A plea for simplicity in the classification of ankle fractures

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Summary

1. Ashurst and Bromer's classification of ankle fractures is a useful one, but falls into the complexities of subdivision into sequential progression of severity, i.e. 'degrees' of fracture.

2. A similar criticism can be made of the Lauge-Hansen classification which has an added semantic disadvantage. Doubts are also cast upon the validity of the direct application of experimental results in cadaveric specimens to a clinical series.

3. A third classification, essentially a modified form of those preceding it but with both an anatomical and a functional basis is presented, in the belief that it can provide evidence of: (a) the mechanism of production and hence the achievement of reduction; and (b) the recognition of significant ligamentous damage, i.e. the recognition of major from minor, stable from unstable injuries—when used in association with radiographs taken while straining the ankle under anaesthesia.

4. An Appendix to the paper (pp. 210–211), giving a more detailed account of our revised classification, is included.

Introduction

The classification of a group of fractures can be scrupulous in its anatomical detail, but unless it has practical significance it degenerates into a pedantic exercise. When a group of diseases or injuries displays certain common features, to seek out the differences that exist in aetiology, clinical presentation and pathology is useful in formulating sensible plans of management. Rose (1962) pointed out that systematic classification is a

logical process of collecting under a common name a number of objects which are alike in one or more respects. But the importance of such associations lies less in the features common to the group, but more in the persistent, but usually less obvious, differences that exist.

Requirements of classifications

Ankle fractures constitute a complex group of injuries. Any fracture involving a joint may be complicated by secondary osteoarthritis. Treatment must be aimed at the restoration of normal function by reconstituting congruity of articular surfaces. Most fractures are diagnosed clinically, but the characteristics of the fracture are seen on radiographs. Recognition of broken bones can be easy, but the associated ligamentous damage that may exist is recognized with difficulty—or not at all, unless one presupposes a knowledge of the mechanism of the injury, i.e. recognition of the force producing it. Hence, a rational classification of fractures and fracture dislocations at the ankle should be based on the predominant force acting on the ankle at the moment of injury, for only in this way can the route of displacement be retraced to achieve reduction.

Ankle fractures are common and a busy casualty department will deal with a large number in a short period of time. The bulk of these are dealt with by junior staff who, at an early stage in their professional career, must use their judgment in recognizing fracture types. In so doing they assume the responsibility of deciding which injury is of minor and which is of major significance (and associated with important morbidity) of differentiating the stable from the unstable injury and of electing to follow a course of treat-

ment which, by its planned orderliness, results in the functional restoration of the part. This implies that they have an understanding of biomechanics and a wealth of clinical experience or, alternatively, that they can pick out certain salient features on a radiograph which will fit into an easily recognizable and understandable pattern.

A classification of ankle fractures should be simple and immediately applicable to any individual problem. It should be based on information obtained from the patient's history and clinical and radiological examinations, i.e. founded on observed clinical data. In the limited dissections of open operations some corroborative evidence justifying the classification may be found. Mechanical experiments in cadaveric limbs can provide a wealth of information on the pathogenesis of such fractures. This ideal classification should be a clinical one. However, it is well known that 'the history of injury is often disappointing' (Rose, 1962). The confusion of the accident and the disquieting effect of pain make it unlikely that the patient will have a clear recollection of the position of his foot or the direction of the causative force at the time of injury. Certainly physical examination may reveal specific areas of bruising or tenderness overlying fractured bony processes or damaged ligaments. Deformity of foot and ankle may be a helpful clue, but in fact has little bearing on the full extent of displacement at the time of injury. Radiographs provide considerable information if they are of good quality and taken in at least two different planes. Oblique views and, particularly, views while straining the ankle under anaesthesia are a valuable aid.

The experimental production of fractures in cadaveric limbs is essential for confirmation, but the facts obtained must be interpreted with caution and applied judiciously to a clinical classification. The wearing of footwear, the protective contraction of muscle at the time of injury and the influence of transmission of body weight are features which cannot be fully considered in laboratory experiments, yet are acting significantly at the moment of fracture in clinical practice.

Importantly, any classification which is based on the recognition of forces producing a fracture stands or falls (other things being equal) upon the functional and anatomical results of logically applied treatment.

Historical aspects

Astley Cooper (1822) used a simple classification based on observation. Patterns of frac-

ture were recognized according to the displacement of the proximal fragment, i.e. the distal tibia. While failing to take into account the complexities of the fracture and associated ligamentous rupture, it did provide the clue to reduction.

The trend in experimental production of ankle fractures in cadaveric limbs was set by Maisonneuve (1840), Bonnet (1845), Tillaux (1872) and Rochet (1890). These men described specific fracture types or associated ligamentous damage by applying controlled forces in certain planes. Of necessity, in the absence of radiographs, such experiments were valuable, but interpretations were somewhat speculative when applied to clinical series. Honigsmied (1877) listed his results of cadaveric studies, but in so doing produced a somewhat academic classification.

Destot (1911), Quenu (1912a, b) and Quenu & Mathieu (1912) returned to a more obviously clinical basis for their interpretation of ankle fractures. Tanton (1916), combining the views of these latter two, recognized: (a) fractures of the malleoli—isolated or associated, and (b) fractures of the tibial pestle (lower end of the tibial shaft)—isolated, associated or complete. This, at least, was a division according to observed radiographic and anatomical fact, but it paid no heed to the mechanism of production.

Two authors whose work is essential for any understanding of fractures of the ankle are Ashurst and Lauge-Hansen. The former (Ashurst & Bromer, 1922) undertook a critical analysis of 300 fractures, so formulating a comprehensive classification based on the principal deforming force producing the fracture complex. Reliance was placed on the experimental evidence of previous authors, but only in a confirmatory way. If one excludes those fractures grouped as due to direct violence, then ankle injuries are caused by external rotation, abduction, adduction and vertical compression. Each group was subdivided into first, second and third degrees, depending on certain recognizable clinical and radiographic features. This numerical index of severity implied a sequential prolongation of the deforming force in either time-duration or magnitude or both, which, on the evidence, did not seem justified.

Lauge-Hansen (1948, 1950, 1952, 1953) produced, experimentally, a sequential group of fractures and fracture dislocations determined not only by the deforming force applied, but also by the position in which the foot was placed at the time during which the deforming force was acting. This 'genetic' classification, he claimed, allowed 'genetic' reduction. Realizing the shortcomings of such experimental results, he related

them to a group of clinical injuries and found complete accord.

One drawback to the understanding of Lauge-Hansen's work is his use of words which can be misunderstood and, therefore, are ill-used. He used the terms 'pronation' and 'supination' in reference to movements of the foot when, in fact, these are specifically defined in standard works of anatomy (Cunningham, 1964) as rotatory movements of the radius and ulna at the superior and inferior radioulnar joints—a state of affairs not comparable to that existing in leg and foot. This may seem pedantic, but to explain these terms to students and surgeons in training in reference to the foot makes confusion more confused.

The position of the foot and ankle at the time of experimentally produced fracture is easily determined, but this cannot be directly applied to a clinical series where the factors of footwear, muscle contraction and transmission of body weight are playing a part.

Despite these criticisms the classifications of Lauge-Hansen and Ashurst are well founded and have meaning in clinical orthopaedics. Both take

into account the mechanism of injury, both differentiate minor fractures from those of greater functional significance and both consider the detection of ligamentous rupture (i.e. possible ankle instability). However, can they be simplified for the understanding of those who must use them?

Object of present study

This present study was undertaken to determine the possibility of readily recognizing from these classifications, suitably modified, that: (a) certain patterns of fracture are produced by specific deforming forces; (b) certain fractures are associated with significant ligamentous injuries, and (c) that features of the X-ray provide the clue to ankle instability.

Method

In order to analyse critically the merits of methods of classification of ankle fractures, a large series of such fractures has been studied clinically and radiologically. This series has been classified in three ways. The ease with which any one method can be applied to this fracture series will be shown, but, more importantly, the signi-

TABLE 1
Lauge-Hansen classification

Classification	No. of fractures
A. Supination-eversion	
Stage 1: Tear of anterior inferior tibio-fibular ligament }	60
Stage 2: Oblique spiral fracture distal fibula }	
Stage 3: As above + posterior margin of tibia	16
Stage 4: As above + fracture of medial malleolus at its base – or detachment of deltoid ligament	30
(variant—oblique spiral fracture of distal tibia)	1
B. Supination-adduction	
Stage 1: Transverse fracture of lateral malleolus (or avulsion of lateral ligament of ankle)	44
Stage 2: As above + vertical fracture of medial malleolus	11
C. Pronation-abduction	
Stage 1: Horizontal fracture near the base of the medial malleolus	23
(Stage 2: Avulsion of anterior and posterior inferior tibio-fibular ligaments often with a bony shell)	
Stage 3: An oblique or transverse fracture of fibula 0.5–1 cm above the distal articular surface of tibia	3
D. Pronation-eversion	
(Stage 1: As for Stage 1 pronation-abduction)	
Stage 2: Disruption of interosseous ligament complex	
Stage 3: A spiral fracture of fibula more than 8–9 cm above the tip of the malleolus	5
Stage 4: Detachment of posterior margin of tibia	6
E. Pronation-dorsiflexion	7
F. Direct violence	2
G. Maisonneuve	1
Total	209

TABLE 2
Ashurst and Bromer classification

Classification	No. of fractures
A. Fractures by lateral rotation	
First degree: Lower end of fibula only (mixed oblique)	60
Second degree: As above + rupture of medial ligament or fracture of the medial malleolus	
viz:	
(a) Medial ligament uncomplicated	10
Medial ligament complicated by posterior marginal fragment of tibia	5
(b) Medial malleolus uncomplicated	20
Medial malleolus complicated by posterior marginal fragment of tibia	11
Third degree: Same plus fracture of whole lower end of tibia	1
B. Fractures by adduction	
First degree: Transverse fracture of lateral malleolus	44
Second degree: Same plus fracture of medial malleolus	
(a) Below level of tibial articular surface	5
(b) Median surface of tibia upwards and medially from joint surface	6
C. Fractures by abduction	
First degree: Medial malleolus only	22
Second degree: Same plus fracture of fibula	
(a) Below inferior tibio-fibular joint	1
(b) Above inferior tibio-fibular joint (with diastasis)	13
Third degree: Same plus whole lower end of tibia (supramalleolar)	1
D. Vertical compression	7
E. Direct violence	2
F. Maisonneuve	1
Total	209

ficant exceptions to each will be stressed and illustrated.

Lauge-Hansen's classification has been claimed by many as the answer to the understanding of ankle fractures. His classification is reproduced in Table 1. Our series of 209 ankle fractures has been analysed accordingly. The classification of Ashurst & Bromer (1922) is reproduced in Table 2 and again our series has been analysed in accordance with this.

One of us (Monk, 1966) has repeated Lauge-Hansen's work on the experimental production of ankle fractures. It was not found possible to endorse completely all Lauge-Hansen's conclusions. This was particularly true of the 'supination-eversion' (lateral rotation)* injury, where it was found that the sequence of events he described could not be reproduced. Lauge-Hansen further stated that if the foot is held in 'pronation' while a lateral rotation force is applied (after preliminary fracture of the medial malleolus) a fracture occurred in the lower third of

the fibula above the inferior tibio-fibular joint. Attempts to reproduce this were unsuccessful. The clinical examples of fibular fractures at this level were found to have associated complete separation of the inferior tibio-fibular joint. Further experimental studies may be justified, but it may be more convenient, and indeed more accurate, to regard the pronation-eversion (lateral rotation) injury simply as a variant of the pronation-abduction group.

As a result of experimental work one of us (Monk, 1966) has formulated a classification which is in two parts; the first is a division into the number of bones fractured and the second an assessment of the mechanism involved, but carrying with it the implication of ligamentous damage not visible radiographically. This classification is reproduced in Table 3 and again our series of 209 fractures analysed accordingly.

In all three methods of classification fractures due to vertical compression (the pronation-dorsiflexion group of Lauge-Hansen) are readily recognized and are excluded from further discussion—Fig. 1. This is also true of two fractures produced by direct violence. The rare fracture

* The term 'eversion' as used by Lauge-Hansen is interpreted as meaning 'lateral rotation'.

TABLE 3
Proposed simplified classification (Monk, 1966)

Classification	No. of fractures
1. Lateral malleolar fractures	
A. Abduction type	
Distal to syndesmosis	0
Proximal to syndesmosis	3
B. Adduction type	44
C. Lateral rotation type	72
2. Medial malleolar fractures	
A. Abduction type	23
B. Adduction type	1
3. Bimalleolar fractures	
A. Abduction type	
Distal to syndesmosis	1
Proximal to syndesmosis	7
B. Adduction type	10
C. Lateral rotation type	19
4. Lateral malleolar and posterior tibial marginal fractures	
A. Lateral rotation type	5
5. 'Trimalleolar' fractures	
A. Abduction type	
Distal to syndesmosis	0
Proximal to syndesmosis	3
B. Lateral rotation type	11
6. Vertical compression fractures	7
7. Maisonneuve fractures	1
8. Direct violence fractures	2
Total	209

FIG. 1. This vertical compression fracture is characterized by the large triangular fragment from the anterior aspect of the distal tibia. A common feature also visible here is comminution of the tibial articular surface.

described by Maisonneuve (1840), although produced by lateral rotation, has been segregated (Fig. 2).

FIG. 2. In this Maisonneuve fracture the fibula is fractured at its neck. The lateral rotation strain produces typically an oblique fracture line directed upwards and laterally.

Lateral rotation

In the group of injuries produced by lateral rotation the characteristic feature is the oblique or spiral fracture of the fibula (Fig. 3). Both Lauge-Hansen and Ashurst recognized this as the first stage of this fracture complex (although preceded by rupture of the anterior inferior tibio-fibular ligament). In the third classification (Monk, 1966) an additional twelve fractures are included in the group of lateral malleolar fractures caused by lateral rotation. These twelve are unstable injuries because of the co-existence of a ruptured medial ligament (Fig. 4)—a feature of importance which, in less obvious examples, can be missed by the inexperienced. The implication is that unimalleolar fractures are not, of necessity, basically stable. Both Lauge-Hansen and Ashurst consider associated rupture of the medial ligament as a continuation of the lateral rotation force, making provision for this, includ-

ing it together with that group in which there is a fracture at the base of the medial malleolus. Rightly, this latter falls into our bi-malleolar lateral-rotation series.

When there is an associated posterior marginal fragment of the tibia (so-called 'third malleolus') there is little discrepancy between Lauge-Hansen and Ashurst, other than to state that there is a reversal in sequence of production, i.e. Lauge-Hansen believes that the posterior marginal fragment is produced before the medial malleolus fractures or the medial ligament ruptures. That this is not always so is shown in Fig. 5. But in our classification one can avoid the rather irrelevant argument of sequential production of this fracture-ligament complex by regarding it as a separate entity. An associated rupture of the medial ligament, determined by taking strained views, causes this lesion to assume the functional significance of a 'tri-malleolar' fracture. Only one fracture could be grouped in the Ashurst third-degree external rotation type, i.e. where fracture of the distal tibia represents the medial malleolus and posterior marginal fragment. Likewise, it is easily recognized in the Lauge-Hansen method and falls into our bi-malleolar lateral rotation group.

Adduction

Between Ashurst's adduction group and Lauge-Hansen's supination-adduction group there is no difference of note. In our classification the only difference is that one fracture was placed among the medial malleolus group, implying an intact lateral malleolus, but with rupture of the lateral ligament of the ankle—a point of functional importance to be discussed in a later communication. Fig. 6 illustrates a typical adduction fracture.

Abduction

Fractures produced by abduction provoke the most serious disagreement among the classifications. Although Lauge-Hansen recognizes that the first stage of pronation-abduction and pronation-eversion (lateral rotation) is a horizontal fracture near the base of the medial malleolus (Fig. 7), he reckons that each force, continuing to act, produces its own specific fracture-ligament rupture complex. It has already been stated that this has not been confirmed experimentally. If, in fact, Lauge-Hansen's pronation-abduction and pronation-eversion (lateral rotation) series are grouped together, then they differ little from Ashurst's abduction group, although the latter does emphasize that in abduction injuries the fracture of the fibula may be distal to the inferior tibio-fibular joint, or proximal to it with

FIG. 3. A lateral rotation fracture in which the characteristic feature is a fracture line in the distal fibula, either oblique or spiral, directed upwards and backwards but commencing at the level of the distal tibial articular surface. This is seen most clearly on the lateral view.

FIG. 4. In this lateral rotation injury the typical oblique fracture of the fibula is noted and is displaced. On the antero-posterior view the talus (with the lateral malleolus) is displaced laterally but the proximal fibular fragment maintains a normal relationship to the tibia, i.e. there is not complete disruption of the inferior tibio-fibular syndesmosis. With an intact medial malleolus such displacement is occurring because of complete rupture of the medial (deltoid) ligament.

FIG. 5. In this lateral rotation injury the typical oblique fracture of the fibula is noted. The fracture of the medial malleolus is transverse in the antero-posterior plane and is just distal to the joint level. Note that the posterior tibial margin is intact.

FIG. 6. In this typical adduction fracture of the ankle the fibular malleolus is fractured distal to the joint level and almost transversely. The fracture of the medial malleolus is almost vertical and involves the 'tibial' as opposed to the medial malleolar articular surface.

FIG. 7. In this abduction fracture the fibular malleolus is intact. The medial malleolus is fractured just proximal to the joint level. The fracture line is nearly horizontal.

FIG. 8. This is a typical abduction fracture in which the fibular shaft is fractured transversely. The talus and the distal half of the fibula are displaced laterally so that the normal relationship of fibula to tibia is lost. This signifies complete disruption of the inferior tibio-fibular syndesmosis (classical diastasis). The nearly horizontal fracture of the medial malleolus is also seen. The posterior tibial margin is intact.

FIG. 9. This abduction fracture may be grouped in the Lauge-Hansen pronation-eversion (lateral rotation) group, but the obliquity of the fibular fracture is not typical of a lateral rotation injury. Again the normal relationship of the fibula to the tibia at the inferior tibio-fibular joint is lost because of disruption of the syndesmosis (classical diastasis). The horizontal fracture of the medial malleolus is noted.

consequent disruption of this joint and complete separation of the tibia from the fibula (i.e. classical diastasis). This has serious functional implications. It must, however, be said that in this fracture complex there can be included a fracture of the posterior tibial margin, but this may be of little practical significance. On the other hand, in our classification the anatomical nature of the abduction fracture is stressed by division into uni-, bi- and 'tri-malleolar' types, but like Ashurst, a consideration of the possibility of complete disruption of the inferior tibio-fibular joint leads us to retain the subdivision of this group according to the level of the fibular fracture—an anatomical feature of considerable functional importance. Lauge-Hansen pays direct attention to rupture of the medial ligament rather than fracture of the medial malleolus as the earliest stage of this mechanism of injury. Two characteristic abduction fractures are illustrated (Figs. 8 and 9).

Discussion

It must be repeated that any classification of

ankle fractures should provide information regarding the nature of the fracture and its associated ligamentous damage, so permitting a logical plan of management. A classification falling short of this ideal can be supplemented by information obtained from radiographs of the ankle, strained under anaesthesia. This will often demonstrate significant ligamentous rupture and confirm the mechanism of production of the total ankle injury.

Our classification, if only founded on an anatomical basis, would over-simplify the ankle injury, and this is particularly true of the lateral rotation, lateral malleolus group. However, there is the second, more important, consideration of the direction of the force producing the injury, i.e. abduction, adduction, etc., which by the anatomical details noted at X-ray give the indication for supplementary strain views under anaesthesia. This classification immediately brings to the surgeon's notice the possible ligamentous injuries that co-exist with radiologically visible fractures whose characteristics point to the direction of the force producing them. Indeed, this

classification would allow us to answer in the affirmative the questions already posed, i.e.:

(a) That patterns of fracture seen on X-ray can be related directly to the force producing them;

(b) That certain fractures are associated with important ligamentous injuries, whose existence can be implied from the radiological picture (although strain views under anaesthesia may well be necessary); and

(c) When these ligamentous ruptures are recognized or when fractures co-exist both on medial and lateral sides of the ankle, instability can be said to be present.

Lauge-Hansen's and Ashurst's classifications can equally provide answers to the questions posed. That this is so is due to the fact that there is very little difference between them. If one admits that the pronation-abduction and pronation-eversion (lateral rotation) subdivisions are simply variations on an abduction theme and if one drops the somewhat unnecessary word referring to the position of the foot at the time of injury, viz. pronation or supination, then these two classifications are very similar indeed.

Both classifications, but particularly that of Ashurst & Bromer (1922), by attempting to imply an ordered progression of events consequent upon injury add to the complexity of the method without necessarily adding to its comprehension. This is the danger and, perhaps, the fallacy of equating directly experimental evidence to clinical problems. It would, however, be foolish to belittle the classifications of Lauge-Hansen and Ashurst & Bromer, but it would seem wise to adhere to the simpler, more readily understood system outlined in Table 3. Indeed this simplified, though admittedly not original, classification is given in a more detailed and explicit form in the 'Appendix' to this paper (pp. 210-211).

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Appendix

PROPOSED SIMPLIFIED CLASSIFICATION OF ANKLE FRACTURES

Under each type of fracture there will be described where relevant:

- (1) The position and direction of the fracture line.
- (2) The findings on strained view X-rays.
- (3) The coincident ligament damage.

In the light of the findings on strained views it is felt that in the past too much emphasis has been placed on the significance of the direction of the fracture line. As far as ligament damage is concerned we have only recorded major degrees of damage, i.e. such as will allow movement of the talus in the mortise. Although the capsular ligament is frequently torn this, alone, will not permit abnormal mobility at the ankle.

Anatomical lesion	Predominant deforming force	Characteristics of fracture	Evidence on strain views	Possible associated ligament rupture	Comments
1a Lateral malleolus—distal to syndesmosis	Abduction	On antero-posterior X-ray, fracture line runs obliquely distally and laterally. On lateral X-ray, fracture line is horizontal	May be displaceable by both abduction and lateral rotation strains	Medial ligament	—
Lateral malleolus—proximal to syndesmosis	Abduction	Horizontal line in two planes with possibly a 'butterfly' fragment or comminution	Separation of tibia from fibula at inferior tibio-fibular joint	(a) Medial ligament (b) Anterior, posterior, and interosseous tibio-fibular ligaments	Classical diastasis or separation of tibia from fibula, inferiorly, occurs only when all three ligaments of the inferior syndesmosis are ruptured
1b Lateral malleolus	Adduction	Horizontal fracture line in two planes and distal to the level of distal tibial articular surface	Stable — no talar shift	Nil	—
1c Lateral malleolus	Lateral rotation (see Figs. 3 and 4)	Fracture line is oblique, running from above posteriorly to below anteriorly in the lateral projection (may be spiral)	No instability or unstable to lateral rotation (talar shift)	Medial ligament	Anterior inferior tibio-fibular ligament is partially torn but this does not impair ankle instability of its own accord
2a Medial malleolus	Abduction	In both planes, a horizontal fracture line at or distal to the inferior tibial articular surface	A stable injury	Nil	—
2b Medial malleolus	Abduction	Fracture line in antero-posterior plane runs upwards and medially from the junction of tibial and malleolar articular surfaces	When lateral ligament is ruptured ankle is unstable to abduction strain	Lateral ligament	—
Isolated fractures of the medial malleolus produced by rotation were not encountered					
3a Bimalleolar fracture—distal to syndesmosis	Abduction	Both malleoli fracture distal to inferior tibial articular surface; fracture lines in the malleoli are parallel	Easily displaced by abduction and lateral rotation strains	Nil	—

Bimalleolar fracture – proximal to syndesmosis	Abduction (Fig. 8)	Fracture lines in the malleoli are described above	Easily displaced by abduction and lateral rotation strains	Complete tear of all three ligaments of inferior tibio-fibular joint	—
3b Bimalleolar fracture	Adduction (Fig. 6)	Fractures in the malleoli are described above	Displaced by abduction strain	Nil	—
3c Bimalleolar fracture	Lateral rotation (Fig. 5)	Lateral malleolar fracture is spiral or oblique as described above, medial malleolar fracture line is transverse or oblique upwards and medially in the antero-posterior plane	Fracture is stable to adduction; displaced by abduction and grossly displaced by lateral rotation strains	Nil	Partially torn anterior inferior tibio-fibular ligament does not of its own accord impair ankle stability
4 Lateral malleolar, posterior tibial marginal fracture	Lateral rotation	The lateral malleolar fracture is oblique, and the posterior tibial marginal fracture is almost vertical in the lateral projection	Presumed to be similar to isolated lateral malleolar fracture produced by lateral rotation	Medial ligament	It is suspected that a similar combination of fractures can occur in abduction injuries
5a 'Trimalleolar' – distal to syndesmosis	Abduction	Typical bimalleolar abduction fracture but includes a fracture of posterior tibial margin	Easily displaced by abduction and lateral rotation strains	Nil	The fracture of the posterior tibial margin is often vertical in the lateral X-ray and of such size that it is a constituent of a large medial malleolar fracture
'Trimalleolar' – proximal to syndesmosis	Abduction	Typical bimalleolar abduction fracture but includes a fracture of posterior tibial margin	Easily displaced by abduction and lateral rotation strains	All three ligaments of the inferior tibio-fibular joint	Ditto
5b 'Trimalleolar'	Lateral Rotation	Typical bimalleolar lateral rotation fracture but includes a posterior marginal fracture	Easily displaced by lateral rotation and abduction strains	Nil significant	Ditto

Trimalleolar fractures produced by adduction were not encountered

ADDITIONAL FRACTURES

6 Vertical compression fractures (Fig. 1)

Usually these fractures are caused by a longitudinal compressing force across the ankle but often with accompanying secondary abduction, adduction or rotation strains – as in a fall from a height, landing on the feet. Although the fracture line or lines are essentially vertical, impaction and comminution are frequent. Ligament rupture is variable

7 Maisonneuve fractures (Fig. 2)

The fracture line in the fibula is high – in the neck or upper third of the bone and runs obliquely downwards and forwards in the lateral plane. Strain views show instability to lateral rotation; the talus, carrying the distal fibula with it, can be rotated laterally through 90° in relation to the distal tibial articular surface. Rupture of ligaments is confined to the anterior and interosseus tibio-fibular ligaments allowing syndesmosis to open like a book, but lateral shift of the talus within the mortise is not permitted

8 Direct violence fractures

Such fractures, caused by bullets, other missiles and heavy objects are isolated fractures, not necessarily displaced but often comminuted and rarely associated with significant ligament damage unless the ankle joint is considerably displaced