INSTABILITY OF THE FOOT AFTER INJURIES TO THE LATERAL LIGAMENT OF THE ANKLE

M. A. R. FREEMAN, LONDON, ENGLAND

From the Middlesex Hospital, London

The tendency for the foot to " give way " (a complaint here referred to as functional instability) after an ankle sprain has been attributed to a number of pathological processes, among which the most widely accepted are varus instability of the talus in the ankle mortise (Nilsonne 1932, Elmslie 1934, Watson-Jones 1955, Dziob 1956, Wiles 1959, Perkins 1961) and adhesion formation at the subtalar joint (McMurray 1934, Lake 1952, Watson-Jones 1955, Perkins 1961).

Other pathological processes to which functional instability of the foot has been attributed include antero-posterior instability of the talus in the ankle mortise (Anderson, LeCocq and LeCocq 1952), instability at the subtalar joint (Bosien, Staples and Russell 1955; Perkins 1961), inferior tibio-fibular diastasis (Mullins and Sallis 1958), peroneal muscle weakness (Bonnin 1950, Bosien *et al.* 1955) and a " weak spot " in the ligament (Thorndike 1959). The evidence that these pathological processes are etiological is slender, and it is accepted by some surgeons that there is a group of patients who, following a sprain, develop a foot which tends to " give way," but in which no abnormality is detectable on examination (Wiles 1959).

The attribution of the symptom of functional instability to these pathological processes has usually been based upon the detection of abnormal physical signs in patients presenting with the established disability. The demonstration of such associations, however, does not show which is cause and which is effect. It is possible for instance that the repeated sprains suffered by a patient with a functionally unstable foot finally lead to substantial varus instability of the talus rather than that the mechanical instability initiates the tendency for the foot to give way.

In this study a group of previously asymptomatic patients presenting with a recent ankle sprain have been followed for one year and the physical and radiological findings upon the completion of treatment have been correlated with the symptom of functional instability of the foot one year later.

MATERIAL

Forty-two patients presenting with a rupture of the lateral ligament and twenty patients presenting with a simple sprain were included in the study (Tables I to IV). These sixty-two patients had previously had an asymptomatic uninjured ankle and were selected from among a larger group of patients with ankle injuries on the ground that clinically and radiologically the injury was confined to the lateral ligament. Two patients (Cases 78 and 103) were exceptions: they had in addition a small transchondral fracture of the dome of the talus.

Thus, the pathology of the injuries was known and, since the patients were previously asymptomatic, their later disability could certainly be attributed to the injury described in this study.

All but three patients were fit young adult male soldiers. The exceptions were two children (Cases 71 and 84) and one woman (Case 98).

METHODS

Stress radiographs were performed under general anaesthesia or with regional analgesia by common peroneal nerve block. Ruptures were diagnosed if the talar tilt on the injured side exceeded that on the uninjured side by 6 or more degrees (Freeman 1964).

Every simple sprain was treated by strapping with Elastoplast, by mobilisation, and by a course of physiotherapy aimed at maintaining normal muscle power and a full range of movement.

Patients with ruptures were randomly selected for one of three forms of treatment: twelve were treated by strapping and mobilisation, sixteen by immobilisation in plaster for six weeks, and fourteen by suture of the ligament followed by immobilisation. Every patient was treated in a physiotherapy department (either immediately after injury in the case of patients treated by mobilisation or after removal of the plaster in the remainder) to regain a normal range of movement and normal muscle power.

TABLE I

THE OUTCOME OF TREATMENT IN TWELVE PATIENTS WITH A RUPTURE OF THE
LATERAL LIGAMENT OF THE ANKLE TREATED BY STRAPPING AND MOBILISATION

| Case number | Degrees of talar tilt shown on stress radiographs | | | Functional instability one year after injury |
| | Injured ankle | | Uninjured ankle | |
	Before treatment	After treatment		
44	7	0	0	Absent
77*	10	0	—	Absent
58	11	0	0	Present
47	12	0	0	Present
57	13	4	0	Absent
37	15	—	0	Present
61	20	3	1	Absent
60	6	0	0	Absent
53	16	10	9	Absent
38	10	7	0	Present
45	15	10	2	Present
46	27	9	5	Absent

* Diagnosis confirmed arthrographically.

On completion of treatment, patients were followed clinically, if possible, until they were symptom-free. During this time every patient except one (Case 37) with a rupture of the ligament had a second stress radiograph performed to determine the final mechanical stability of the ankle.

One year after injury every patient completed a postal questionnaire concerning the symptomatic state of his ankle at that time.

RESULTS

Final varus mechanical instability of the talus—In fourteen patients the injured ankle was mechanically more unstable at the completion of treatment than was the uninjured ankle. Six of these patients (Cases 38, 40, 45, 62, 82 and 101) complained of functional instability one year after injury; the remainder (Cases 46, 53, 57, 61, 70, 75, 83 and 84) were symptomless (Tables I to V). Since twenty-four patients (out of a total of sixty-two) complained of functional instability one year after injury, there was thus no statistically significant association between a persistent varus tilt of the talus and late functional instability. Furthermore, 1) the incidence

of functional instability among patients who had suffered simple sprains (35 per cent) was very similar to that amongst patients who had suffered ruptures (40 per cent), and 2) no ankle was finally as unstable mechanically as are some asymptomatic ankles with congenitally lax ligaments. (An example of such an ankle is the uninjured ankle in Case 52.)

Nevertheless, the four ankles which finally displayed 6 or more degrees of talar tilt in excess of that on the uninjured side (that is, those for which a diagnosis of a chronic rupture might have been made after the completion of treatment) were all functionally unstable (Table V). Thus, in spite of the absence of an overall significant association between mechanical and functional instability, it is hard to resist the conclusion that in these four ankles at least,

TABLE II

THE OUTCOME OF TREATMENT IN SIXTEEN PATIENTS WITH A RUPTURE OF THE LATERAL LIGAMENT OF THE ANKLE TREATED BY IMMOBILISATION FOR SIX WEEKS

| Case number | Degrees of talar tilt shown on stress radiographs | | | Functional instability one year after injury |
| | Injured ankle | | Uninjured ankle | |
	Before treatment	After treatment		
71	16	0*	10	Absent
74	15	4	4	Absent
84	15	8	4	Absent
83	18	5	4	Absent
70	15	2	0	Absent
82	25	3	0	Present
72	31	4	5	Present
78	52	0	0	Absent
73	13	0	0	Present
40	14	6	0	Present
75	15	3	0	Absent
65	10	0	0	Absent
63	15	0	0	Present
66	15	0	0	Absent
64	17	0	0	Present
62	15	8	0	Present

* This may have been a technically faulty radiograph.

persistent varus instability of the talus played some part in the etiology of the final functional instability of the foot.

Antero-posterior instability of the talus—Antero-posterior instability of the talus was sought at the time of injury by performing antero-pulsion stress radiographs. No example of this instability was found in the absence of a varus tilt. Initially an antero-pulsion stress radiograph was performed on every patient after injury, but to reduce the irradiation of the examiner this radiograph was not performed towards the end of the study, save when the final inversion stress radiographs revealed a varus tilt. A total of thirty-two ankles were examined with antero-pulsion stress radiographs upon the completion of treatment. In none of these patients was anterior subluxation of the talus demonstrated. In none of the remaining patients was

anterior subluxation demonstrated clinically after treatment (and none of these patients displayed a varus tilt).

Antero-posterior instability of the talus was not, therefore, associated with late functional instability of the foot.

Adhesion formation—Adhesion formation was diagnosed if ankle or subtalar motion was finally limited. Most patients displayed limited ankle and subtalar motion immediately after injury. In patients treated by mobilisation the range steadily increased and was usually almost full by the third week after injury. It was invariably full by the time of discharge. Among patients treated by immobilisation with and without surgery the range of ankle and

TABLE III

The Outcome of Treatment in Fourteen Patients with a Rupture of the Lateral Ligament of the Ankle Treated by Suture of the Ligament Followed by Immobilisation for Six Weeks

Case number	Degrees of talar tilt shown in stress radiographs			Functional instability one year after injury
	Injured ankle		Uninjured ankle	
	Before treatment	After treatment		
102	15	7	8	Present
101	17	9	6	Present
106	12	0	0	Absent
89	14	0	0	Present
88	15	0	0	Present
94	15	0	0	Absent
96	16	0	0	Absent
98	16	0	0	Present
100	20	0	0	Present
104	25	4	4	Absent
105	22	0	0	Absent
103	30	0	0	Present
99	30	0	0	Present
97	45	0	0	Present

subtalar motion was always limited on removal of the plaster. Over the following weeks patients treated by immobilisation alone all regained a full range of movement with physiotherapy. Among those patients whose ligament was sutured before immobilisation four patients (Cases 96, 97, 99 and 100) failed to regain a full range of inversion: two of these patients failed in addition to regain a full range of dorsiflexion, two of plantar-flexion and one of eversion. One of these four patients became symptom-free, one developed functional instability (together with pain and swelling) and two developed pain and swelling only.

Thus only operative treatment led to adhesion formation, and adhesion formation was not associated with functional instability save in one patient.

Instability at the subtalar joint—No patient in any group was found clinically, or under anaesthesia, to have an increased range of subtalar motion after injury.

Calf muscle weakness—No patient had detectable calf muscle weakness at the time of discharge, and by this time every patient had received a course of physiotherapy which had been continued until the strength of the calf muscles showed no further improvement.

Tibio-fibular diastasis—No patient included in this study was tender over the inferior tibio-fibular joint at the time of injury. Every patient was examined radiologically and in no case was the ankle mortise found to be broadened.

TABLE IV

The Outcome of Treatment in Twenty Patients with a Simple Sprain of the Lateral Ligament of the Ankle Treated by Strapping and Mobilisation

| Case number | Degrees of talar tilt shown on stress radiographs | | | Functional instability one year after injury |
| | Injured ankle | | Uninjured ankle | |
	Before treatment	After treatment		
4	0	—	0	Absent
6	0	—	0	Absent
7	0	—	0	Absent
10	0	—	0	Absent
11	0	—	0	Present
13	0	—	0	Absent
17	0	—	0	Present
19	0	—	0	Present
24	0	—	0	Present
27	0	—	0	Absent
31	0	—	0	Present
33	0	—	0	Absent
52	16	—	13	Present
22	0	—	0	Present
3	2	—	2	Present
9	0	—	—	Absent
21	0	—	0	Absent
30	0	—	—	Absent
5	0	—	—	Present
25	0	—	0	Absent

A " weak spot " in the ligament—This term is poorly defined but has sometimes been used to describe the presumed pathology in patients found to have a tender lateral ligament and pain on full forced inversion of the foot.

Among the patients described in this study the last abnormal physical sign to disappear as healing progressed was tenderness over the lateral ligament and pain on full forced inversion and plantar-flexion of the foot. Tenderness over the lateral ligament in patients treated by suture of the ligament was hard to evaluate since it had a particular " needle-like " quality and appeared to be due to stainless steel suture wire impinging on the deep surface of the skin:

in one patient it was cured by removing the wire. Among the forty-eight injuries untreated by surgery eighteen patients were discharged whilst still tender over the lateral ligament after an average follow-up of thirteen weeks; the remainder were discharged sign-free in this respect after an average follow-up of fifteen weeks. The distribution of complaints one year after injury in these two groups is set out in Table VI.

TABLE V

THE SYMPTOMATIC STATE ONE YEAR AFTER INJURY
IN FOURTEEN PATIENTS WHOSE INJURED ANKLE WAS
MECHANICALLY UNSTABLE (AS COMPARED WITH THE
UNINJURED ANKLE) UPON THE COMPLETION OF TREATMENT

Patients with no complaint	
Case number	Final relative talar tilt (degrees)
53	1
83	1
61	2
70	2
75	3
46	4
57	4
84	4
	Mean 2·5

Patients complaining of functional instability of the foot	
Case number	Final relative talar tilt (degrees)
82	3
101	3
40	6
38	7
45	8
62	8
	Mean 6

Note: Since the talar tilt angle cannot be measured satisfactorily to within ±2 degrees, differences of up to 4 degrees have little significance.

There was no association between functional instability of the foot and tenderness over the lateral ligament at the time of discharge: indeed functional instability was slightly less frequent among those patients who displayed local tenderness or pain.

DISCUSSION

This study has been based only upon patients with previously uninjured asymptomatic ankles who (with two exceptions) suffered pure lateral ligament injuries. Simple sprains were

distinguished from ruptures by stress radiography. Thus the late disability could confidently be attributed to the injury which brought the patient into the study and the nature of this injury was known exactly. Patients included in the study were not selected in any other way and the features of the injury were all recorded before the existence of late functional instability was established. These points enhance the validity of the somewhat controversial conclusion which may be drawn from this investigation.

The incidence of functional instability recorded in this study (39 per cent) might be thought to be surprisingly high. However, the great majority of the patients who noted this complaint were not incapacitated by it, and often the presence of the complaint would not have come to a physician's attention had it not been directly sought. Almost all the patients were fit young soldiers whose leisure activities included sport and their attention was therefore drawn to minor degrees of instability which would have passed unnoticed in a sedentary life. Thus the incidence of functional instability recorded in this study was probably maximal; it was, in any event, little greater than the incidence recorded elsewhere (Bosien et al. 1955, Freeman 1964). In this study no patient was found at the time of discharge to display antero-posterior instability of the talus, an inferior tibio-fibular diastasis, or calf muscle weakness. Therefore,

TABLE VI

THE INCIDENCE OF FUNCTIONAL INSTABILITY OF THE FOOT ONE YEAR AFTER INJURY IN FORTY-EIGHT PATIENTS WITH AND WITHOUT THE FINDINGS OF TENDERNESS OVER THE LATERAL LIGAMENT OF THE ANKLE AND PAIN ON FULL FORCED INVERSION AND PLANTAR-FLEXION OF THE FOOT AT THE TIME OF DISCHARGE FROM CLINICAL FOLLOW-UP

Functional instability one year after injury	Tenderness over the lateral ligament and pain on forced inversion of the foot	
	Present	Absent
Present	7	10
Absent	11	20

in no case could late functional instability be attributed to these pathological processes. Neither could a " weak spot " in the ligament have accounted for this disability since there was no significant association between local tenderness at the time of discharge and subsequent functional instability.

Mechanical instability of the ankle (to inversion stress) may have accounted for functional instability in six patients (Table V). In the remainder, either 1) the ankle was stable upon the completion of treatment, or 2) in the case of patients with simple sprains the ankle had never been unstable in the first place, or 3) the patient was symptom-free although the ankle finally displayed slight mechanical instability. Even in those six patients for whom the possibility arose, the tendency for the foot to " give way " could not confidently be attributed to mechanical instability since: 1) among these patients no ankle was as unstable as are some congenitally unstable but symptomless ankles, 2) these six ankles were not markedly more unstable than the eight symptomless unstable ankles, and 3) there was no statistically significant overall association between functional instability and a varus tilt of the talus after treatment.

On the other hand, four of the six patients with both functionally and mechanically unstable ankles finally displayed 6 or more degrees of relative talar tilt, whereas the maximum relative talar tilt amongst functionally stable ankles was 4 degrees. These four ankles might be regarded as having finally had a chronic rupture of the lateral ligament and it is tempting to suggest that in these patients, if in no other, mechanical instability contributed to the ankle's tendency to " give way."

Thus, the findings in this study suggest that mechanical instability of the ankle can only rarely be the initial cause of the symptom of functional instability of the foot. It is possible, however, that the repeated sprains caused by a tendency for the foot to " give way " finally produce a mechanically unstable ankle, and that this sequence accounts for the well known association between mechanical instability of the ankle and functional instability of the foot.

In those patients who complain that their foot tends to " give way," but in whom stress radiography reveals that the ankle is stable, some pathological process other than mechanical instability is obviously at work. Since these patients may display limited subtalar or ankle motion, and since it has been shown that the ability to stabilise the body weight in the coronal plane when standing on one foot depends upon normal (or perhaps near normal) subtalar motion (Hicks 1961), it has been suggested that these patients' disability is caused by the development of subtalar adhesions (Perkins 1961).

All save four of the ankles reported in this study displayed a full range of movement at the time of the patient's discharge from clinical follow-up. A diagnosis of adhesion formation cannot be sustained in the presence of a full range of movement so that only in these four ankles could the persistence of adhesions after injury have initiated the late functional instability. In fact, only one of these patients complained that his ankle tended to " give way " (one was symptom-free and two complained of pain and sometimes of swelling). Thus, only in one patient could adhesions have caused functional instability.

It is therefore unlikely that adhesions often initiate the symptom of functional instability of the foot. On the other hand, it seems quite possible that repeated sprains cause adhesions, and that this accounts for the association of the symptom of functional instability with adhesion formation.

Therefore, in this study, the development of a tendency for the foot to give way after a lateral ligament injury could be attributed to mechanical instability of the talus in the ankle mortise in four (or possibly six) patients, and to adhesion formation in one patient. In the remaining seventeen patients who finally noted this complaint no abnormality was detectable at the time of discharge with which late functional instability could be correlated. Presumably in these patients some at present unknown pathological process was at work. The nature of this process will form the subject of a further communication (Freeman, Dean and Hanham 1965).

Although this study suggests that functional instability is not initiated by mechanical instability or by adhesion formation, it remains perfectly possible that both these pathological processes, should they develop, themselves contribute to the tendency for the foot to " give way." Hence treatment by tenodesis or manipulation respectively is reasonable and can be expected to ameliorate, but not necessarily to cure, functional instability.

SUMMARY

1. Forty-two previously asymptomatic patients presenting with a recent rupture of the lateral ligament of the ankle, and twenty similar patients with a simple sprain of this ligament, have been followed for one year. The physical and radiological findings upon the completion of treatment have been related to functional instability of the foot one year later.

2. Persistent mechanical varus instability of the talus in the ankle mortise was a possible cause of functional instability one year after injury in four (or perhaps six) patients.

3. Adhesion formation was a possible cause of functional instability in one patient.

4. Seventeen patients finally displayed no clinical or radiological abnormality after injury, but noted functional instability of the foot one year later.

5. It is concluded that the pathological process which is usually responsible for functional instability of the foot after a lateral ligament injury is at present unknown.

REFERENCES

ANDERSON, K. J., LeCocq, J. F., and LeCocq, E. A. (1952): Recurrent Anterior Subluxation of the Ankle Joint. *Journal of Bone and Joint Surgery*, **34**–A, 853.

BONNIN, J. G. (1950): *Injuries to the Ankle*, p. 104.   London: William Heinemann Medical Books Ltd.

BOSIEN, W. R., STAPLES, O. S., and RUSSELL, S. W. (1955): Residual Disability Following Acute Ankle Sprains. *Journal of Bone and Joint Surgery*, **37**–A, 1237.

DZIOB, J. M. (1956): Ligamentous Injuries about the Ankle Joint. *American Journal of Surgery*, **91**, 692.

ELMSLIE, R. C. (1934): Recurrent Subluxation of the Ankle-Joint. *Annals of Surgery*, **100**, 364.

FREEMAN, M. A. R. (1964): Ligamentous Injury: a Study of Injuries to the Lateral Ligament of the Ankle. *M.D. Thesis Cambridge University*.

FREEMAN, M. A. R., DEAN, M. R. E., and HANHAM, I. W. F. (1965): The Etiology and Prevention of Functional Instability of the Foot. *Journal of Bone and Joint Surgery*, **47**-B, 678.

HICKS, J. H. (1961): The Three Weight-bearing Mechanisms of the Foot. In *Biomechanical Studies of the Musculo-skeletal System*, p. 172. Editor: F. Gaynor Evans. Springfield, Illinois: Charles C. Thomas.

LAKE, N. C. (1952): *The Foot*. Fourth edition, p. 150. London: Baillière, Tindall and Cox.

McMURRAY, T. P. (1934): Acute and Chronic Sprain. Discussion. *British Medical Journal*, **ii**, 321.

MULLINS, J. F. P., and SALLIS, J. G. (1958): Recurrent Sprain of the Ankle Joint with Diastasis. *Journal of Bone and Joint Surgery*, **40**-B, 270.

NILSONNE, H. (1932): Making a New Ligament in Ankle Sprain. *Journal of Bone and Joint Surgery*, **14**, 380.

PERKINS, G. (1961): *Orthopaedics*, p. 607. London: The Athlone Press.

THORNDIKE, A. (1959): Frequency and Nature of Sports Injuries. *American Journal of Surgery*, **98**, 316.

WATSON-JONES, Sir R. (1955): *Fractures and Joint Injuries*. Volume 2, p. 813. Fourth edition. Edinburgh and London: E. & S. Livingstone Ltd.

WILES, P. (1959): *Essentials of Orthopaedics*. Third edition, p. 303. London: J. & A. Churchill Ltd.