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SYMPOSIUM: AAOS 75TH ANNIVERSARY TRIBUTE TO PAST PRESIDENTS

The Classic

Fractures of the Femur. End Results*

Melvin S. Henderson MD (1883–1954)
The 5th President of the AAOS 1936

Melvin Starkey Henderson was born in St. Paul, Minnesota and received his early schooling there and in Winnipeg, Manitoba [4]. He received his undergraduate and medical degrees from the University of Toronto. He then interned in the City and County Hospital in his home town of St. Paul, and in 1907 went to work as an assistant with the founders of the recently formed Mayo Clinic, William James and Charles Horace Mayo. To further his training and evidently at the suggestion of the Mayo brothers, in 1911 Dr. Henderson went abroad to work under Sir Robert Jones in Liverpool and then Sir Harold Stiles in Edinburgh. He returned to organize and direct the section of orthopaedic surgery at the Mayo Clinic and spent his entire professional career there.

Dr. Henderson was involved in many national and international organizations, and was a founder and first President of the American Board of Orthopaedic Surgeons when it was established at the Kahler Hotel in Rochester, Minnesota, on June 5, 1934, after several previous organizational meetings [5]. Wickstrom [5], describing the organization of the Board, commented, "After all, in the opinion of the East coast establishment, Dr. Henderson (who was born in St. Paul, was educated in Canada, and had his beginning with the Mayo brothers as a clinical assistant riding a bicycle around Rochester, making house calls on the Mayo brothers' patients) was a mere upstart." However, at the time Dr. Henderson was 50 years old and had been President of the American Orthopaedic Association and Clinical Orthopaedic Society, as well as prominent in the American Medical Association and other organizations. Dr. Henderson was one of three of the first 15 AAOS Presidents (the other two being Drs. Philip D. Wilson and John C. Wilson, Sr.) who had a son who succeeded him as President. He was greatly respected for his organizational abilities, particularly at the Board, whose objectives were uncertain in the beginning and required sage guidance [5].

Melvin S. Henderson, MD is shown. Photograph is reproduced with permission and ©American Academy of Orthopaedic Surgeons. *Fifty Years of Progress*, 1983.

We reproduce here an article in which Dr. Henderson reviewed 222 consecutive cases of femur fractures, 165 of which had been referred late because of complications of fractures treated elsewhere (clearly, by 1921, the Mayo Clinic was a referral source for others) [2]. Followup could not have been easy at a time when patients often came from a distance and travel was difficult, but it was described when available and in 40 of the 57 recent fractures, Henderson reported 87.5% were "cured." Of the 165 old fractures, he was able to trace 143 (87%), a remarkable figure even today. He reported 90% of the femoral neck fractures were cured by various sorts of nonsurgical (6 patients) or surgical reconstructive (39 patients) means;

85% of the femoral shaft fractures were cured by either nonoperative (29 patients) or operative (69 patients) means. While he did not use the sort of outcomes we use today (the earliest orthopaedic outcome instruments were not introduced for four more decades: by Carroll B. Larson in 1963 [3] and William H. Harris in 1969 [1]), we can only presume Henderson meant union was achieved when patients were "cured" since nonunion or malunion would not have likely produced good results. That being the case, his rate of union was remarkable and would be enviable today in these sometimes difficult situations, attesting to his understanding of the individual situations and his skills.

Richard A. Brand MD

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(The Classic Article is reproduced with courtesy from Henderson MS. Fractures of the femur: end results. *J Bone Joint Surg Am*. 1921;3:520–528.)

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My part in this symposium is to discuss the end results of fractures of the femur. In order to gain the proper perspective, I have reviewed the literature of the past five years and have carefully, with the assistance of Dr. J. I. Mitchell, studied the records of 222 consecutive cases in the Mayo Clinic. The literature on the subject is so abundant that I shall not attempt to discuss it, but proceed at once with the discussion of data concerning the patients who have been under our care.

Fifty-seven of the 222 patients had sustained fractures recently; the remaining 165 presented the end results of treatment which they had received elsewhere. These patients came to the Clinic because of malunion, delayed union, nonunion, chronic osteomyelitis, stiff joint, and so forth.

Recent Fractures

Eighteen of the fifty-seven patients were under fifteen years of age. The data concerning patients who were not traced or under observation have been eliminated from the discussion, since the end results were too indefinite. There were three deaths. One patient died of a fractured skull the day of the accident, two died postoperatively, one of pulmonary fat embolism, the day of the operation, and one, a woman, aged 50, died in the third week from pulmonary embolism following reduction and treatment by the Whitman method of a fracture of the neck of the femur. Necropsy disclosed a huge pulmonary embolism evidently having its origin in a thrombosis in the common iliac vein. Thus remain definite records of forty patients from which to estimate end results.

Nine patients had sustained fractures of the neck of the femur; seven were cured. One fracture was of the intertrochanteric type, and a satisfactory result was obtained. One was a frank failure owing, I believe, to improper reduction of the fracture. One patient failed to carry out the treatment.

The Whitman method of treatment was preferred, but when for some reason it could not be carried out, the Ruth Maxwell traction and counter-traction method was employed, with a certain amount of abduction. Counter-traction, an essential part of this treatment, when properly applied, raises the trochanter and rotates the foot inward. It has been our practice, regardless of the type of fixation to break down the impaction and set the fracture as one would any broken bone. On the whole, it is probably better routinely to break up a so-called impaction of a fractured hip except when for some reason, such as old age with debility, or a systemic terminal disease, such as pernicious anemia, malignancy, or tabes dorsalis, the treatment of the fracture must be carried along on palliative lines. There is no reason why a fracture of the neck of the femur, either of the subcapital or the intertrochanteric type, should fail to unite in persons in good health, and old age is not in itself unfavorable.

Seven patients had sustained fractures in the upper third of the femur; all obtained satisfactory results. Four were operated on and three were treated conservatively. Theoretically, owing to the slightly forward and outward displacement of the upper fragment, traction should be

applied in a corresponding direction. The distance from the symphysis pubis to the adductor tubercle on the inner condyle is increased by more than 2 cm, when the hip is in full abduction. The powerful adductor magnus must, therefore, be stretched correspondingly. I believe this is sufficient reason why traction should not be made in this manner. Lee has mentioned this recently. Straight extension is sufficient if properly applied and not used as a mere ritual.

There were fifteen fractures in the middle third of the femur, with fifteen cures. Ten patients were operated on and five were treated conservatively. A slight angulation will not so easily cause a static arthritis in this area as at either end, of the bone. Sagging of the lower fragment posteriorly and laterally may occur, and care should be taken not to permit it to become too greatly displaced.

There were five fractures in the lower third, with three cures. One patient was operated on and four were treated conservatively. The lower fragment may become displaced posteriorly and the end press: on the popliteal vessels and nerves. If the fracture is not readily reduced by manipulation, one should not hesitate to reduce it by operation, for if it is left but a short time, reduction even by the open method may be very difficult.

In children, the epiphysis may be separated and displaced forward. There were three fractures of this type in the series, with two satisfactory results. One of the patients who died was a boy of nine, with an epiphyseal separation. He died the first day from pulmonary embolism. There were two open operations and one closed. It is astonishing how little deformity is evident in an epiphyseal separation with forward displacement, and it is not surprising that this somewhat unusual condition is often not recognized by the general practitioner. Acute flexion of the knee, with traction and manipulation, may reduce the deformity. If the reduction is difficult and open operation is decided on, the split patellar incision gives excellent exposure and enables the surgeon to replace the epiphysis accurately. Personally, I have no hesitation in making a full exposure of the joint in this manner.

The problem of when to permit weight bearing is most important. The time varies with the type and location of the fracture and the age of the patient, but there should be a cardinal rule that patients with fractures of the femur should not be allowed to walk, when the time comes to permit weight bearing, without a Thomas caliper walking splint. The splint should be discarded only when the clinical and roentgen-ray examinations show firm union. I find that I am inclined to lengthen the period of restricted weight bearing rather than to shorten it.

Of the forty patients, thirty-five (87.5 per cent.) were cured. Two had residual shortening and a consequent limp, and although they obtained excellent function, they are classified in the group of improved. The failures in the shaft were usually the result of bowing of the bones. This occurs even when the patient is wearing a cast. Some of the patients were permitted weight bearing without the walking caliper splint too soon, and some disregarded instructions.

Our practice now in treating recent fractures of the femur may be tersely described: The younger the patient, the easier is the application and the carrying out of conservative measures, although occasionally, even with babies, difficulty will be encountered in satisfactorily engaging the ends of the bone. When this occurs, open operation should be resorted to. In vigorous adults, under proper surroundings, the open operation, using beef-bone plates, or if necessary, metal plates, as internal fixation, in my experience at least, has been more satisfactory than conservative measures. In a well-equipped fracture ward in a hospital with trained attendants, conservative measures would, I believe, give equally good functional results, but such ideal conditions are rarely at hand. The proper internal splinting and postoperative fixation insures a perfect anatomic result. A good fracture table is essential; every hospital should have one. In elderly patients, I have been prone to resort to conservative measures, but in the future I believe I shall operate more often if patients are in good general health. This does not apply to patients with fractures of the neck of the femur, for which the Whitman abduction method gives perfect control of the fragments. Prolonged fixation in plaster tends to stiffen the knee and we are now putting joints in casts to permit early active motion of the knee.

Old Fractures

Of the 165 patients who came to us for consultation because of faulty end results, fifty had had fractures of the neck of the femur, and all but six of the fifty were operated upon. Five patients left our care too soon to show the end results. Thirty-nine of the traced patients were operated upon and twenty-eight (71.7 per cent.) were cured. In the successful cases, an autogenous bone transplant was used for nonunion in eight, beef-bone screws in eight, and metal screws or nails in four. Two patients had malunion, and osteotomy was performed. In six, the union was delayed and plaster of Paris casts were applied. There were no deaths, although a patient operated upon recently, who was not included in the group, died three days after the operation because of cerebral embolism originating in a thrombosed common iliac vein. The thrombus passed through a patent foramen ovale, which had not caused symptoms during life. Plaster of Paris extending from the chest to the toes on the side involved, and to the knee on the opposite leg affords firm

fixation. On the affected side a joint may be made in the cast at the knee so that the knee may be moved gently and stiffness be prevented.

I have not sufficient time to permit a free discussion of the type of case that should be selected for the pegging operation, and the type for the Brackett operation. I may say, however, that if absorption of the neck is practically complete and the head lies flush with the margin of the acetabulum, a bone pegging operation, no matter how carefully performed, is useless. Roentgenographs should always be taken with the foot in eversion and in inversion to show the amount of neck remaining. When a fair sized remnant of neck remains, I prefer to use the fibula as a transplant on account of its size and strength, but when there is little or no neck, I prefer the Brackett operation.

Transtrochanteric fractures and subtrochanteric fractures, as a rule, unite without any difficulty, but malunion may follow, necessitating an osteotomy. If the fragments are comminuted there may be excessive callus with some shortening, but strenuous attempts to obtain lengthening are not unattended with danger, for the muscles, nerves, vessels, and tendons may all be very much shortened. Even though there is considerable shortening, if union is firm, and the weight bearing line is satisfactory, it is my opinion that no interference should be undertaken.

In treating old fractures of the shaft of the femur, whether in the upper, middle, or lower third, the problem is much the same. An operation is difficult and may be attended with infection and risk to life. It is difficult to estimate end results in such patients because a study should be made of individual cases, and because in some it would be absolutely impossible to obtain perfect results. I have arbitrarily classified as cured patients in whom we have attained what I consider the maximum of benefit for the individual, thus making the classification a personal equation. Therefore, a discussion of some of the interesting facts I have elicited in the scrutiny and study of the histories of these patients may possibly be of more value than an attempt to tabulate results.

I was very much impressed by the fact that it is an extremely difficult matter to keep the records of patients who are under observation for some time in a manner so that an intelligent and comprehensive résumé of the patient's progress from the time he enters the hospital until he is dismissed cured, improved, unimproved, or still under observation, can be made. An editorial in the March issue of the *Journal of Orthopaedic Surgery,* on the subject of reporting results in fractures, briefly states what such a report should be. But few of us can really offer such valuable data.

The metal plate was used in fifty-eight operations. In this day of autogenous bone grafting this seems rank heresy, but I must confess that in many of these old fractures of the femur, after I have made a tediously long dissection to expose the fragments, freshen them, and fit the ends, I am only too glad to fall back on the metal plates and screws as the easiest and quickest way out of a difficult position. Prolongation of the operation to apply a bone graft is attended with a risk that cannot be lightly considered. The oblique and spiral fractures may often be easily held with beef-bone screws alone, and in the transverse fractures the beef-bone plate and screws combined are in many respects ideal. Sepsis is more prone to follow the use of the metal plates than the use of the beef-bone plate or autogenous bone graft. It is now my practice to remove every metal plate as soon as union is sufficiently firm to permit its discontinuance. Infection may spoil a well conducted operation, and is a factor to be considered in dealing with end results. In the present series infection ran high and occasionally caused failure. We have classified as infections all cases in which pus discharged, regardless of whether or not it influenced the convalescence. Twenty per cent. of the clean cases became infected. In the cases in which operations had previously been performed (in many, infection had followed the primary operation), 43 per cent. developed infection afterward. I do not believe this to be the fault of our technic, but rather the type of case, for in a recent investigation of 413 autogenous bone grafts, in 247 operations for ununited fractures, infection developed in 10 per cent. of the clean cases, and in 41.3 per cent. of the previously infected cases there was a discharge of pus. In the easily conducted 166 spinal transplants of the series, however, only 2.6 per cent. became infected, in spite of the fact that two large incisions were made and the motor saw employed in each case. Under a system of close checking up on the postoperative condition of wounds following general surgical operations in the Mayo Clinic, Sistrunk funds that almost 10 per cent. of the clean cases show some degree of infection.

Whatever the means taken to hold the fragments in position, some form of postoperative fixation is essential. There are two ways to secure this: one is fixation in a cast, and the other is some form of extension. I have no hesitation in saying that to rely on the cast to hold the fragments in place in a fracture of the shaft of the femur, either recent or old, when there is any tension of the muscles and tendons, is to court disaster. Bowing may occur no matter how carefully a east is applied, particularly if it is put on under extension on a fracture table. The only safe way is to put the patient in bed with enough extension to overcome the spasm of the powerful muscles. I prefer to apply a light cast to the thigh and a Thomas splint, elevate the foot of the bed and by a combination of weights strung over a pulley and the patient's own weight, maintain extension until the fracture is firmly enough united so that

either a cast or a walking caliper may be used. In the majority of instances adults should not be permitted full weight bearing for six months following operative measures.

There were 115 fractures of the shaft of the femur. Twenty-four were in the upper third; fifty-seven in the middle third, and thirty-four in the lower third. Ninety-eight patients were traced, seventeen were not traced. Sixty-nine were operated upon by some form of open operation. In this list are the nonunions, malunions and delayed unions, with fifty-three (76.7 per cent.) satisfactory results. Twenty-nine patients were treated by conservative measures with twenty-seven (93.1 per cent.) satisfactory results. The nonoperative treatment gave a greater number of proportionately good results than the operative treatment. It must be remembered, however, that operative measures were employed for the more serious fractures, while nonoperative measures, such as manipulations under ether to line up the fragments, and treatment by extension and Thomas splints, were employed for the more simple fractures.

It is not possible to deduce the best method by statistics, but I believe that in fractures of the neck of the femur, if enough of the neck remains, the bone peg, preferably the fibula, is the method of choice, but if the neck is absorbed, the Brackett operation offers the most encouragement. In the shaft, theoretically, the bone graft, either the intramedullary, inlay, or massive, is preferable, but for practical reasons the metal plate must often be used. The beef-bone plate is supplanting the metal plate in our practice, and I believe is much better tolerated by the tissues.

One hundred and two operations were performed for old fractures with two deaths. One woman, aged 38, with nonunion of the middle third of the femur, died the day of the operation from pulmonary embolism; necropsy was not permitted. One patient, a man aged 32, died the sixth day after operation, and necropsy failed to disclose adequate cause for death. A slight broncho-pneumonia and a slightly contracted kidney were found, but no evidence of pulmonary embolism. I am inclined to believe the patient died of renal insufficiency, although clinical examination had been negative.

There are two serious complications that are of clinical significance and which stand out in this review. First, thrombosis of the common iliac artery in fractures of the neck of the femur. This is, I believe, more common than we have thought. It was demonstrated at necropsy in two of our patients dying of embolism, and probably was the cause of the persistent edema seen in some of our patients, who, as far as the fracture was concerned, obtained excellent results. Second, dilatation of the stomach. This occurs but rarely in orthopædic eases, but if it is unrecognized, may cause the death of the patient. I have often heard Dr. C. H. Mayo say that if in the surgical wards of hospitals the internes carried stomach tubes hanging about their necks instead of stethoscopes, the mortality rate would be reduced.

Summary

Fifty-five of the fractures were recent; nine were in the neck of the femur, and seven were cured. The two failures were owing, in one instance, undoubtedly to improper reduction, and in the other to the removal of the cast in three weeks and the patient's refusal of further treatment. Forty patients were observed to end results; thirty-five (87.5) had obtained entirely satisfactory results. Although I am not prepared to state, from such a small series of cases, whether open operation or conservative measures is the preferred treatment, I do not hesitate to operate on patients, providing conditions are satisfactory, if I am satisfied that the fragments are not in good position.

One hundred sixty-five of the fractures were old, or end results of fractures of the femur. It is difficult to judge the conditions under which the primary treatment was carried out, but it was undoubtedly quite inefficient in the greater number of cases. In the smaller number, union had been slow and the pull of the powerful muscles, or too early weight bearing had caused bowing. It is difficult to determine from the roentgenograms or from clinical examinations when union is complete in a case of malunion. On opening some of the fractures of this type, motion was easily demonstrated. In fifty patients, the causes of the disability were faulty end results following fractures of the neck of the femur. Five patients were not traced and six were not operated on by the open method; the remaining thirty-nine were operated on. Osteotomy for malunion was performed in two; the others were treated for non union, and twenty-eight (71.7 per cent.) were cured. In cases in which the neck was absorbed and union was attempted by using a bone peg, failures were uniform. A fair amount of neck must remain if there is to be any chance of union. The Brackett operation is the method of choice when the neck is destroyed.

One hundred fifteen patients with fractures of the shaft were treated and ninety-eight were traced. Sixty-nine were operated on and 76.7 per cent. were cured. Twenty-nine were treated by conservative measures, and twenty-seven (93.1 per cent.) obtained satisfactory results.

End Results in Fractures of the Femur, 222 Cases

57 Recent Fractures; 165 Old Fractures.

40 patients with recent fractures traced, 35 (87.5%) cured
10 fractures were of the neck, 8 were cured 7 fractures were of the upper third, 7 were cured 15 fractures were of the middle third, 15 were cured 5 fractures were of the lower third, 3 were cured 3 were separations of the epiphysis, 2 were cured
2 postoperative deaths, both due to pulmonary embolism
143 patients with old fractures were traced
50 fractures were of the neck 39 were operated on. 28 (71.1%) were cured 6 were manipulated and casts applied, 6 were cured 5 patients were not traced
115 fractures were of the shaft 69 were operated on, 53 (76.7%) were cured 29 were not operated on, 27 (93.1%) were cured 17 patients were not traced