HINGED CAST AND ROLLER TRACTION FOR FRACTURED FEMUR

A SYSTEM OF TREATMENT FOR THE THIRD WORLD

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Hinged casts and roller traction were used in two developing countries to treat fractured femora, most of which were due to road traffic accidents or civil violence. This method of treatment, developed by Neufeld, is particularly useful in the Third World because it uses local materials, adapted in a hospital workshop, and circumvents the difficulties and complications of standard traction and of operative treatment.

The results are reported from 11 patients treated in Uganda in 1979 and from 110 treated in the Dominican Republic in 1981 and 1982. All but one fracture united without complication or significant shortening after a brief period in hospital. The method was easily taught to hospital staff and is strongly recommended.

The development of the Third World has led to greater use of road vehicles, especially motor cycles, and to more road accidents. Fractures of the femur resulting from these accidents absorb a disproportionate share of the limited medical resources available in what is usually a fragile economy. In some countries civil violence, in part a result of new political freedom, makes matters even worse.

The problem of the management of these fractures can be almost overwhelming, a fact which the well-equipped and well-supported Western surgeon may find difficult to comprehend. The standard methods of conservative and of operative treatment used every day in wealthier economies are not applicable when the simplest equipment, competent personnel and the time available for active treatment are all in short supply.

A feeling of despair and hopelessness in the face of numerous patients under these conditions may lead to inadequate care of traction apparatus and the acceptance of deformity. Pressure on hospital beds may enforce the hasty application of a hip spica to an unhealed fracture and, in the absence of supervision, malunion is likely. Or it may lead to undue emphasis on operation for intermediate nailing; these operations, often delayed for a number of reasons and carried out with inadequate instruments and an incomplete range of implants, have their own severe complications of infection, non-union, rotational deformity and knee stiffness.

What is needed is an effective method of treatment which can be used without delay, by relatively unskilled personnel, which needs minimal supervision and requires no costly or imported material.

The Neufeld system of a hinged cast and roller traction (Mays and Neufeld 1974; Neufeld and Hopson 1981) provides one answer. Snug casts from groin to knee, and knee to toes are connected by a simple hinged device, and traction is applied through a single rope via a roller on a beam above the bed. Adjustment is simple and the patient is able to move about in bed and to detach his traction to get up on crutches for increasing periods, usually within two weeks of injury.

This method of treatment encourages muscles and joint function while keeping the limb at full length and in good alignment. All the equipment needed, apart from one Steinmann pin, can be obtained or made locally at minimal cost. The method has been used successfully in the United States (Mays and Neufeld 1974; Lesin, Mooney and Ashby 1977; Montgomery and Mooney 1981) and cast-bracing has been in use for some years, with well-documented and accepted biomechanical principles (Yamagishi and Yoshimuru 1955; Procter 1962; Sarmiento 1967; Hardy and Baddeley 1979; Meggitt, Juett and Smith 1981; Wardlaw et al. 1981).

This paper gives an account of the problems encountered in the management of three series of fractures of the femoral shaft, one from Uganda and two from the Dominican Republic. It describes the Neufeld method of treatment and gives the results.

THE PROBLEMS

Conservative care. In developing countries, the use of routine skeletal traction is compromised by the lack of
The hardware required for cast-brace and roller traction. Figure 1—Equipment made locally. Figure 2—Neufeld’s manufactured set.

standard equipment and portable x-ray machines, and of trained nursing staff. Deformity may have to be accepted and valuable beds are blocked for months. In a tropical country the application of a spica cast is no solution. Plaster is scarce and of poor home-made quality, high humidity delays drying and makes skin care difficult, return to a village by lorry presents huge problems and the proper care of a cast in a dirt-floored home is well nigh impossible.

Operation. Third World operating theatres are associated with a high rate of infection. Instruments and the range of intramedullary rods are usually inadequate. Delay of two to four weeks for blood, operating time, anaesthesia, and support services or supplies are not unusual and partly negate the hospital time advantage of operation. If infection does follow, the problem is even more serious because of lack of laboratory facilities, antibiotics and proper nursing care. Knee stiffness and chronic sinuses are common. These hazards of operation are accepted because the results of the usual conservative treatment are even worse. The method now described avoids surgery, allows early mobilisation, prevents malunion and non-union and makes the patient comfortable.

MATERIALS AND METHODS

Materials (Figs 1 to 4)

An overhead beam of wood or metal: this is supported by uprights at the head and foot of the bed. It is aligned with the fractured limb, not the patient, and extends 30 cm beyond the foot of the bed.

A roller of wood or rubber, which runs on top of the

Figure 3—The sophisticated version of cast and roller traction. Figure 4—Using local materials in a Third World country. Note the strip of inner tube replacing the spring. The tibial pin is in place and its ends covered.
beam, is provided with a wide wire loop to carry the ropes below the beam. A wooden spool, made for thread or wire, can be adapted for this purpose.

Two hinges, made of heavy wire or a thin metal rod of 4 to 5 mm thickness; two 35 cm lengths for each side of the cast-brace are linked by eyes or loops, formed by pliers or in a mechanic's vice. After a straight 5 cm, each rod is formed into a flat zig-zag so that when hinged the zig-zags lie flat in the plane of the side of the casts (see Fig. 6).

Two heavy wires or thin rods, about 20 cm long, formed into waves; these are incorporated in the front of the cast sections to act as suspension loops.

A coiled spring or shock cord for the suspension rope; a section cut from the inner tube of a tyre, forming a giant elastic band, works well.

Also needed are one simple pulley, two wire hooks, suitable cord or rope and a 5 to 6 kg weight.

Method

On admission, a Steinmann pin is placed through the tibial tubercle and simple straight traction of 7 to 9 kg is applied. At a convenient time, from a few days to about a week after injury, depending on the condition of the patient and of any wound, the hinged cast is applied, usually with the patient in his bed.

The limb is supported by the Steinmann pin and a light below-knee cast is applied, with the foot at 90°. The plaster includes the pin, but is kept low at the back to allow flexion. The hip and knee are then both flexed to 90° with enough vertical traction by weights to lift the buttock from the bed (Fig. 5).

A snug thigh cast is applied with care to avoid varus or valgus bowing, and especially posterior angulation. The traction suspension helps to stretch the muscles and reduce the diameter of the thigh. A cotton-filled stockinet roll or strip of felt round the groin helps to form a tight padded upper rim. Careful moulding, with or without the use of a long curved shoehorn as a temporary splint, helps to obtain and hold a graceful anterior bow (see Fig. 5).

When these plasters have set, the hinges are applied with the limb under traction, in almost full extension, so that the valgus alignment can be seen to be correct. The hinges should articulate at the level of, and slightly behind, the femoral epicondyles and should be bent to conform to the shapes of casts and knee (Fig. 6). Suspension loop wires are applied to the front of both femoral and tibial casts and the traction bow is then removed.

The cast is suspended as shown in Figures 3, 4 and 7 with a weight of about 5 to 6 kg (12 lb) as traction. The foot of the bed is raised 15 cm. The patient is then able to move freely in bed (Fig. 8) and the cast has free circulation of air allowing it to dry rapidly even in a humid climate.

General movement and knee flexion are encouraged. The spring or rubber band permits active exercise.
A patient with bilateral femoral fractures under treatment by cast-brace and roller traction in the Dominican Republic. Note his mobility in bed.

of the knee, the hook in the lower plaster taking its weight. When the hook is close to the knee, it is easier to flex; when nearer the ankle, the knee will straighten. Once the patient can move easily and well, the leg is tested by slowly lifting the traction weight. When this procedure is painless, as is usual after 5 to 10 days, then a walker or crutches can be used (Neufeld and Hopson 1981).

After a walking session, the traction should be hooked up again. Clinical measurement of leg length in comparison with the opposite side may indicate adjustment of the weights, although 5.5 kg (12 lb) was almost always satisfactory. While the patient is walking, taking no weight, the weight of the cast provides traction. Walking sessions should be made longer each day until the patient can tolerate being off traction all day. This may take from three to four weeks, depending on the degree of comminution of the fracture. The thigh cast should then be tightened by removing a 2.5 cm strip anteriorly and squeezing it together (Fig. 9). A check radiograph may be helpful, but is not essential and may even be alarming (Figs 10 to 17). Very comminuted fractures

In Uganda, technicians were taught to apply, adjust and remove the cast-brace.

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without longitudinal stability may need extra attention and the clinical length of the femur should be rechecked.

The foot of the lower cast may optionally be removed before partial weight-bearing is allowed at about one month, though while the patient is on traction the limb is more comfortable with the foot in plaster since this avoids pressure from the lower edge of the cast. The Steinmann pin can also be removed just before discharge.

The patient is reviewed at about eight weeks after injury and is encouraged to take more weight on the injured limb. At 12 weeks, if the limb is mechanically sound, the cast may be removed for assessment of the fracture. If there was much initial comminution the period of non-weight-bearing may be increased and the cast may be left on for a few weeks longer. Mechanical soundness (Montgomery and Mooney 1981) is diagnosed when the patient is painfree and can walk well; it does not depend on the radiograph. Function and not film is the chief criterion of the stability of early union.

RESULTS

These are available for three groups of patients. The first group, not reported in detail, were 11 of 44 patients from Uganda in 1979, treated at Milago Hospital of Makarrerre University in a two-month period and not fully followed up because of renewed fighting (Gates 1979). Cast-braces were applied on average 22 days after injury, following a period of indecisive neglect in traction, and patients had an average of 48 days in hospital. All fractures united in satisfactory alignment by 12 weeks, although shortening (attributed to the delay between injury and bracing) was over 2.5 cm in nine patients, all patients were up and about on crutches when they were discharged. This is a fact of great significance for the patient, his family and his extended family. These patients, in very difficult conditions, are all likely to have satisfactory results and were very obviously better off than those patients treated by standard traction and spica or by operation.

The second and third groups were treated in the Dominican Republic at the Jose Maria Cabral y Baez Hospital. During two months of 1981, 44 patients with fractured femora were treated, most being male motorcyclists, aged from 17 to 76 years. Of these, 24 were treated by cast-brace and roller traction and 19 of these were followed-up. In 1982 when the method had been fully worked out, most femoral shaft fractures were treated in this way and 76 fractures in 75 patients are reported.

The detailed results from the latter two groups are given in Table I and show that the last group averaged only 26 days in hospital, and that posterior angulation was significant in only six of 76 femora, being improved by the introduction of the shoehorn technique reported above. Knee flexion was over 90° in 85%, stiffness being related to supracondylar and joint injury and to delay in starting movement. The longer time in hospital for the earlier group was largely due to delay in bracing caused by the use of a new method, the sheer volume of work and the number of patients with severe multiple injuries. All except one fracture in these groups had united sufficiently to allow cast removal at the first review after 12 weeks, and there were no refractures. In the latest group of 76 patients, shortening averaged 1.4 cm, being related to the degree of comminution and delay in applying brace and roller traction.

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<th>Table I. Results of 110 patients with 111 femoral fractures treated in the Dominican Republic by hinged casts and roller traction</th>
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<td>Posterior angulation 10-20</td>
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DISCUSSION

Fracture care aims to obtain union with as normal a limb as possible as quickly as possible with as little discomfort as possible. A hinged cast provides support for the fractured femur by converting the thigh into a semi-rigid hydraulic tube. An increase in fluid pressure is obtained by encasing the thigh within a rigid external support. Walking on a partly healed fracture is not destructive, but actually enhances fracture healing (Yamagishi and Yoshimuru 1955). Neufeld teaches that healing is proportionate to the amount of painless exercise. The leg suspended on roller traction acts as a pendulum. Low energy, early movement is allowed, with increasing loading as healing progresses. Function of the hip and knee joints and surrounding muscles is permitted. Walking should start as early as possible and should not cause pain. Traction is always replaced when the patient is in bed. The more comminution, the longer should be the period of traction (Lesin et al. 1977).

Montgomery and Mooney (1981) reported 32 fractures treated by the Neufeld system. Average time in hospital was 25 days, average time to union was 13 weeks,
median shortening was 1 cm, and there was no case with significant angulation. Montgomery and Mooney also give good practical hints on this method of treatment, emphasising that the cast be applied while traction is maintained on the fracture. They found that minimal adjustment of traction is necessary other than changes in the weight and in placement of the hooks.

Lesin et al. (1977) used the roller traction system with an adjustable thigh socket for 26 femoral fractures with excellent results and only one case of non-union. Average shortening was only 0.6 cm, only six knees had less than 90° of flexion and there were no refractures. Mooney et al. (1970) reported a prospective study of 153 patients treated by cast-bracing for an average of 14.5 weeks with no cases of non-union or malunion and no refractures. A control group treated by traditional traction and a hip spica showed three cases with non-union and three with re-fracture.

Hardy (1983) reports 163 patients treated with tibial traction for an average of 16 days and then in a cast-brace with complicated and expensive hinges. Extensive use was made of radiographs and wedging. The results were comparable to those from intramedullary nailing. In an earlier series Hardy, White and Williams (1979) reported 79 patients and related shortening to comminution and to the effect of either early or late application of the cast-brace. But their method was different from that which we report, since traction was stopped and weight-bearing allowed as soon as the cast-brace was applied and exercise in traction was not advised. In 1982 Hardy recommended, as we do, that the cast-brace be applied with the thigh adducted, and that skeletal traction and bed rest be reinstated if there is shortening. We continue roller traction in all cases and avoid early weight-bearing, which Hardy agrees may produce a varus deformity.

Wardlaw (1977) reported 98 fractures treated by six weeks of traction, followed by a cast-brace, a further two weeks in hospital and brace removal 15 weeks after injury. He felt that union was quicker with an earlier return to normality, and concluded that cast-bracing was a real advance in management. Connolly, Dehne and LaFollette (1973) reported 143 fractures treated by skeletal traction for about four weeks, followed by a cast-brace and walking with good results, and felt that the method was especially useful for distal, comminuted mid-shaft and open fractures. Transverse fractures of the middle and proximal thirds could be managed successfully in this way provided that alignment was closely watched. They considered that the greatest advantage of cast-brace application was its effect on the entire patient and not just on his fracture, especially when used for infected fractures and for open fractures.

The advantage of Neufeld's system can be considered under three headings. The first is the advantage of conservative treatment over operation—the avoidance of infection and surgical complications. The second is the advantage of roller traction over other methods of traction, especially in a developing country. Roller traction needs a minimum of imported equipment, and little or no supervision from nursing or medical staff to avoid angulation, rotation, pressure necrosis and shortening. Skilled physiotherapy and extensive radiography is unnecessary. A hospital stay of only one month is needed and the patient is comfortable and progressively independent.

The third advantage is that of the hinged cast over the spica cast. In developing countries, plaster is in short supply, is crude and difficult to use, and humidity may make drying difficult. The hinged cast is more comfortable, allows movement, the patient needs no special transport from hospital to home, and home care in a village is much easier. Shortening and angulation, even in the presence of comminution, are minimised by non-weight-bearing and continued intermittent traction for at least the first month. Rothwell (1982) reported up to 2 cm of shortening after closed intramedullary nailing for comminuted fractures; while Dencker (1965), reviewing 1033 fractures treated by various methods, included cases with shortening of up to 3 cm in the excellent group of his results.

One of the most satisfying gains from the use of this method has been the ease of management of the patients. The constant battle to maintain control of a fracture with nursing staff who do not understand the general principles is no longer needed. A technician can easily be taught to apply the traction, and once it is applied, the apparatus is simple and largely takes care of itself. It is an effective, manageable treatment that keeps the patient in hospital for only one month, and encourages knee movement. The results confute any argument that only operation can save time and avoid bad results. The very valuable human and material resources and operating time saved can be used to better advantage. All fractures of the middle and distal thirds of the femur can be treated by this method.

**Conclusion.** The use of the hinged cast and roller traction for fractures of the mid and distal femur is an ideal method of treatment in the countries of the Third World. It produces good results and is more economical than any other method in human and material resources and in time.
REFERENCES


