Byrd (W. A.)

WITH COMPLIMENTS OF AUTHOR.

ON THE

WIRE LIGATURE

IN

THE TREATMENT OF UNUNITED FRACTURES, AND IN RESECTIONS OF BONES FOR DEFORMITY.

BY

WILLIAM A. BYRD, M. D.,
QUINCY, ILL.

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ON THE WIRE LIGATURE IN THE TREATMENT OF UNUNITED FRACTURES, AND IN RESECTIONS OF BONES FOR DEFORMITY.[1]

Prof. Hamilton, in his work on "Fractures and Dislocations," fourth edition, page 71, uses the following language: "Tying the fragments together by means of metallic ligatures, after a recent fracture, is as old as the days of Hippocrates; but in 1805 Horeau adopted the same procedure in a case of ununited fracture, since which date it has been practised successfully by many surgeons. My own experience confirms the value of the method, especially when the fragments overlap."

It shall be my object in the present article to collect such cases as I can find in current literature within my reach, and deduce from them the conditions demanding the operation, and other practical points of interest to the surgeon.

Prof. H. J. Bigelow, of Harvard, kindly sent me a pamphlet containing the history of eleven cases of ununited fracture occurring in his practice, that were treated with the metallic ligature, from which I make the following abstract:

[1] A modified portion of the President's Annual Address, read before the Adams County Medical Society, May 10, 1875.

Case I. *Humerus.*—E. J., twenty-two years old, had ununited fracture, caused by having his right arm drawn between the rollers of a splitting-machine, eleven months before his admission to the hospital, October 15, 1857. He was treated by seton, rubbing the bones together, resection, and a splint so applied that the ends of the bone were crowded together, after being irritated by pliers made to pierce the ends of the fractured fragments, without securing union.

February 14, 1860.—Dr. Bigelow operated by making a crucial incision over the fracture, dividing the bands of ligamentous tissue between the fragments, and turning out the ends of the bone. The periosteum, with the muscles attached, was detached an inch or more from each end of the bone. The ends were then sawed off. A hole was drilled through each end of the bone, a silver wire passed through and twisted until the ends were brought in apposition. The external wound was united with sutures, with the ends of the wire protruding.

June 13*th.*—The wire was untwisted and taken out, union being firm.

July 12*th.*—Discharged. The arm appeared to be nearly as useful as the other one. Wire remained four months.

Case II. *Ulna and radius.*[1]—A. D., aged fifty-six years, entered hospital February 6, 1861. Four years before both bones of right forearm were fractured by machinery. Nine months after the injury, there being no union, the ends of the ulna were sawed off and wired together, and various other means resorted to without success.

9*th.*—Dr. Bigelow operated by making an incision over the seat of fracture, along the upper border of the radius; the ends of the bone were turned out, the periosteum was dissected up, and half an inch of each fragment sawed off. A hole was then drilled through each end of the medullary cavity, and a stout silver wire passed through and twisted. The arm was placed on an external angular splint and bandaged firmly to prevent motion.

February 13, 1863.—Patient returned to have wire re-

[1] In Dr. Bigelow's report this case is headed "Radius," but the history of the case shows it to be an ununited fracture of both radius and ulna.

moved, which was done the next day, two years from the time of insertion. He had good use of his arm.

Case III. *Humerus.*—J. C., aged twenty-four years, entered hospital November 4, 1861. Eight months before, he received an oblique fracture of the left humerus, extending from about four inches above the lower end on the outer side to a point two inches above the inner condyle. Fracture ununited.

9th.—Dr. Bigelow operated by cutting down on the fracture, turning out the ends of the fragments, carefully detaching the periosteum, and sawing off an inch and a half from the lower fragment and an inch from the upper. Holes were drilled through each end, a silver wire passed, and twisted until the fragments were in apposition. The musculo-spiral nerve was divided with the exception of a single fasciculus.

March 11th.—A small piece of necrosed bone came away.

May 22d.—Discharged, well. Sensation and motion in the hand perfect. Wire remained six months.

Case IV. *Humerus.*—C. D., aged thirty-one years, entered hospital December 4, 1862. Received a comminuted fracture of nearly the whole length of the left humerus a year before, by arm being caught by a revolving shaft. Various means were resorted to to procure union, without effect.

December 6th.—Dr. Bigelow operated by cutting down upon the false joint, exsecting the pearly, gristly ligament that united the two ends, and dissecting the periosteum up from each end for about a inch. The ends were then sawed off, holes drilled through them, a wire passed and twisted until the fragments were in apposition. The free ends of the wire were left projecting from the wound. An abscess formed near the elbow that required opening, as also did some sinuses.

March 9th.—Discharged, well. Wire remained two months.

Case V. *Femur.*—B. H., aged twenty-seven, entered hospital March 10, 1863. Received a fracture of middle of left thigh, by being run over by a heavy wagon, five hours before. November 12th, there being no union, Dr. Bigelow operated by cutting down upon the fracture, dissecting up the periosteum for an inch from either extremity, and cutting off the ends with a chain-saw. A hole was drilled through each

end of the bone, and a silver wire passed and twisted until the ends were nearly together. A small space was left to prevent breaking the wire or the bone. The limb was placed on McIntyre's double-inclined iron splint. July 12th, furnished with a thick-soled shoe, and discharged well. Wire remained five and a half months.

Case VI. *Humerus.*—T. C., aged forty-one. Right humerus splintered at the junction of the middle and upper third, at the first assault on Port Hudson, in 1863. Entered hospital April 15, 1864. Dr. Bigelow operated April 16th, by cutting down on the fracture, dissecting up the periosteum, sawing off the ends of the fragments, drilling holes in the ends of the bone, passing a wire and twisting it until the ends were in apposition. June 24th, the arm being considerably firmer, he was discharged. September 17th, union being perfect, the wire was removed, having remained five months.

Case VII. *Humerus.*—E. S., female, aged forty-five, entered hospital November 10, 1864. Had received a compound fracture of right humerus a year and a half before. On entrance, the fragments were drawn widely apart by the weight of the arm. November 19th, Dr. Bigelow operated by cutting down upon the ends of the fragments and turning them out. The periosteum was dissected back about an inch and a half on the upper fragment, and two inches on the lower, and the denuded bone sawed off, the upper with a single stroke of the saw. The bony tissue was so soft as to be easily cut with a knife, and the holes for the passage of the wire were made with an awl. The wire was passed and twisted until the fragments were brought nearly into apposition. The wire was not twisted tightly, for fear of breaking through the bone. March 10th, no union. April 1st, an incision was made down to the bone, the ends of the fragments turned out, and found so degenerated as to be easily broken down with the fingers. The arm was amputated.

Case VIII. *Humerus.*—W. W., aged twenty-eight, entered hospital January 2, 1865. Had his left humerus fractured a little below the middle twelve weeks before. February 25th, there being no union, Dr. Bigelow cut down upon the fracture, dissected up the periosteum, and sawed half an

inch from the upper, and three-fourths of an inch from the end of the lower fragment, drilled holes through the ends and passed a silver-plated copper wire, which was twisted until the ends of the bone were brought into apposition. The musculo-spiral nerve, which had been drawn out of its natural position, was accidentally divided during the operation. A suture was passed through each end of the neurilemma of the divided nerve, and the ends brought together. June 24th, the wire was withdrawn. The humerus was perfectly stiff. Sensibility had returned to the thumb and index-finger, but motion in all the extensors of the hand and wrist was absent. March 17th, motion returned to the extensors perfectly. Union of humerus perfect and free from pain. Wire remained four months.

Case IX. *Humerus.*—T. G., aged twenty-six, entered hospital June 12, 1865. Had received a compound fracture of the middle of right humerus a year before. The bone was still ununited. June 21st, Dr. Bigelow operated by cutting down upon the fracture, from the outer aspect of the arm, carefully seeking and turning aside the musculo-spiral nerve, dissecting up the periosteum, sawing off half an inch from the lower and three-quarters of an inch from the upper fragment, drilling holes in each fragment, passing a silver wire and twisting the same until the fragments were in apposition. November 4th, the bone being perfectly stiff, a pair of curved scissors were thrust down, and the wire cut close to the bone and easily removed. December 15th, discharged well. Wire remained four and a half months.

Case X. *Humerus.*—W. M. W., aged thirty-three, entered hospital January 26, 1866. Received a compound comminuted fracture of right humerus at its middle, from a gun-shot-wound received at the battle of Gettysburg. July 5, 1863, three inches of bone were resected; no union was sought or obtained. January 27th, Dr. Bigelow, being disabled, requested Dr. Hodges to operate, which he did by cutting down on the fracture, dissecting up the periosteum, and sawing off half an inch from the end of the lower and three-quarters of an inch from the end of the upper fragment, which was degenerated and soft. The ends were drilled and nearly approximated by

a silver wire. May 23d, the wire was cut and removed. The union was firm, the wire having remained four months.

Case XI. *Humerus.*—P. M., aged twenty-three, entered hospital January 12, 1867. Received a gunshot-wound at the battle of Cedar Mountain, in 1862, which shattered the middle of the left humerus. The small pieces of bone were removed, the ends sawed off, and the fragments approximated. Six months later there was no union. The ends were again sawed off, and the bones wired together. In two weeks the wire was removed. In October, 1864, a number of small pieces of necrosed bone were removed from the seat of fracture; there was no union. In November, 1865, he entered the hospital. Still no union. There was necrosed bone at the bottom of a couple of sinuses in the lower fragment. An incision was made over the fracture, the periosteum reflected, and the ends of the bone sawed off. In March, 1866, there was no union. March 31st, Dr. Bigelow again operated. The periosteum was detached from both fragments for a sufficient distance, and about an inch and a half sawed off the lower and an inch off the upper fragment. The ends were drilled, silver wire inserted, and the fragments brought in apposition. April 28th, the arm had stiffened at the point of fracture. June 10th, he fell upon the arm and rebroke it. July 15th, he was discharged with an ununited fracture, to return when the arm looked and felt better. January 12, 1867, Dr. Bigelow operated by cutting down on the fracture. Great difficulty was experienced in everting the ends of the now short fragments, and in detaching the periosteum. The bone was finally separated from the periosteum for a sufficient distance, and a piece, one inch long, was sawed from the upper and three-quarters of an inch from the lower fragment. The lower fragment was two inches in diameter; the upper one was of normal size, but with fatty degeneration of the marrow. A hole was drilled through the sides of both fragments, a silver wire inserted, the ends placed in apposition, and the wire twisted. The periosteum was replaced, and its edges united by sutures. The external wound was partly closed by sutures. A folded towel was placed in the axilla, to lift out the short upper fragment, and the arm secured to the side, with

the forearm across the chest. January 13th, there was almost complete paralysis of the extensors of the fingers of the left hand. No nervous trunk was known to have been divided in the operation, and the paralysis was perhaps due to a compressing of the nerve in very forcibly everting the shortened fragments; 21st, the arm was placed in an apparatus which consisted of a firm cap about the shoulder, secured by a strap around the chest. This was made firm by two steel bridges to a splint that invested the arm like a coat-sleeve. April 16th, the fracture was firm. Could flex the forearm and raise the humerus from the side freely; 22d, discharged, probably well.

The humerus shortened seven inches by the five operations it was subjected to—two before entering the hospital and three by Dr. Bigelow afterward; yet the muscles were fulfilling their functions and the patient was getting good use of his arm. The wire remained four months.

The above abstract contains about all of the material facts as reported in each of Dr. Bigelow's cases.

Prof. S. D. Gross, in his "System of Surgery," second edition, vol. i., page 955, refers to ligaturing ununited fractures under the categorical heading of excision. He gives Horeau the credit for originating it, and states that it is pretty generally condemned by European surgeons, but is often employed on this side of the Atlantic, apparently from the high authority of Dr. J. Kearney Rodgers, who was the first to perform the operation in this country.

He then describes the operation and recommends the tying of the fragments *firmly* together with a silver wire. Then follows an account of two cases that he operated upon, both of the humerus. In one a single wire ligature was passed, and after union it was taken away. The second had two ligatures passed, which were permanently retained. Prof. Gross uses a common gimlet to make the holes in the bone with. He says of the operation: "It is generally imagined that this procedure is necessarily followed by violent inflammation, jeopardizing both limb and life; but this is an error. If the operation be carefully performed, and the after-treatment conducted upon proper principles, I believe that it will

commonly be found to be entirely free from danger, while the utmost confidence may be placed in its efficacy."

The next case I find is one reported by Mr. Thomas Annandale (*British Medical Journal*, January 9, 1875, and *Monthly Abstract*, March, 1875, page 127).

R. K., aged twenty-nine years, was admitted to the Edinburgh Royal Infirmary, June 24, 1873, for ununited fracture of both bones of the forearm. He had received a compound comminuted fracture of both bones of the arm about six months before. The flesh-wounds had healed, but the bones had not. Mr. Annandale operated June 27th, by cutting down upon the fracture of the ulna and sawing off one-fourth of an inch from each of the atrophied and rounded ends. There was fully an inch of space between the fragments of the ulna, and the ends had become pressed in until they had united by fibrous bands with the radius. These adhesions were broken up, and, to render the ulna and radius of the same length, fully an inch of the partially-united radius was exsected. Holes were drilled through the extremities of both bones, and silver wires, of the size usually employed to fasten the corks of soda-bottles, passed through them and twisted until the ends of the fragments were in apposition.

August 3d.—The wire through the radius was removed, and on the 13th that through the ulna likewise.

29th.—The patient left the hospital nearly well. Six weeks afterward he returned, with the bones firmly united, with partial pronation and supination. The motion of his arm was steadily increasing. The wire remained one and a half month.

Mr. Annandale recommends a sprig-awl for making the holes for the passage of the wire in these operations. He also recommends this mode of treatment for cases of recent compound fractures of the bones of the forearm, where there is great difficulty in preventing them being pressed toward each other and adhesions forming between them.

Dr. John H. Packard, of Philadelphia, reports in the *American Journal of Medical Sciences*, July, 1875, page 125, *et seq.*, a case of ununited fracture of the radius and ulna

of left arm. The time elapsing between the receipt of the injury and the operation was a hundred and ten days.

Dr. Packard operated, after first applying Esmarch's bandage, by cutting down upon the point of fracture first of the ulna and then of the radius, and sawing off the ends of the fragments with a Butcher's and a chain saw. He gives the chain-saw the preference, because in using it less forcible distortion of the parts is necessary. Holes were drilled half-way through the ends of each fragment—to the medullary canal—and a pure silver wire passed, and the fragments brought into apposition by three twists of the wire from left to right. The ends of the wires were left over an inch in length and bent over, with a piece of lint between the ends and the skin. A very ingenious tin splint was made to reach from the middle of the upper arm to the ends of the fingers, and was applied with silicate of soda brushed over the layers of the bandage so as to form an immovable apparatus. Holes were cut through the dressing over the points of incision. There was considerable difficulty experienced in drilling the holes, on account of the extreme hardness of the bone.

Dr. Packard's mode of detaching the wire is both unique and useful. He passes the ends of the wire through a wire-twister, such as is used in operating on cases of vesico-vaginal fistula, and pushes the instrument well down on the twisted portion of the wire, keeping the free ends of the wire tense in the mean time; then, by giving the instrument as many reverse turns as were given the wire upon applying it, it is untwisted and easily removed. The wire in the radius was removed one hundred and eight days after the operation, and that in the ulna one hundred and twenty-four days after, at which time the bones were firmly united, with good use of the limb.

The January (1876) number of the *Monthly Abstract* contains an abstract of a paper Prof. Dolbeau contributed to the *Bulletin Général de Thérapeutique*, July 15, 1875, in which he recommends the metallic ligature in cases of ununited fracture of the humerus. He makes a distinction between ununited fractures and cases of delayed union, believing that those cases which get well without exsection and the wire ligature are merely cases of *delayed* union. To sixteen

cases operated upon by exsection and suture, of which eight were failures, he adds a successful case of his own. He recommends that the ends of the bone be sawed very slanting, so as to counteract shortening as much as possible. The most of his other recommendations that are of any value are contained in the abstracts of Drs. Bigelow and Packard's cases.

The January (1876) number of the NEW YORK MEDICAL JOURNAL contains the report of a case of ununited fracture of the radius and ulna of three years' standing, which, having resisted various other means, was operated on by Dr. Thomas M. Markoe, November 11, 1875, by cutting off the ends of the fragments and drilling holes in them, passing a silver wire and bringing the fragments in apposition. The February number of the same journal contains a favorable account of the progress of the case.

The above are all the cases I have been able to find purely of exsection of bone and wiring the ends for ununited fracture, but to them I wish to add a case of section of a united fracture and the wiring of the ends that was reported by Prof. Paul F. Eve, to the *Nashville Medical Journal*, and copied into the *Richmond and Louisville Medical Journal* for May, 1873.

Mr. A. M. Smith received a fracture of the right collar-bone from being thrown from a mule. The fragments had united with a lapping of one inch, and with more than the usual amount of deformity. The head of the humerus so pressed upon the nerves and blood-vessels of the axilla as to seriously interfere with the use of the right arm. Prof. Eve cut down upon the point of fracture by making a semilunar incision three inches in length, the convexity down, the middle of the incision reaching below the clavicle at the point of fracture. The flap was dissected up, exposing the overlapping fragments fully, and the subclavian artery and internal jugular vein. The viciously-united fragments were divided with a pair of cutting pliers, and the roughened ends squared off. The periosteum was cut through and a hole drilled in each fragment half an inch from the end, a silver wire passed through, and the ends of the fragments brought into apposition by pressing the shoulder backward, outward, and up-

ward. The wire was then tightly tied and the ends thrust into the holes. The wound was closed with sutures and adhesive plaster, and dressed with carbolic lotion. A soft pad was placed in the axilla, and the hand carried across the chest and placed in a sling. The patient suffered from ague and erysipelas after the operation, but got well, with a fine result. To use Prof. Eve's words: "And why not; for who does not know the innocuity of silver wire to the flesh, and how easily it may become incased in callus? I, therefore, recommend the metallic suture for all fractures of the clavicle, recent or otherwise, believing that the slight exposure made by the operation as described would not much increase the danger in such cases, wherein the methods now resorted to fail to keep the ends of the broken bone in apposition."

To these cases I will add one of my own, in which I resected a portion of the continuity of a sound ulna, and wired the ends, to correct a deformity resulting from an ununited Colles's fracture of the radius. The case is reported at length in the October (1874) number of the *Richmond and Louisville Medical Journal*, and a fair abstract is contained in the *Monthly Abstract* for April, 1875.

William M. Francis received a Colles's fracture of the left radius in 1868, when fifteen years old. A physician of considerable reputation for surgery in the local columns of the daily press was called in and dressed the injury. Some time after he first saw the case the fracture became compound by the end of the upper fragment making a hole in the integument at the front of the arm. The wound was several months getting well, when he was discharged by his physician. When I first saw him, six years after the receipt of the injury, he was unable to straighten the left arm to a greater extent than is represented in Fig. 1.

There was an ununited Colles's fracture of the radius, with considerable cupping of the palm of the hand, and an inability to either fully extend or flex the fingers. November 1, 1873, I cut down upon the ulna, opposite the fracture of the radius, and carefully detached the periosteum with its adherent muscles over about an inch of the continuity of the bone, which was then resected with a chain and metacarpal saw.

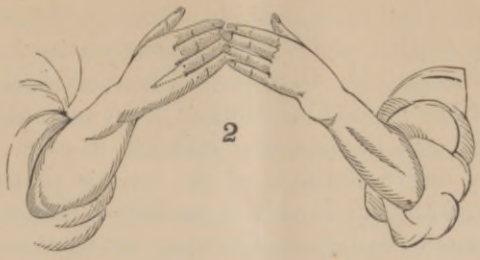
Something over an inch of the lower end of the ulna was left. An incision was made over the ununited fracture at the

radial side of the arm, and the ends of the atrophied fragments cut off with pliers. A hole was drilled to the medullary cavity of each of the fragments of the ulna, and an iron wire passed and twisted tightly, bringing the fragments closely into apposition. The ends of the radial fragments were not wired. Several different kinds of splints were tried and laid aside for one of plaster of Paris, moulded to the back and lower half of the forearm from the elbow to the ends of the fingers.

February 7th.—The radius had united. The wound on the ulnar side of the arm was nearly closed, but there was a sinus on the front aspect of the arm, midway between the radius and ulna, that led down to the wire, and two small pieces of necrosed bone included in its twist, which being loose were removed. The wire was bright and unchanged. The ulna rapidly healed, and April 8, 1874, when he started for California, the cupping of the hand had been in a great measure overcome. He writes from San Francisco, December, 1875, that his hand and arm are as good and useful as the left hand and arm of most people.

Fig. 2 shows the improvement after the operation. There was a deformity to overcome, and I could find no precedent for the operation I performed. I searched in vain for "authorities" that would reconcile me to the views I had upon the subject. The nearest I could find were two cases of compound fracture of the radius, reported by Prof. Hamilton in his treatise upon "Fractures and Dislocations," fourth edition, pages 295, 296, where he successfully cut off the *lower end* of

the ulna to make it the same length as the shortened radius, and to relax the muscles. This operation I considered faulty.



Although the lower end of the ulna does not enter into direct articulation with the wrist-joint, yet I could not but believe that the destruction of the attachments of the ligaments connecting the ulna with the carpus, and the exposure of the triangular fibro-cartilage, would be liable to greatly endanger the integrity and usefulness of the joint. Acting upon that idea, I performed the operation above briefly described; and now if I meet with any cases of fracture of either of the bones of the forearm, having anything like a sufficient loss of bone to cause non-union, or serious deformity, I shall exsect its fellow *in its continuity* and *not the end*, and wire the ends of the fragments together. I shall, in the event of being called to treat a fractured tibia, with the loss of bone-substance, causing a gap, cut down upon the continuity of the fibula and resect sufficient of its shaft to allow the ends of the fragments of the tibia to come together. Such practice I believe will soon be considered the most legitimate for a surgeon to pursue.

That it is not so recognized at present, is evident from Prof. Frank H. Hamilton's most admirable work, "The Principles and Practice of Surgery," second edition, page 254. He says: "Resection is not applicable where, from the resistance offered by parallel bones, the ends cannot subsequently be brought into contact; if, therefore, resection is practised upon the tibia, the fibula being sound, or upon either one of the bones of the forearm, care must be taken that no more than the overlapping extremities of the fragments are removed. If there is no overlapping, this operation is inad

missible." At another place, in the same work, he advises non-interference, and states that non-union is likely to result, and that the best result we can obtain will be more or less of a deformity. But these are his words, page 388, *et seq.*: "Excision of a portion of the shaft of one or the other of these bones, for necrosis or other disease, is often required; but in the case of one bone of the forearm, from any cause whatever, it must be borne in mind that excision of even a small portion of the entire diameter of the bone is pretty certain to result in non-union. It will be far better, therefore, to allow the fragments to remain, and to thus offer a chance for a *deformed* union, than to take the risk of no union at all. I have observed, also, that when a portion of the ulna is lost, and no bony union takes place, the head of the radius is very liable eventually to become displaced; or, if it is a portion of the radius which is lost, the lower end of the ulna sooner or later is thrust inward and downward. When both bones are broken, and the forearm is allowed to shorten upon itself, the danger of non-union is much less, and fragments may be removed more freely.

"Excision of the lower end of the radius alone, when not accompanied with a fracture and shortening of the ulna, invariably results in more or less deflection of the hand to the radial side. I have seen it turned in this direction to nearly a right angle. If, therefore, excision of the lower end of the radius is practised, and the ulna is not broken and overlapped, it will be advisable to remove at the same time an equal portion of the lower end of the ulna. In the single case in which I have adopted this practice, the subsequent inflammation and suppuration were moderate, the hand was restored, occupying its normal position, with good motion at the wrist-joint, and a useful amount of motion in the fingers. The great value of thorough excision of both bones in this class of cases, as a means of insuring complete relaxation of the muscles and of preventing subsequent inflammation, will be found fully explained and illustrated by cases in my 'Treatise on Fractures and Dislocations of the Long Bones.'"

To my mind, the time is past when surgeons can, with safety, allow deformities that may be remedied to ensue from

lesions they are called upon to treat. It is far better that a surgeon, when called to treat conditions as spoken of above, should make a free resection from the continuity of a sound bone, if necessary to secure parallelism, knowing that the quality of contracture of the muscles will secure a useful limb without deformity, other than shortening, than have his patient get well with a deformity to embitter his life, and perhaps go to some competitor and have it corrected, much to the surgeon's discomfiture.

In making resections of the ends of bones for ununited fractures, Dr. Bigelow accredits Jordan, of Manchester, with priority in detaching the periosteum. But Jordan, and likewise Sedillot, failed, because they first detached the muscles, and then pounded the periosteum to loosen it from the bone; thereby devitalizing and ruining it for the reproduction of bone. Jordan also neglected to wire the ends of the fragments in his cases.

As to the kind of wire to be used, surgeons differ. Some use silver, or silver-plated copper, but I have a preference for iron wire, imbibed perhaps from the teachings of the late Prof. Joseph N. McDowell, of the Missouri Medical College. I first heard him mention it in connection with fractures of the patella, in a lecture to his class during the 1866–'67 session. He spoke about thus: "Gentlemen, between twenty-five and thirty years ago, while passing along the streets of Philadelphia, the late Dr. George McClellan, an illustrious surgeon of that city, called me to his buggy and requested me to accompany him, to assist in an experiment he said he was going to perform upon a fractured patella. When we arrived at the bedside of his patient, he cut down upon the fracture with a longitudinal incision, and bored holes slantingly from about half an inch in each fragment from the edge of the fracture to the centre of the fractured surfaces, and passed through these holes a soft-iron wire, and tied the fragments nicely in apposition. Dr. McClellan's experiment was a success. The patient got well with the only bony union I believe I ever saw of a fractured patella. Dr. McClellan used the best metallic substance for a ligature that, in my opinion, has yet been found. But, gentlemen, my advice to you is, don't try the same experiment."

With, of course, but limited experience with the various metallic ligatures, I agree with Drs. McClellan and McDowell. I even prefer iron wire in operating for vesico-vaginal fistula.

Prof. Dolbeau recommends a plurality of ligatures, and that they be passed through the whole thickness of the bone; both of which propositions I believe to be faulty. If the wire is sufficiently strong, one ligature will hold the bones in apposition, unless they are softened, if passed sufficiently far back from the point of section to the medullary cavity. Then, if in twisting they are drawn so tightly as to cause bruising, and necrosis of the bone included in the twist, there will be sufficient surface unaffected in that manner for union, which would not be the case if the whole thickness of the shaft were included in the twist of the wire, or more than one ligature were used. He also cuts the ends of the bones very slanting, which requires very great care in stripping up the periosteum and in making the sections. If the ends are not cut exactly right, when union takes place the patient will have a deformed limb, which is not at all probable if the ends of the fragments are cut square off, as then any malposition of the limb may be corrected by giving it a slight twist during the after-treatment.

Of course, no surgeon will rely solely on the wire ligature to hold the limb in proper position during the time required for treatment. The best splint for the femur, under such circumstances, would be the same the surgeon would use for compound fracture of the same bone, and for that purpose Dr. John T. Hodgen's wire suspension splint fills the indications better than any other I have tried; for the other portions of the limbs, plaster-of-Paris splints, made by cutting out a pattern of paper that will encircle half the limb, and from that pattern cut the splint out of cotton-flannel, doubled so that the rough sides are together. These pieces of cloth are to be dipped into a mixture of plaster of Paris and water, somewhat thicker than cream, and then bound with a roller over the half of the limb where they are expected to act as a splint. It is well to cover the limb with newspaper before applying the splint, to prevent the plaster sticking to the hairs. When the plaster is set, the splint may be taken off and dried well over a stove and the rough edges trimmed off. It is well to

have two plaster splints, so that, if one gets covered with the secretions from the wound, it may be taken off and cleaned and disinfected while the other one is being worn.

The next thing to consider is the instrument with which to make the holes in the bone. Dr. Gross uses a gimlet, which makes too large a hole, is difficult to work, and is liable to split an eburnated bone. Dr. Bigelow uses a bone-drill, which generally makes too large a hole. Mr. Annandale uses a joiner's small pricker, an instrument that has completely failed in my hands when experimenting on bones to decide upon the best instrument. Dr. Fifield, in the *Boston Medical and Surgical Journal* for May 20, 1875, page 608, says that Mr. Lund, of Manchester, uses a jeweler's brooch for a bone-drill, which, gradually enlarging from its point, does not clear itself, and consequently does not work well in hard bone. I have tried all of the above instruments, and like none so much as what machinists call a common twist-drill. With one of these instruments in a breast drill-stock, a surgeon can bore rapidly through the hardest bone, or even iron, with the greatest accuracy.

The drills may be had of almost any hardware-merchant, from one-sixteenth to three-fourths of an inch in diameter. It is best to go to an operation with one or two extra drills, for fear one, if it is very small, or the surgeon awkward, may be broken. If the surgeon does not wish to use this form of drill in a breast-stock, he can work it fairly well by fastening it in a universal tool awl-handle.

I have gone thus carefully into the details of the instruments with which to make the holes, because I believe that some that have been recommended would fail the surgeon in the time of his need, and nothing could be more unfortunate than to cut down on an ununited fracture, promising the patient and your assistants that the ends of the fragments are to be wired together, and then be unable to bore a hole in the bone through which to pass the wire.

The wire in one of Prof. Gross's cases, and in Prof. Eve's case, was left in the bone indefinitely; but with the introduction of Dr. Packard's wire-*untwister* such a course is entirely unnecessary.

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