DISABILITY OF THE HINDFOOT AFTER FRACTURE OF THE TIBIAL SHAFT

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Hindfoot (subtalar) movement and disability after fracture of the tibial shaft have been studied. One hundred patients with soundly healed fractures of the tibial shaft treated by immobilisation in a long leg plaster cast were examined at least one year after the fracture had healed. Subtalar movement was accurately measured by a special technique and the patients were questioned specifically about any disability associated with their hindfoot. Subtalar movement was limited to some degree in 72 per cent of patients. Forty-three per cent of patients complained of symptoms related to their subtalar joint and 12 per cent found these symptoms troublesome.

Factors associated with restriction of hindfoot movement were: 1) age of patient; 2) site of fracture; 3) duration of immobilisation; 4) severity of trauma; 5) wound infection and non-union of fracture; and 6) prolonged ankle oedema after removal of the cast.

When a fracture of the tibial shaft heals soundly in good alignment it is thought to cause little subsequent disability. Ellis (1958), in a study of disability in soundly healed tibial shaft fractures, found that 86 per cent of patients had excellent functional results, but that 6 per cent had limitation of ankle movement or foot movement or both. He did not specifically refer to subtalar or hindfoot movement.

The purpose of this study was to investigate subtalar or hindfoot movement, and any hindfoot disability resulting from fracture of the tibial shaft. Because subtalar movement is difficult to measure accurately by any of the means usually available in the out-patient department a special technique was used.

TECHNIQUE OF MEASURING HINDFOOT (SUBTALAR) MOVEMENT

The American Academy of Orthopaedic Surgeons (1965) in their handbook *Joint Motion: Method of Measuring and Recording*, recommended the following technique for measuring movement at what they describe as the "hindpart of the foot (the subtalar joint)". "Zero starting: The heel is aligned with the midline of the tibia. Inversion: Heel is grasped firmly in the cup of the examiner's hand. Passive motion is estimated in degrees, or percentages of motion, by turning the heel inward. Eversion: This motion is estimated by turning the heel outward." The average range of eversion and inversion are each reported as being 5 degrees. The position of the ankle was not specified during these movements.

Manter (1941) and Hicks (1953) have shown that the axis of the subtalar joint passes upwards and medially through the neck of the talus at an angle of 16 degrees to the longitudinal axis of the foot and 42 degrees to the vertical. Therefore any true measurement of movement

occurring at the subtalar joint should be estimated about this axis. The movements described above do not take place about this axis and are a combination of movements occurring at the hindfoot, some possibly from slight tilting of the talus in the ankle mortise, but mostly at the subtalar joint. Since the movement is not about the true axis it does not represent the true range.

The amount of tilting of the talus in the ankle mortise is usually small and of minor importance, but varies with the position of the ankle joint. Talar tilting is least when the foot is extended to the neutral position when the broader anterior part of the talus is locked into the ankle mortise.

This combination of movements described as movement of the "hindpart of the foot (the subtalar joint)"—henceforth in this paper simply referred to as hindfoot movement—is an important functional movement because it is at these joints that the foot adapts itself to walking over uneven ground.

For the purpose of this investigation the following special technique was used to measure hindfoot movement as accurately as possible.

The patient was placed supine with his foot and lower leg on a large drawing board. The foot was placed in the neutral position between supination and pronation and the ankle midway between extension and flexion. A specially constructed pointer was then fixed to the middle of the heel with adhesive strapping, with the axis of the pointer in line with the longitudinal axis of the tibia (Fig. 1). From this position the movements of inversion and eversion were performed by the method described above. At the extremes of both inversion and eversion, marks were made by an assistant in the line of the pointer (Figs. 2 and 3). After the foot had been removed from the drawing board these marks were joined by means of a ruler and projected back until the two lines

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FIG. 1

FIG. 2

FIG. 3

FIG. 4

Method of measuring hindfoot movement. Pointer is fixed to the middle of the heel with the axis of the pointer in line with the longitudinal axis of the tibia. Figure 1—Neutral. Figure 2—Inversion. Figure 3—Eversion. Figure 4—Marks indicating maximum hindfoot inversion, eversion and the neutral position are connected and projected back. Degree of inversion and eversion is measured. Inversion 20 degrees; eversion 5 degrees.

crossed (Fig. 4). The angle contained between these two lines was a measurement of the full range of hindfoot movement.

The degree of inversion and eversion could also be estimated by marking the original starting place of the pointer.

CLINICAL MATERIAL

One hundred patients with soundly healed fractures of the tibial shaft were personally examined at a special clinic eighteen months to six years after the initial injury. The average follow-up was three years and four months. All patients were over twenty years of age. The fractured tibia was unilateral so that the normal and affected sides could be compared.

Treatment following reduction was by means of a long leg plaster. No patient had been treated by internal fixation or by skeletal traction. Thirty-two patients had compound injuries of varying severity which were treated by wound excision and primary closure. Three of these patients developed superficial wound infections all of which responded to antibiotic therapy. Fifteen patients developed non-union and required bone grafting but without internal fixation. All then healed satisfactorily.

METHOD OF ASSESSMENT

The patients were questioned specifically about any disability associated with the hindfoot.

Radiographs of the original injury were reviewed and the findings at operation for compound fractures noted in an attempt to grade the severity of the injury. A fracture of major severity was one in which there was severe comminution at the fracture site with or without an open wound. A fracture of minor severity was one in which there was either no comminution or only slight comminution at the fracture site. Any compounding of the fracture was small and usually occurred from within.

Thickening of the soft tissues beneath the medial and lateral malleoli was measured by means of a caliper placed 2 centimetres below the lateral malleolus and spanning the heel. This measurement was repeated on the uninjured limb.

Hindfoot movements of both the injured and normal limbs were measured by the technique described earlier.

Radiographs were taken to show the subtalar joint.

CLINICAL FINDINGS

Symptoms—Forty-three per cent of patients complained of difficulty in walking over uneven ground but only 12 per cent found the symptoms sufficiently troublesome to interfere with recreational activities or work. Many patients said that these symptoms had only become apparent after they had been discharged and had returned to work or had become more active. Some complained of a feeling of stiffness or instability and others of discomfort or actual pain located around the lateral malleolus

or just anterior to it. Two patients with severe symptoms had to give up their original jobs which necessitated standing on an uneven surface.

Hindfoot (subtalar) movement—The range of movement at the hindfoot of the injured limb was expressed as a fraction of the range of movement at the hindfoot of the opposite leg which was taken as normal for that patient.

Normal range—In twenty-eight patients the range of movement was equal on both sides.

FIG. 5

A histogram showing the numbers of patients with varying degrees of hindfoot stiffness and the numbers complaining of either mild or troublesome symptoms.

Mild limitation—In twenty-seven patients the range was at least two-thirds that of the normal side.

Moderate limitation—In nineteen patients the range was between one-third and two-thirds of the normal side.

Severe limitation—In twenty-six patients the range was less than one-third of the normal side. Eight patients were found to have a completely rigid hindfoot.

The number of patients with varying degrees of stiffness or limitation of hindfoot movement are shown in Figure 5, along with the number of patients complain-

ing of either mild or troublesome symptoms in each group.

Patients with severe limitation of hindfoot movement had the most symptoms. Five of the eight patients in this group with a clinically rigid hindfoot had no complaints and it was the remaining patients in the group who had only a jog of movement and were symptomatic.

The average range of motion at the hindfoot of the 100 normal limbs combining both inversion and eversion was 30 degrees. The average range of eversion to the nearest degree was 5 degrees and of inversion was 25 degrees.

The American Academy of Orthopaedic Surgeons in their handbook on Joint Motion (1965) estimated the range of inversion to be 5 degrees. It is difficult to understand so wide a disparity in the measurement of a movement which was performed identically in each case.

Persistent submalleolar thickening—Submalleolar thickening greater than half a centimetre as compared with the same measurement of diameter on the opposite side was taken as abnormal. Thickening of the soft tissues beneath the malleoli occurred in fifty-six of the 100 patients. In nineteen of the patients hindfoot stiffness was severe; in sixteen it was moderate and in sixteen mild. Five patients with a full range of hindfoot movement had borderline submalleolar thickening.

Radiographs of subtalar joint—Radiographs showed no evidence of damage to the subtalar joint.

FACTORS INFLUENCING HINDFOOT (SUBTALAR) MOBILITY

Factors which were thought to be possible contributing causes to limitation of hindfoot movement after a tibial shaft fracture are shown in Table I. There seemed to be

TABLE I
POSSIBLE FACTORS INFLUENCING HINDFOOT (SUBTALAR) MOVEMENT AFTER TIBIAL SHAFT FRACTURE

		Limitation of hindfoot (subtalar) movement							
		Severe (26 patients)		Moderate (19 patients)		Mild (27 patients)		Normal (28 patients)	
Age at time of fracture (<i>average in years</i>)		43.7		46.3		35.0		24.0	
Sex		Male 22	Female 4	Male 9	Female 10	Male 16	Female 11	Male 25	Female 3
Duration of immobilisation (<i>average in weeks</i>)		24.5		21.8		21.8		15.4	
		Number of patients	Per cent	Number of patients	Per cent	Number of patients	Per cent	Number of patients	Per cent
Severity of initial injury	Minor	16	61.5	13	68.4	24	88.8	23	82.2
	Major	10	38.5	6	31.6	3	11.2	5	17.8
Site of tibial fracture	Upper third	1	3.8	1	5.3	2	7.5	4	14.3
	Middle third	7	26.9	5	26.3	19	59.2	14	50.0
	Lower third	18	69.3	13	68.4	9	33.3	10	35.7
Ankle swelling after immobilisation (>4 weeks)		10	38.4	13	68.4	14	51.8	0	0
Complications	Non-union	6	23.0	2	10.5	3	11.1	2	7.1
	Infection	2	7.6	1	5.2	0	0	0	0

six significant factors. 1) Age at the time of fracture. The older the patient, the more likely he was to develop hindfoot stiffness. 2) Fractures occurring in the lower third of the tibial shaft were more prone to cause stiffness. 3) Although prolonged immobilisation tended to cause increasing stiffness of the hindfoot, this was not always true; the younger patients could withstand much longer periods of immobilisation than could the older ones. 4) The more severe the initial trauma the greater the tendency to hindfoot stiffness. It was difficult to differentiate between the parts played by the severity of the trauma and by prolonged immobilisation because both of these factors were directly related due to the delayed healing associated with severe trauma. 5) Complications such as wound infection or non-union of the fracture promoted stiffness. 6) Prolonged ankle oedema after removal of the plaster was of prognostic significance.

DISCUSSION

In this study forty-three of the 100 patients with healed tibial shaft fractures were found to have symptoms which appeared to originate in the hindfoot and seventy-two patients had some limitation of hindfoot movement. Although this incidence of persistent functional disability might be thought to be surprisingly high, the majority of patients with symptoms were not unduly troubled by them.

The normal range of hindfoot movement, although small, is of the greatest importance in adapting the foot

to uneven ground, and any small restriction of this movement may cause a disproportionately large loss of function. This explains the number of patients with a limitation of hindfoot movement who were symptomatic. Radiographs showed no evidence of damage to the subtalar joint and it therefore has to be assumed that limitation of hindfoot movement was caused by changes in intra- or extra-articular soft-tissue structures or both rather than by damage to the joint itself.

Severe trauma producing compound fractures with or without severe comminution with much soft-tissue damage or wound infection will give rise to severe oedema of the neighbouring soft tissues. Because of the effect of gravity, and especially in fractures of the lower third of the tibial shaft, the oedema tends to accumulate around the ankle and hindfoot. The oedema will persist in the older patient who is not active in his cast. If immobilisation is prolonged because of either delayed union or non-union of the fracture, the oedema will stagnate and give rise to fibroblastic reaction in the soft tissues of the submalleolar region, so restricting hindfoot movement. In addition, those patients who, after removal of the cast, develop prolonged ankle oedema, may also develop a similar reaction.

This hypothesis is supported by the fact that of the seventy-two patients with some limitation of hindfoot movement fifty-six patients (77 per cent) also had a measurable degree of thickening of the submalleolar soft tissues when compared with the normal side.

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