and accurately, but it is most certainly an operation not to be undertaken "lightly and ill-advisedly."

The part played by syphilis in such cases should at least teach us the importance of a Wassermann being made in each case, and the appropriate treatment instituted if found positive.

The treatment of ununited fractures in the old and feeble presents an entirely different problem, for here any radical surgery is out of the question, and yet the comfort of these patients has to be considered. In these cases a most careful search should be made for some of the constitutional diseases of old age, and proper medication started—at the same time comfortable splints should be applied so as to obtain partial immobilization and relief from pain.

We have made no mention of the role played by the periosteum in the repair of fractures, nor have we advanced any theory concerning the life of the grafts or pegs as regards their absorption or serving simply as a frame-work for new bone deposits, for to consider any of these points would constitute a separate essay. To be convinced of this one has only to review the literature published on these subjects during the past two or three years and then to consider the existing confusion, some of which seems to me to be due to a difference of opinion of what constitutes the true periosteum, whether the outer fibrous layer by itself or whether taken in conjunction with the underlying layer containing osteoblasts.

Before closing it is a pleasure for me to have this opportunity of extending my thanks to Dr. W. Brownley Foster, Health Officer of the City of Roanoke, for having taken entire charge of all the bacteriological work contained in this study; to Dr. E. T. Brady for his pains and care in the X-ray work on the rabbits, and to my assistants for many hours of extra labor outside of their regular hospital duties.

DISCUSSION.

Papers of Drs. Knox and Trout.

Dr. R. L. Payne, Jr., Norfolk, Va.: To open the discussion on fractures, and especially after having heard the papers read this morning, is a very difficult proposition. I know of no problem in our general surgical work that is more of a puzzle to us than the treatment of fractures, and,

in that we do a great deal of railway surgery and see a large number of fractures every year, the problem becomes more pressing to us all the time.

It is especially evident from what has been said this morning that our present procedures are due to the evolution of our efforts to do away with the introduction of foreign bodies into open fracture wounds. There is no doubt but what the average plate has to be removed and more important is the fact that foreign bodies of the plate type almost invariably produce a delayed union. The trend of experimental work in the past year has led to the development of autogenous bone grafts, which I believe is going to solve the problem, but one in speaking upon this subject should be extremely careful as to what he says, and I only have to recite to you the main points brought out by Murphy concerning the periosteum as long as two years ago, which are almost completely refuted at the present time. How many of us here, in beginning our bone operations for fractures, have completely destroyed the periosteal covering, or have failed to bring the periosteal coverings together in the manner that we have been taught to do and urged to do by early bone writers, yet in those cases the results have been very good, and I believe that we can say this morning, regarding the periosteum, that in nearly every sense it is a limiting membrane. If we go back to the embryology of bones, we must recall the fact that the osteo-genetic centers start from the cartilage proper, and with these facts in mind I believe it will help us understand bone formation and help our bone surgery.

Now, there is one point I would like to refer to in connection with Dr. Knox's paper. He spoke particularly on the use of plaster in the treatment of fractures and the non-operative treatment. I believe, in the hands of the average man who does not do a great deal of plaster work, that the plaster is overdone, in that they obtain a too great immobility of the fracture. I believe Dr. Knox knocked the nail on the head when he said, in allowing the patient to get up that friction between the ends caused the union. I do not know when I have followed a paper which has dealt with actual work in the operating room that will prove of more value to me and to the rest of you than that of Dr. Trout, and he has clearly proved that the autogenous graft is better than any sort of a foreign body that can be produced.

Lastly, the X-ray. Too great importance is put on the X-ray as a diagnosis. Too little diagnosis attempted by the old physical signs, especially crepitus. How often, in failing to elicit crepitus, do we leave between the fragments of bone soft structures that militate against union.

Dr. J. Shelton Horsley, Richmond, Va.: I was attending the council and did not hear the papers, but it seems to me, in the treatment of fractures, the points we have to consider are the basic principles. Indirectly bearing upon that, the work that seems most valuable is the work of the presiding officer and of McWilliams, of New York, who has shown that bone need not be in contact with the osteo-genetic living tissues to live. Why should it have to be in contact? The prin-

ciple established by the experimentors is, after all, the same general underlying principle of nutrition. If there is a small piece of bone and considerable vitality, there is enough vitality to preserve that bone. It is simply a question of supply and demand. There is not enough nutrition to support the ordinary function and repair, too, and a large bone graft is absorbed. That has a vital bearing upon the treatment of ununited fractures. It was formerly the practice to saw the ends off, to screw them together, just as the cabinet-maker would make a joint, and expect them to unite and remain united. That type of operation was unsuccessful, and we know now why it was unsuccessful. It is a question of supplying sufficient nutrition to comply with the ordinary principle of repair. In most ununited fractures the callus or bony tissue fills up the ends of the bone as a solid block, so that the nutrition cannot get inside. That is occupied by bony tissues which has also to be nourished. The periosteum can give the only blood. We should cut down the amount of the bone to the minimum to merely a cylinder of bone, instead of a solid mass. There is then not only less bone, but room for the endosteum to extend to the injury. We know that a blood clot causes not only hyperaemia, but leukocytosis; so that instead of having an accurate union, we should make it rough. It seems that in some way the Lane plate does not stimulate the throwing out of bone tissue. That has been demonstrated, I think, fairly well. Of course in fractures, where there is plenty of nutrition. A Lane plate can be used.

Dr. H. P. Cole, Mobile, Ala.: Any findings of those who depart from the usual procedure are subject to criticism. I scarcely feel it my duty to defend the doctor's position, but I think we should all give him credit for stimulating our interest in a department of surgery which has been sadly neglected until within recent years.

Many visitors to Lane's clinics carry away the idea that he is an enthusiast on the open treatment of fractures, and perhaps he is. However, comparing the treatment of former days with the treatment by Lane plates in fractures of the tibia or femur, one cannot be other than deeply impressed by the final effects on the hip joint in Lane cases.

I have had no experience with the autogenous graft, but have had some slight experience with the Lane plates. The inability of osseous tissue to harbor a foreign body in the presence of infection is a fact now too evident to require comment. About two years ago a Pittsburgh physician reported the results of a series of collected cases operated on by bone plate in that city, with evidence in his report that infection had occurred in nearly 50 per cent of the cases. This is a commentary on technique rather than the method of treatment.

It seems hardly necessary to insist that all such cases should, in the first place, present no evidence of a circulating or concealed infection. The use of gloves and the proper instruments to prevent the introduction of even a gloved finger into the wound is essential.

In the past four years I have treated fifteen

cases by bone plate, none were compound fractures, though two were recently healed compound fractures. Several weeks after healing these two cases were bone-plated, and in both instances there was infection about the plates. I consider these cases of concealed infection. In two cases bone-plates were inserted near the epiphysis of the humerus in children 5 years of age. The plates were removed several weeks after union to prevent retardation of growth. I have seen loose plates remain without disturbance for two years; two cases have been men 60 years of age, with twenty-penny spikes through the femoral neck, remaining now nearly three years without infection.

Other men, I believe, have had the same experience.

In conclusion, I do not mean to say that the foreign body plate is more valuable than the autogenous graft, but in a great many properly selected cases with careful technique the Lane plate may be successfully employed.

Dr. Carroll W. Allen, New Orleans, La.: Mr. Chairmen and Gentlemen: This subject has been admirably presented by Dr. Trout, and I agree with him in the use of autogenous bone splints in preference to foreign bodies.

In regard to the treatment of non-union and vicious union, I think that the splint is particularly useful, especially in vicious union, where the fragments come together at an angle, and it is impossible to reduce it, or hold them reduced. When you break up the vicious union, and of course it must be done by open operation, and something used to hold the bone in proper alignment; there, I think, the bone inlay has a place. We often have to operate for the interposition of soft parts, and when those soft parts are of sufficient quantity that they have not disappeared under the pressure absorption between the two ends of the bone, here, too, the inlay can be used to advantage.

Dr. Knox calls attention and shows an ambulatory plaster cast which he has used very effectively. We have found a better method by using an instrument-maker's appliance. The cast we found too heavy. The one I wish to describe was introduced by Prof. Motes in our clinic several years ago, and has served so effectively to accomplish its purpose that we are operating on fewer cases of fracture than we formerly did. A cast is taken of the fractured limb. That cast is taken off by being slit before and behind. A mould is then taken of the patient's limb.

Suppose we illustrate it for a fracture of the tibia. The instrument-maker moulds around that a heavy piece of leather of which shoe soles are made. That is perforated for ventilation. It is allowed to dry and forms a perfect cast of the limb. It is trimmed so as to form a perfect support for the limb and laced together in front; two iron braces are put on the side and this iron rod is riveted on to this leather, then riveted on to the sole of the shoe just in front of the heel. This brace has a hinge joint at the ankle.

With this kind of appliance the patient takes care of himself, taking it off every night by unlacing it and giving the limb a good massage and

bath before reapplying it next morning. Where there is but a limited amount of interposition of soft parts these will gradually be absorbed by the constant pressure of the ends of the bone, but where this interposed tissue is extensive or consists of tendons or aponeuroses, an operation becomes necessary. Cases that are tardy in uniting by the ambulatory plan, and where the bones are in good contact, can often be much hastened by passing a long fine needle down through a non-vascular area and scarifying the ends of the bones; this creates a little hemorrhage and irritation—just enough to stimulate osteogenesis sufficient to bridge the gap between the bones.

Dr. Duncan Eve, Nashville, Tenn.: Mr. Chairman and Gentlemen: I have just gotten into the room and did not have the pleasure of hearing the paper or even the discussion. This is a subject I am very partial to, and one that I would like to enter into a discussion on, but not having heard the paper, I wish to be excused. I wish to state, however, it was not my own fault I have not been able to be here. I have been on the Council.

Dr. Jere L. Crook, Jackson, Tenn.: I am sure we have lost a fine discussion. Perhaps no paper read in recent years has provoked more discussion than the memorable one read by Mr. Lane at the A. M. A. about eight years ago. There are some by-products of this paper that are not good, and they are the indiscriminate operation for fractures and especially simple fracture by men not gifted with the technical ability to perform these operations and by our letting fall into disuse some of the operations we formerly did.

I think the doctor has given us the proper conservative note in the series of fractures. The pendulum has swung too far in the way of mechanical appliances next to the bone, as advocated by Mr. Lane. Dr. Trout has shown wonderful mechanical ability as regards his technic and results. It is stated that no operation should be done in the presence of potential infection. I believe the experience of many men over the country will contradict that. We did get good results before Mr. Lane read his paper, and are still getting them. We admit the conditions are not ideal where we operate on a compound fracture, but it is not always feasible to reduce the fracture without opening up the wound and clearing out the debris. If we do treat it without doing that, we are taking serious risks. Shortly after Mr. Lane read his paper I had two fractures—one by a sawyer, sawing the leg almost in two with the tendons and bones and everything else. I operated immediately and the man got splendid results. Another case, a man with a gunshot wound of the tibia. I did not have any Lane plate with me. I simply put a 6-penny nail through the bone and held it together. The nail was removed in about six months under cocaine. Here I secured firm union and a fine result. The main thing I wish to emphasize is this: If we do have to use any appliances outside of the external ones we have used, it seems to me we must substitute the autogenous bone graft for the other forms of mechanical appliances. Let's not forget the surgical technique and ability of our fathers in medicine, and that we have had fine results long be-

fore we had mechanical appliances; and let's get these bones into position by manipulation and by splints on the outside and not be too quick to operate in simple fractures.

Dr. Jos. A. Danna, New Orleans, La.: Mr. President: I wish to express my pleasure in having heard Dr. Trout's paper. He has described it perfectly beautifully—to use a very plain word. I am glad to have heard Dr. Allen speak in favor of conservatism in treating ununited fractures in other ways before operating, because there is a certain number of them treated in that way that will not need after-operation.

I am glad to hear Dr. Crook speak against the use of indiscriminate operations of the open kind, whether they be ununited or otherwise, but I merely arise to make a suggestion: Lane's work is beautiful. The osteoplastic work that the doctor has spoken of is very beautiful work. All these things require special instruments, training and technique. Every man in this room could not have done the work that Dr. Trout did, and if we can suggest some simple method that all of us can use, that will accomplish, in the majority of cases, the same results, I think we ought to do it.

I am not much of an artist, but take a fracture of the femur as an example (illustrating). An ununited fracture of the femur is a very common thing, and it is in such a fracture that appliances such as Lane's plates are of use. If we can suggest something simple that will accomplish the same result, we are doing a great deal. Dr. Allen's picture of the fracture is not what I have seen such fractures look like. Usually fractures of the femur look something like this (illustrating on board). The periosteum comes over this way and this way. What is it that has caused this condition of affairs? First of all, the overriding of ends because they were not broken across as evenly as that, they have slipped across, and then the muscular destruction has caused this overriding sometimes : to 4 inches. You want to get those two bones end to end. Is there any simple way in which that can be done? Incise the periosteum, peel it off of both ends and saw off each end with whatever instrument you please, just exactly that way (illustrating). When you have done that, the ends of the bones fall into position and they are end to end, but they stop a little bit laterally, then all you have to do is in suturing your periosteum to take it up a little bit, and you have the tough membranous sheet, and if the periosteum has not thrown off any new bone that prevents your bones from moving laterally.

Now all you need is a straight splint. The objection is advanced that the piece of the bone might be interfered with by the use of pegs here and here, and it gives you a procedure which requires the least amount of traumatism, and which interferes to the least extent with the actual nutrition of the parts, and I use this in every case of this kind, and I think the results justify the means.

Question: Don't you get shortening?

Dr. Danna: It does not matter what you use. I am speaking of fractures two or three months old—ununited fractures that we call ununited because they have not developed bony union, and this is usually one picture you have, so that you

do not get any more shortening than by any other method.

Question: Suppose you had an acute case, how are you going to prevent that case from overlapping?

Dr. Danna: Of fracture of the femur?

Question: Yes.

Dr. Danna: It is almost impossible to do. X-ray studies of fracture of the femur show unless you do an open operation immediately (and I do not like to advocate that), that you get a certain amount of overriding, and I think that has been the experience of most of what work I have observed, but that is a point I have not touched upon, purposely.

Dr. R. L. Turner, Meridian, Miss.: I have enjoyed these excellent papers and the beautiful X-ray pictures of so many cases in which Lane's bone splints have been used, and I wish to say that I appreciate the work very much as a piece of art. Coming to the practical side of these cases of fracture, I feel there is a tendency with some to think that it is necessary to open and put on a Lane's splint, or some such retaining apparatus on most fractures.

I think there is a field of usefulness for Lane's splints, but that it is limited almost entirely to a vicious position of the bones, most of which would remain corrected if the patient is anesthetized and the proper apposition made, and then thoroughly and properly immobilized.

There are times when it is necessary to use a Lane's splint for awhile to hold bones in position in compound fractures with infection. I have seen a great deal of railroad surgery, and all of you know it is the severest kind of surgery we have to come in contact with; the tissues are severely traumatized and the patients are usually profoundly shocked. It has been my experience recently to see two railroad wrecks, in which over one hundred people were injured and more than thirty killed. All of these cases were handled without the use of a single Lane splint, with one exception, and that was in the case of a man so severely injured that it was thought for some time that he would die. Later an anesthetic was given and a vicious condition of the tibia corrected by the use of a Lane's splint, but after the ends of the tibia were cut off and adjustment made, the bones showed little tendency to become displaced.

Dr. R. W. Knox, Houston, Texas: It would seem, from remarks of the last speaker, that if overriding occurs in the case of fracture of the femur the proper thing to do would be to wait for a few months and then cut down and remove the overlapping portion, a process which would greatly shorten the leg. In my opinion, where we have access to a good X-ray machine and are unable to keep the fractured femur from overriding, the operation should be done within the first ten days and the bone plated, if necessary, according to Lane's method. Under proper precautions and proper handling there is very little danger in this method and it certainly saves the patient a long period of invalidism and the final results are much better. I have had no experience with bone pegs nor bone grafts, but I can see no reason why a steel splint should not be made just as aseptic

and have a greater holding power than the material mentioned. The danger of non-union from delayed operation is greater as the bone at this time may have exhausted its power of reproduction. If the bone plate is put on properly, not too superficially nor too near the joints, there is no reason why it should not remain indefinitely without removal.

THREATENED AND REAL GANGRENE OF THE EXTREMITIES AS SEEN BY THE MODERN SURGEON. ITS CAUSES AND TREATMENT.*

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The providential introduction of asepsis into general surgical practice has revolutionized conditions that must have been painful, intolerable and discouraging in the extreme to thoughtful men. Only by hearsay now from those of our masters fortunate enough to have lived through the one era and to have aided in the development of the other, do we realize the conditions that formerly prevailed and marvel at the herculean efforts put forward to overcome them. Certain forms of ailment are banished forever, certain ones are still with us to a slight degree; still others are present, draped in a garb somewhat different and less dreadful, but none the less baffling—perhaps even more so because of the obscurity of underlying causes and the consequent difficulty of overcoming them. Of these, gangrene of the extremities presents many features worthy of study.

It is obvious that an impaired circulation is the forerunner of any gangrenous process. It is not so clear, however, that the circulation is not primarily at fault in many instances, and gives way only toward the last when supporting structures have entirely abandoned it!

*Read in Section on Surgery, Southern Medical Association, Eighth Annual Meeting, Richmond, Va., November 9-12, 1914.

An illustrative case will perhaps explain this better than a detailed explanation.

A Mr. S., age 34, had suffered from an extremely severe tonsillitis, which had been badly handled, until he fell into the hands of Dr. J. McP. Scott, of Hagerstown, Md., when proper measures for relief were for the first time instituted. Gradually the infection yielded and the patient was well on the road to recovery when he began to complain of pain on the dorsum of his left foot. An infection—surely of metastatic origin—made its appearance and, in spite of prompt and thorough treatment, spread. Several other areas of infection arose, and finally the whole foot became gangrenous, the patient meantime lapsing into a state suggestive, but only suggestive, of septicæmia. When I saw him the throat was nearly well, but the foot was gangrenous, and in addition there was a well-defined thrombosis of the internal saphenous vein almost up to the groin. There was some oedema of the lower leg, but no line of demarcation. Careful examination revealed the fact that the circulation was intact down to the mid-point of the calf. It was therefore decided to amputate just below the knee, but before anything was done the internal saphenous vein was ligated doubly just at its entrance into the femoral vein and just above the thrombotic process, this precaution being taken to eliminate the possibility of infectious material washing into the general circulation from the thrombi. The vessel was not cut between the ligatures for fear of infecting the tissues of the groin. As a further precaution, a dissecting amputation was carried out; a tourniquet could have done untold damage to vessels already threatened and might have crushed, and therefore spread, the thrombi contained in the saphenous vein. The patient recovered.

This, then, is a septic, an embolic, gangrene. Infectious material was assuredly carried by the vessels, possibly minute capillary emboli occurred, but no one would lay the resultant gangrene primarily to the door of the vascular system.

As a rule, though, the fault is in the first and in the last analysis a circulatory one. The traumatic gangrene need not be dwelt upon. Always the result of an accident, diagnosis is not, as a rule, difficult, and the treatment is self-evident. Where possible a blood vessel suture or transplantation should be done promptly. Failing in this, the limb had best be