THE FUNCTIONAL TREATMENT OF FRACTURES OF THE FEMUR*

D. S. C. PROCTER, M.B., CH.B. (CAPE TOWN), D.C.H., F.R.C.S. (ENG.)

*Formerly Consultant Surgeon to the Provincial Hospitals at Eshowe and Empangeni, Zululand, Natal***

It is surprising that from time to time sound basic theoretical principle is encountered which, through trepidation or respect, has not been implemented in practice. The result is that misinterpretations have been handed down through generations and still find their place in modern literature. If this is to be rectified where fractures are concerned, it is clear that the pathology of trauma must be subjected to the disciplines of physiology, rather than mere anatomy, and the aim be a functional repair, rather than a mere radiological one. It will be shown that if function is adequately restored, anatomical restitution inevitably follows.

Hence a simple method of treating fractures of the femur has been devised. It is based on the well-known principles of Charnley[1] and the practice of Perkins,[2] which has been modified considerably. The method recognizes economic considerations on behalf of both the patient and the institution, making it possible for most fractures to be treated almost anywhere.

The merits of conservative treatment are convincingly argued by Charnley,[1] and need not be enlarged upon.

PRINCIPLES

The aim of this method is to restore full function of the limb in every respect, without sequelae, in the shortest reasonable time. To achieve this the soft tissues as well as bone must be treated by active exercise and strong traction. It is a serious omission to treat only an X-ray appearance and, as alleged by Apley,[3] this occurs all too often. Proof of a successful treatment is frequently confined to the X-ray room.

Knee-stiffness

The most notorious complication of a fractured femur is the subsequent stiff knee which invariably prolongs the period of invalidism.

There are three causes of knee-stiffness following trauma: (1) patello-femoral adhesions, (2) fibrosis following post-traumatic capsular and periarticular oedema, and (3) adhesions between callus and muscle mass.

Active exercise from an early stage makes it impossible for these causes to operate, and is clearly the only rational preventive measure against knee-stiffness. That this is

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** Present address: Department of Surgery, University of Cape Town.

not a panic measure, as has been alleged, can be demonstrated logically by investigation of the effects of early active exercise on the fracture itself.

Callus Formation

It has been observed that a definite relationship exists between the appearance of firm callus and the disappearance of knee-stiffness.[1]

Moreover, it should be remembered that non-union of a fractured femur is almost unknown, and if and when it occurs it is always due to some obvious error, such as gross excess traction, or to infection or the presence of a foreign body. Recognition of this fact is probably the most valuable contribution of Watson-Jones[4] to the treatment of fractures of this bone. Most authors acknowledge this, but few have exploited the fact.

The femur is richly supplied with blood and, because of this, fractures heal so rapidly that it is almost impossible to stop union occurring. The cortical blood supply is derived mainly *via* the periosteum from the surrounding muscle attachments. The nutrient artery seems to play little or no part. This has been shown in rabbits by Greville and Janes,[5] who produced a fracture and ligated the nutrient artery with no ill effects on union. The presence of a rich potential subperiosteal network, derived obviously from muscle attachments, was shown experimentally by Zucman[6] while investigating muscle ischaemia. Moreover, this vascular potential has been found by Wray and Lynch[7] to be utilized fully for about 8 - 10 days following the fracture.

With disuse, this increased vascularity recedes rapidly. An active muscle with its necessarily good blood supply will in this way maintain a rich vascular pattern to the periosteum. Plentiful callus formation at the fracture site is dependent on this vascularity. The better the blood supply the more efficiently and earlier will healing occur. Hence, active exercise, far from delaying union, enhances it.

Movement of Fragments

The muscular attachments of the femur and humerus distinguish these bones functionally from the tibia, radius and ulna to their advantage. Besides providing blood supply for callus formation, these muscles themselves tend to act as live splints across the fractured ends. Their line of pull is along the line of the bone, almost completely surrounding it, thus protecting the site of the fracture. This point was emphasized by Perkins[2] who claimed that simple splintage only is necessary. Strong skeletal traction, opposed by tonic muscle, provides this splintage. This ensheathing effect of thigh muscles is described by Apley[3] as being of practical importance in minimizing movement of the fragments in relation to one another.

What movement does occur cannot, *sui generis*, prevent union. By the very nature of callus formation and bony union this is so. Provided there is no excessive distraction of bone ends, periosteal callus can cross the gap produced by the fracture regardless of movement of the fragments caused by controlled exercise.

Once this gap has been bridged and continuity re-established, changes in the callus immobilize the fractured ends. This is followed by replacement of this temporary and bulky callus with the ultimate lamellar or trabeculated bone. Charnley's[1] dictum cannot be stressed too strongly — that the fundamental error in delayed or non-union is the inability to start bridging the gap, and not the inability to maintain or augment the first strand of callus to get across. Charnley goes on to state that the rigidity of fixation is probably not as important as the abolition of the gap. Active contractions of the muscles appose the bone ends more strongly, enhancing early union by reducing the gap and adding stability to the fracture.

Strong Traction

It is not always appreciated that to delay union or cause non-union, the traction force has to be extremely great; great enough to overcome an actively functioning powerful muscle mass. Conversely, if this muscle mass is atonic and wasted from disuse during lengthy immobilization, excessive distraction can be achieved with greater ease.

Quadriceps drill alone, although an essential adjuvant to the treatment, is not sufficient to prevent wasting, which will occur in spite of this limited exercise. Wasting can be prevented effectively by the inducement of muscle tone by means of active contractions and by reflex inhibition of muscle tone produced by contraction of the muscle opponents. The fibres are moved through their full distance, while the force of traction is sufficient to balance muscle tone.

Alignment

It would be absurd to suppose that traction alone is adequate to maintain alignment, since other forces are present, e.g. gravity, which act in directions across the line of traction. These, however, are countered by the simple procedure of placing sand-bags and/or pillows in the appropriate places.

Overall alignment is maintained by these measures alone, and is assessed entirely clinically.

Any angulation can be detected readily by inspection, comparison with the opposite leg, and palpation. Similarly, shortening or excess traction can be assessed adequately and accurately in this simple manner. Should angulation occur, simple adjustments are made to the sand-bags or pillows or to the degree of abduction at the hip.

Since function is the guide, the line of upthrust in the erect ambulant posture is simulated in the horizontal by forces acting along identical lines. These are achieved by skeletal traction opposed by strong muscular tone.

The architecture of bone trabeculation in the callus will be directed by these lines of force according to Wolff's law.* Union is then at its maximum mechanical advantage, and is consolidated early.

To the uninitiated, failure of the bone ends to be maintained neatly and to be apposed directly is horrifying. Perkins,[2] on the other hand, pointed out that some overlap of bone ends is not serious.

While complete reduction and its maintenance is desirable and should always be aimed at, failure to attain this is of no importance provided due regard is given to alignment in sagittal and coronal planes, and shortening prevented by adequate traction. Charnley[1] even suggested that some overriding with shortening may be an inducement to union.

* All changes which may occur in the function of a bone are attended by definite alterations in its internal structure.

The early position of the fracture may be aesthetically unacceptable, but if it is functionally and clinically satisfactory, anatomical correction is ultimately inevitable. As already described, the gaps become filled in and the edges smoothed off in accordance with Wolff's law.

Thus it is far better to accept the unreduced fracture under these circumstances, than to resort to open operation which delays union.

PROCEDURE

The exercises are commenced within 24 hours of manipulation and insertion of the Steinmann's pin. They are carried out twice daily, with the patient lying on the special Eshowe fracture bed. This can be constructed by simple alterations to the standard hospital bed.

At the start, the exercises are very gentle, and only 2 genuflexions are carried out on each occasion. These must be active, with concentrated efforts to control the movement at all times. Assistance from an attendant will be necessary in the early stages. Some support for the heel will be required in addition to a controlling hand on the thigh. The Eshowe bed allows the patient to maintain most of this control himself, almost from the start. Later on, this assistance will no longer be necessary.

Care must be taken on every occasion to adjust sandbags and traction to maintain alignment immediately afterwards.

Initially the exercises may be somewhat painful, but the patient must be exhorted and cajoled, and if necessary bullied into cooperation. Analgesic and tranquillizing drugs in small doses are helpful for the first few days. The doctor in charge should supervise the exercises for the first week or more, and throughout should examine the patient and correct any malalignment, at least twice daily.

The weight of traction varies between 10 and 30 lb., depending on age and build, and frequently requires adjustment during the first 2 - 3 weeks. It is important that the Steinmann's pin be properly placed and the correct stirrup with a rotating cuff used.

It will be noted that simultaneous hip and knee flexion are not allowed to take place until firm clinical 'union' is established. When the thigh is flexed, there must be rigid extension of the knee. Between exercises the patient is instructed to concentrate on quadriceps drill.

With each successive day, more flexion should be achieved, and more vigorous effort used, and the exercise must be more prolonged. During this time it must be remembered that the rest of the body and the mind also require exercise.

Frequent X-rays are unnecessary. The patient is X-rayed on admission, and again at about the 12th week or when full weight-bearing is contemplated.

Fig. 1 (A - D) shows the results of treatment by this method after manipulation had failed. Fig. 2 (A - C) shows excellent results following a compound supracondylar fracture.

RESULTS

In this series 41 patients were treated. There were 17 females and 24 males. The ages of the patients varied from 14 to 85 years. Average ages were: males 35 - 40 years, and females 50 - 55 years. All were Zulu Africans.

Seven of the patients had multiple injuries, and 5 of the fractures were compound.

Two were pathological fractures — one from a secondary carcinomatous deposit, and the other from Albers-Schönberg disease.

The sites of the fractures were as follows: upper third 12, middle third 19, lower third 7, and supracondylar 3.

Complications

There were 2 cases of re-fracture, both of which were preventable. One was treated by the insertion of a Küntscher nail. The other, in which re-fracture was caused by premature full weight-bearing against advice, was treated by skin traction, interrupted twice daily by exercise. In this case, firm clinical union was re-established in just under 4 weeks, and full function had been regained by the sixth month after the initial injury.

Other complications noted were infection of the Steinmann's pin, also usually preventable, and occurring in as many as 15% of cases. This was always a late complica-

Fig. 1. A. Fracture of the left femur on admission 24 hours after injury
B. Result after 7 weeks' management following failed manipulation.
C. The patient after 3 months' treatment by active controlled exercises and traction. Note ability to flex left hip and knee.
D. The fracture 1 year after injury.

tion, and easily treated by removal of the pin. In no case did this interfere with the progress. Antibiotics were not used specifically.

In one patient there was increased lateral mobility of the knee joint after traction. This disappeared within 4 weeks, and also did not interfere with progress.

Delayed union occurred in only one patient — the patient who was treated operatively.

One patient died of pulmonary embolus and another died in congestive cardiac failure; both were aged 70.

None of the cases were complicated by appreciable shortening or other malunion, and no case of myositis ossificans or of fat embolus was recorded.

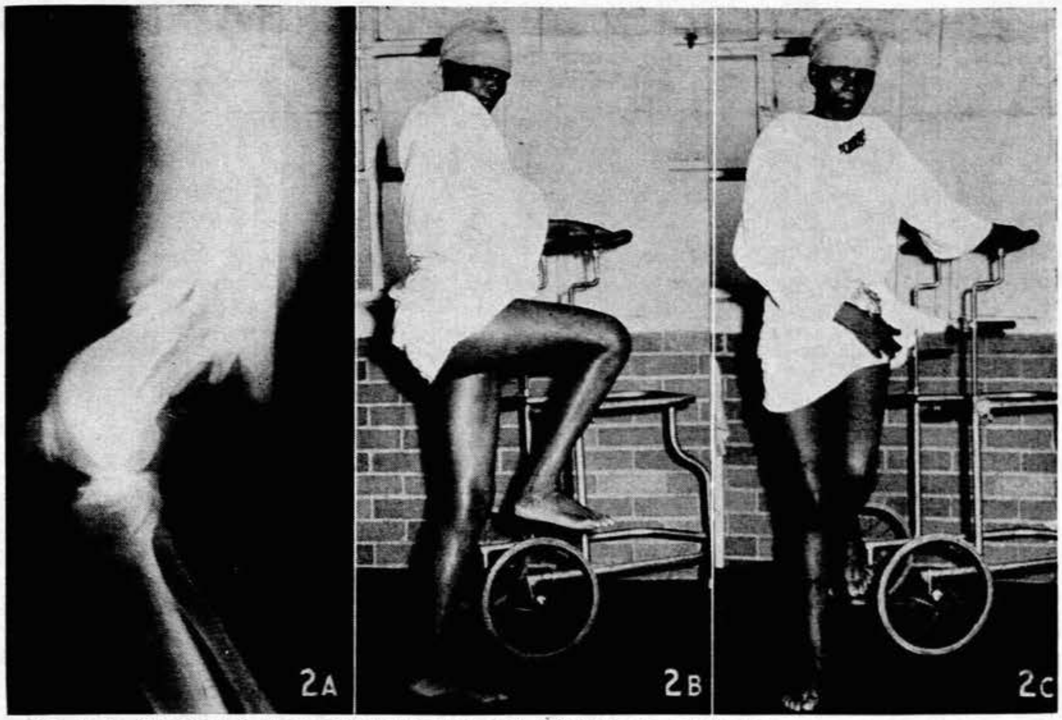

Fig. 2. A. Compound supracondylar fracture of right leg on admission.
B. The patient after 3 months, showing ability to flex right hip and knee.
C. The patient after 3 months, showing weight-bearing on right leg.

Statistics

Regarding the patient treated operatively as a complete failure, the results of survivors may be summarized as follows: 100% had full knee bend (90° - 100°) in 4 weeks (average 2 weeks); 100% had full knee bend and sound clinical 'union' in 10 weeks (average 6 weeks); 98% had recovered full function and were fit for their occupation, unless prevented by irrelevant factors, in 6 months (average 4 months). These figures are similar to those obtained by Apley,[8] using Perkins' methods, although the time intervals are much shorter in the present series.

Follow-up was varied and difficult to ensure. It can safely be assumed that any untoward sequel or mishap would certainly have been brought to our knowledge. Some patients were seen a year afterwards for record purposes.

CONCLUSION

While this method appears to be a definite advance, it is not now claimed to be the ultimate in the treatment of the fractured femur. If it has served only to stimulate further trial and enquiry, then it has been useful. This paper, therefore, would be incomplete without a final reference to Charnley's[1] masterpiece: 'When the fundamental nature of osseus union is eventually discovered, I venture to prophesy it will be found to be a process quite unrelated to the immobilization of the fragments, and it will also be a remarkably rapid phenomenon'.

SUMMARY

A simple functional method of treatment of fractures of the femur is described. Emphasis is laid on the fact that active controlled muscle exercise, and not rigid immobilization, is the key to early restoration of function. Bony union is enhanced and not prejudiced by this procedure. Malunion on clinical assessment has not yet been encountered.

Support for this method of treatment is found in basic physiological principles. The results obtained substantiate this and are claimed to be an improvement on any other form of treatment.

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