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The ankle injury—indications for the selective use of X-rays

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Summary

The radiograph is rapidly superseding the clinical examination as the diagnostic tool for acute ankle injuries. Twenty-four independent variables which might help distinguish between soft tissue injuries and fractures at the ankle were identified and then used prospectively to study 150 consecutive patients with ankle injuries. Nineteen patients had fractured ankles (12·7 per cent) and 131 (87·3 per cent) had soft tissue injuries. Only the patient's ability to bear weight on the injured ankle and the presence of tenderness over the lateral aspect of the ankle below the malleolus proved to be helpful. When these 2 signs were present together, regardless of all other variables, there was a 97·5 per cent probability of soft tissue injury $P < 0{\cdot}005$). This study suggests that careful patient assessment will permit more discriminating use of ankle X-rays.

INTRODUCTION

THE injured ankle is one of the most common conditions seen in the Emergency Department and the examining doctor frequently includes the ankle's radiograph as a major part of the patient's assessment. One report suggests that these films may account for 10 per cent of the total number of X-ray studies made in the Emergency Department (de Lacy and Bradbrooke, 1979). A number of clinical reviews have attempted to establish guidance for the selective use of X-rays in diagnosing ankle injuries (Garfield, 1960; Stother, 1974; de Lacy and Bradbrooke, 1979; Brooks et al., 1981; Brand et al., 1982). Unfortunately, none of these reports has employed statistical analysis to support their proposed guidance.

In a retrospective review of over 600 patients with ankle injuries during the past 2 years, fewer than 25 per cent had adequate clinical evaluation and almost all of them (>99 per cent) had radiographs. Seventy-three fractures of the ankle (12 per cent) were diagnosed. From this review, 24 variables were chosen which appeared to be helpful in evaluating ankle injuries. These variables were incorporated into an assessment form which was subsequently used in the following prospective study.

PATIENTS AND METHODS

Over a six month period, 150 consecutive patients were examined for ankle injuries, using the assessment form just described, before X-ray examination. The variables used in the study included those relevant to the history of the injury

Table I. Factors related to the history of injury

Right or left foot
Manner of arrival at hospital.
Ability to bear weight on ankle after injury
Onset of pain immediately after injury
Popping or cracking sound at the time of injury
Mechanism of injury
Direction of injury
Time from injury to arrival at hospital.
Activity at time of the injury

Table II. Findings at the time of the physical examination

Ability to bear weight on the injured ankle
Location of ankle swelling
Degree of swelling
Presence of ecchymosis
Laceration of skin
Location of pain on palpation
Type of pain
Localization
Bone conduction of pain
Pain with motion
Limitation of range of motion
Presence of crepitation at site of injury
Presence of vascular injury
Presence of neurological injury

Table III. Distribution of injuries by age

Age Group	*No. of Fractures*	*No. of Soft Tissue Injuries*
1–10	0	3
11–20	6	37
21–30	6	67
31–40	2	11
41–50	2	4
51–60	2	5
61–70	1	1

Table IV. Distribution of fractures

Fibular	7
Bimalleolar	4
Calcaneal	3
Talar	3
Tibial	2

(*Table I*) and the findings at the time of examination (*Table II*).

The ability to distinguish fracture from soft tissue injury was determined for each variable using chi-squared analysis. *P*-values of less than 0·05 indicated that the variable contributed significantly in distinguishing fractures from soft tissue injuries of the ankle. The relative merit of each variable can be measured by determining the increase over chance in the probability of having a soft tissue injury. This is reported as 'gain over chance' and represents the probability of soft tissue injury for a given variable, minus chance probability (in our study 87·3 per cent). A positive difference indicates a greater likelihood of soft tissue injury; a negative difference indicates a greater likelihood of fracture.

Using higher order contingency tables and log linear models, those variables that contributed significantly to the differentiation of soft tissue injury from fracture were combined. Numerous models were examined and only the model which contributed most usefully, irrespective of all other variables, is represented here.

RESULTS

Among the 150 patients, there were 19 fractures of the ankle (12·7 per cent) and 131 (87·3 per cent) soft tissue injuries. The distribution of injuries by age group is seen in *Table III*. Most patients were under 40 years of age, which may reflect the high proportion of university students in the local population. The distribution of fractures diagnosed is presented in *Table IV*. There was a fairly even distribution of injuries, with fracture of the lateral malleolus being the most common in the series.

Nine of the 24 variables analysed in *Tables V* and *VI* appeared to discriminate between soft tissue injury and fracture. These included: 1) age; 2) the left or right side; 3) the ability to bear weight immediately after injury; 4) a popping or cracking sound at the time of injury; 5) direction of injury; 6) the patient's ability to bear weight on the ankle during the examination; 7) local tenderness; 8) the type of pain present; and 9) bone conduction of pain.

On reassessment of these 9 variables, 5 were eliminated from consideration for further analysis. Statistical analysis in 3 of the 5 variables (the presence of a popping sound at the time of injury, the direction of injury and bone conduction of pain) were often entered as 'unknown'. Thus, these variables may be statistically but not

Table V. Sensitivity analysis for each variable in the history

Variable	*Response*	*Patients*	*% Soft tissue injury*	*P-value*	*Gain over chance (%)*
Sex	Male	75	89·3	0·461	2·0
	Female	75	85·3		2·0
Age	≦ 40	127	88·4	0·022	1·1
	> 40	15	66·7		−20·6
Foot	Right	71	84·5	0·038	−2·8
	Left	77	90·9		3·6
Manner or arrival at hospital	With assistance	58	82·8	0·181	−4·5
	Without assistance	92	90·2		2·9
Ability to bear weight	Yes	46	78·3	0·026	−9·0
	No	104	91·4		4·1
Onset of pain	Immediate	112	84·8	0·112	−2·5
	Delayed	38	94·7		7·4
Popping or cracking sound	Present	52	90·4	0·048	3·1
	Absent	86	88·4		1·1
	Unknown	12	66·7		−20·6
Mechanism of injury	Fall	23	87·0	0·091	−0·3
	Twist	119	89·1		1·8
	Blow	8	62·5		−24·8
Direction of injury	Inversion	98	91·8	0·022	4·5
	Eversion	11	90·9		3·6
	Other	15	86·7		−0·6
	Unknown	26	69·2		−18·1
Time from injury to arrival	≦ 8 hrs	83	84·3	0·220	−3·0
	> 8 hrs	67	91·0		3·7
Activity	Athletics	64	92·2	0·229	4·9
	Climbing	42	81·0		−6·3
	Other	44			
Total		150	87·3	—	—

clinically significant. The comparison of right or left foot was not used because no determination of right or left sided dominance was made in these patients, and dominance may have a greater influence on the type of injury sustained. The ability to bear weight immediately after the injury was statistically significant but it did not make sense because many of these patients were able to bear weight on the ankle at the time of examination. It does point out the fallacy of ruling out a fracture in a patient who walked on the injured ankle immediately after the accident.

The remaining 4 variables were combined to determine if they would enhance each other in discriminating between soft tissue injury and ankle fracture. Only the combination of the localization of tenderness below the lateral malleolus and the ability to bear weight on the ankle significantly improved ($P < 0{\cdot}005$) the probability of diagnosing soft tissue injury. The detailed analysis of these 2 variables can be seen in *Table VII*. Eighty-one patients (54 per cent) had both lateral pain in the ankle and the ability to bear weight on the ankle. Of these patients, 79 (97·5 per cent) had soft tissue injuries. While many combinations had high probabilities of diagnosing fractures, this group had the highest increase over chance of diagnosing soft tissue injuries. Other variables, the 'type of pain' or 'age', had high probabilities of separating soft tissue injuries from fractures when considered alone, but did not improve on the results in this combination.

DISCUSSION

Garfield (1960) suggested that patients under 61

Table VI. Sensitivity analysis for each variable in the physical examination

Variable	*Response*	*No. of patients*	*%Soft tissue injury*	*P-value*	*Gain over chance (%)*
Ability to bear weight	None	40	72·5	0·002	−14·8
	Some	110	90·0		2·7
Location of swelling	Lateral	73	89·0	0·580	1·7
	Medial	6	83·3		−4·0
	Both	59	88·1		0·8
	None	12	75·0		−12·3
Degree of swelling	Severe	18	77·8	0·363	−9·5
	Moderate	85	87·0		0·3
	Slight	35	94·3		7·0
	None	12	83·3		−4·0
Ecchymosis	Present	45	84·4	0·500	−2·9
	Absent	104	88·5		1·2
Laceration	Present	6	100·0	0·339	12·7
	Absent	143	86·7		−0·6
Location of pain	Lateral	102	92·2	0·010	6·7
	Medial	13	69·2		−18·1
	Both	31	83·9		−3·4
	None	4	50·0		−37·3
Type of pain	Bone	52	75·0	0·001	−12·3
	Soft tissue	91	95·6		8·3
	Not specified	7	71·4		−15·9
Localization of pain	Point	52	90·4	0·614	3·1
	Diffuse	90	86·7		0·6
	No pain	1	100·0		12·7
	Not specified	3	66·7		−20·6
Bone conduction of pain	Present	19	80·0	0·050	−7·3
	Absent	98	91·8		4·5
	Unknown	30	76·7		−10·6
Pain with motion	Present	134	87·3	0·695	−0·0
	Absent	12	83·3		−4·0
Limitation of range of motion	Deformity	2	100·0	0·063	12·7
	Pain	119	87·4		0·1
	Not limited	28	89·3		2·0
	Not specified	1	0		—
Crepitation	Present	6	100·0	0·204	12·7
	Absent	144	86·8		−0·5
Vascular Injury	Present	2	0·0	—	—
	Absent	148	88·5		1·2
Neurological Injury	Present	3	66·7	—	—
	Absent	147	87·7	—	0·4
Total		150	87·3	—	—

years of age with histories of walking injuries and the absence of tenderness, bruising or swelling would not require X-ray examination of the ankle. With the exception of age, it was not possible to use his variables to differentiate soft tissue injury from fracture in our population of patients. Older patients may be more likely to sustain fractures from ankle injuries (33·3 per cent of our patients over 40 years of age had fracture) but only 1 patient in this study was over 61 years of age and she suffered a fracture.

De Lacy and Bradbrooke (1979) reviewed the records of 100 patients with injuries of the ankle and compared them with 93 patients who had fractures of the ankle. Sixty-five per cent of patients with injuries of the ankle had no swell-

Table VII. Combined analysis of two variables: location of pain and ability to bear weight

Location	*Ability to bear weight*	*Patients with fracture*	*Patients with soft tissue injury*	*% Soft tissue injury*	*Gain over chance (%)*
Lateral	None	6	15	71·4	−15·9
	Some	2	79	97·5	10·2
Medial	None	2	3	60·0	−25·6
	Some	2	6	75·0	−12·3
Equal	None	2	9	81·8	−5·5
	Some	3	17	85·0	−2·3
None	None	1	2	66·7	−20·6
	Some	1	0	100·0	—

ing and only 5 had fractures. Ninety-two of the 93 patients with fractures of the ankle had swelling at the fracture site. The authors concluded that the probability of soft tissue injury was 92·3 per cent for patients without swelling and therefore X-ray examination was not necessary. In contrast, only 12 patients in this series were without swelling and their probability of fracture was higher than that of the total population (respectively 25 per cent and 12·7 per cent). The absence of swelling therefore, should not determine whether or not to take X-ray films of the ankle.

Brooks et al. (1981) reviewed 241 patients with inversion injuries and concluded that a careful clinical examination was a satisfactory method for differentiating soft tissue injury from fracture. They noted that localized tenderness over the ligaments on the lateral aspect of the ankle without bony tenderness correlated well with the diagnosis of soft tissue injury. They also noted that pain, swelling and bruising were of no help in differentiating soft tissue injuries from fractures. All of their findings concur with the results of this study. While only 98 patients (65·3 per cent) suffered inversion injuries, 91·8 per cent of them had soft tissue injuries and the presence of bony tenderness was associated with ankle fracture (25 per cent).

Brand et al. (1982) conducted a prospective study similar to this one; however, their data are combined in such a way as to make any specific comment about ankle injuries meaningless. In injuries distal to the knee, they found that point tenderness was a helpful determinant whereas in our series, point tenderness was more frequently associated with soft tissue injury (34 per cent) than with fractures (9·5 per cent).

This study demonstrates that it is possible to use ankle radiographs selectively with the expectation of obtaining more positive results without risk to the patient. Patients who came with tenderness over the lateral aspect of the ankle below the malleolus and who could bear some weight on the ankle, did not need X-ray examination. They have a 97·5 per cent probability of having a soft tissue injury ($P < 0{\cdot}005$).

There are other variables, evident from the study, which should alert the examining doctor to the possibility of fracture despite the fact that they did not statistically alter the previously described results. These variables include: age > 40 years, history of a blow on the ankle, bony tenderness or bone conduction of pain.

While it is impossible to expect that all patient populations will be similar to this one, these results provide determinants which others may adopt selectively to eliminate the need for X-ray examination in patients with acute injuries of the ankle. In our population, adherence to the indications described would decrease the number of unnecessary X-rays by 54 per cent without risk to the patients.

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