Ultrasonic assessment of injuries to the lateral complex of the ankle

A. K. SINGH, T. S. MALPASS & G. WALKER

Department of Accident and Emergency, Wycombe General Hospital, High Wycombe, England

SUMMARY

A prospective study of 114 patients who injured the lateral complex of their ankles. All patients were subjected to ultrasound scanning within 48 h of their injury under double blind conditions. The authors' results suggest that the sensitivity of the ultrasound diagnosis approaches that of conventional radiology, if used properly. Furthermore, ultrasonic scanning is a useful adjuvant to clinical assessment of patients with regards to selection for further radiological examination. A case is also made for firms in the medical physics arena to develop suitable hardware in the diagnostic ultrasonic field for fracture management.

INTRODUCTION

That the piezo electric effect of ultrasound causes pain at fracture sites is well known (Oakley, 1978). Furthermore, the use of ultrasound in the therapeutic range has been investigated by various workers (Shenouda, 1987; Bedford, 1982; Nitz & Scoville, 1986) in the field of fracture diagnosis with high correlation (93%) with X-ray findings.

Most of the studies have employed ultrasonic energy at one frequency (approximately 1.5 MHz) and at therapeutic 'strength levels' (1 Watt/sq cm).

The number of X-ray examinations in the A&E departments is increasing at about 6% per annum without a corresponding increase in the population (Raison, 1976). Ankle radiographs represent 10% of these examinations.

Certain clinical guidelines have been suggested to help doctors in deciding whether a radiographic examination would be useful in an ankle injury (Garfield, 1960; de Lacey, 1979) but despite this, fracture diagnosis on clinical grounds alone is notoriously inaccurate especially in the hands of inexperienced casualty officers.

A simple cost-effective method of supplementing clinical examination is therefore a valuable adjuvant for patient selection regarding possible radiology.

In order to accustomize ourselves with the technique of using ultrasound for fracture management we decided to use the simple diagnostic Doppler Unit for vascular/obstetric use available in most casualty departments. We found to our surprise that this small unit could produce paraesthesia over fracture sites which correlated very significantly with pain produced over the same sites by ultrasound in the 'therapeutic range'. This paraesthesia was even more intense with a modified Doppler unit which delivered 4 V across the crystal and 250 mW of power.

METHOD

The selection criteria for patients entering the study were fairly rigid in that isolated injuries to the lateral complex of the ankle associated with weight-bearing (partial or full) were entered. Patients less than 10 years of age and more than 80 were excluded. Clinical examination of the injured part was followed by a quick Doppler ultrasonic examination of the injured ankle (control—normal ankle) and by routine radiology of the affected part. The patient was then sent down to the Physiotherapy Department for an ultrasound test on both ankles using ultrasound at 1.5 watts/sq cm and 1.5 and 3 MHz frequencies.

The initial Doppler evaluation was performed at two frequency levels, ie. 2 MHz and 5 MHz, the examining doctor being unaware of the radiological findings. Similarly the testing physiotherapist was completely unaware of both the radiological and the Doppler findings.

Ultrasonic diagnosis was carried out by a single Senior Physiotherapist using a standard therapeutic ultrasound machine and a water-based coupling medium. The probe diameter was 0.75 cm. The sensation produced was compared to that obtained on the same area of the opposite, uninjured limb. A positive test was pain/paraesthesia over the injured limb only.

Patients with a positive ultrasound examination and negative radiology initially, were followed up and repeat X-rays performed 3 weeks later.

A total of 114 patients were examined.

RESULTS

On reviewing radiographs after the application of the diagnostic Doppler ultrasound it was found that 23 patients had sustained fractures around the lateral complex. Subsequent repeat radiology in those patients with an initially negative X-ray finding, but positive ultrasound testing, revealed the presence of four additional fractures. These included flake fractures of the dorsum of the talus, minor chip avulsions of the tip of the lateral malleolus, fracture of the talar neck and a fracture of the base of the fifth metatarsal. Fractures distal to the ankle were missed as views of the foot/talus were not

initially requested. These patients were, however, included in the trial as it was felt that precisely these patients would have been helped by a positive ultrasonic scanning initially.

It is felt that a positive result to an ultrasound test (in the absence of radiological evidence of a fracture in the available views) would increase the index of suspicion in the attending doctor's mind and therefore prompt him to request additional views.

The results are summarized in Tables 1 and 2. Similarly using both modalities of ultrasonic examination together and comparing them to the overall efficacy of radiological examination, we found a χ^2 value of 45.7.

Further statistical analysis of the results is given in Table 3. To our surprise we found that patients under the age of 55 were more likely to have sustained injuries to the lateral complex of their ankles as compared to those above that age limit ($\chi^2 = 11.8$).

Table 1 χ^2 matrices

	Therapeutic U/s positive	Therapeutic U/s negative	Total
X-ray Positive	21	5	26
X-ray Negative	12	76	88
Total	33	81	114

$\chi^2 = 43.3$

Table 2 χ^2 matrices

	Doppler U/s Positive	Doppler U/s Negative	Total
X-ray Positive	17	7	24
X-ray Negative	10	80	90
Total	27	87	114

$\chi^2 = 37.3$

Table 3

Test	Sensitivity	False Pos.	Specificity	False Neg.
X-ray	85.2%	0	100%	14.8%
Both U/s	88.9%	6.9%	93.1%	11.1%
Doppler	70.8%	11.1%	88.9%	29.2%
Therap. U/s.	80.8%	13.6%	86.4%	19.2%
X-rays and both U/s	96.4%	—	—	3.6%

Furthermore, we found that physical parameters such as swelling over the lateral complex, weight-bearing and time of presentation were completely independent of the radiological findings. However, we found a positive correlation between bony tenderness and the presence of a fracture ($\chi^2=7.5$).

One of the parameters that we recorded for every patient was the time of presentation to the A&E Department. We found that there was no significant correlation between this time of presentation and the sex or age of the patient. Surprisingly, we also found no correlation between this parameter and the patient's ability to weight-bear or the presence radiologically of a fracture.

Using the different ultrasonic frequencies available (1.5, 2.3 and 5 MHz) we found that at the level of therapeutic use of ultrasound, ie. 1 W/sq cm, the 1.5 MHz frequency was most effective as compared to the 5 MHz frequency at the Doppler level (50–250 mWatts).

We subsequently modified our Doppler ultrasound unit to deliver a 4-V potential difference across the crystal surface and thereby quadrupling the available power output. We have found this to be even more effective and sensitive in diagnosing bony injuries around the ankle.

DISCUSSION

This study suggests that ultrasound is a simple, inexpensive and diagnostically effective method for detecting bony injuries to the lateral complex of the ankle. Twenty-four of the 27 bony injuries were detected using both modalities of ultrasound giving an overall sensitivity of 88.9% as compared to 85.2% for routine radiology.

However, when both routine radiology and ultrasound scanning were performed, the overall sensitivity increased to 96.4% with a false negative rate of 3.6%.

It is interesting to note that only one out of the 27 fractures in the study was not picked up by either X-ray or ultrasonic scanning. This turned out to be a minor flake avulsion of the tip of the lateral malleolus in a diabetic patient with peripheral neuropathy. We feel, in retrospect, that our false negative rate would have been negligible had she been excluded from the trial due to the diminished sensation in her foot.

When Doppler ultrasonic examination was used in isolation however, this sensitivity dropped to 70.8%, there being a significant false negative rate of 29.2% (80.8% sensitivity and 19.2% false negative rate being achieved for Ultrasound in the Therapeutic range in isolation.)

It is therefore felt that simple Doppler examination of minor ankle injuries along with reasonably precise clinical examination would result in far more accurate assessment of these injuries regarding the necessity for subsequent radiological examination. It is not suggested by us that routine ultrasonic examination of injuries would replace radiological assessment; rather that when used properly could enable relatively inexperienced doctors to assess the requirements for X-rays more precisely and accurately.

An additional value of ultrasonic assessment is that in the absence of a detectable fracture in the X-rayed region, a positive ultrasound result should raise the doubt of a fracture in a contiguous anatomical area.

We feel that a strong case exists for firms in the diagnostic ultrasound sector to study further the effect of different parameters such as frequency, optimal strength/unit area, crystal size and head profile etc., so that in time an optimal portable diagnostic instrument is made available for most A&E departments to use.

REFERENCES

- Bedford A. F., Glasgow M. & Wilson J. N. (1982) Ultrasonic assessment of fractures and its use in the diagnosis of the suspected scaphoid. *Injury*, **2**, 180–2.
- De Lacey G. J., Bradbrooke S. (1979) Rationalizing requests for X-ray examination of acute ankle injuries. *British Medical Journal* **1**, 1597–8.
- Garfield J. S. (1960) Is radiological examination of the twisted ankle necessary? *Lancet* **ii**, 1167–69.
- Nitz A. J. & Scoville C. R. (1980) Use of ultrasound in early detection of stress fractures of the medial tibial plateau. *Military Medicine* **145**, 844–6.
- Oakley E. M. (1978) Dangers and contraindications of therapeutic ultrasound. *Physiotherapy* **64**, 173–9.
- Raison J. C. A. (1976) *Proceedings of the Royal College of Medicine* **69**, 755.
- Shenouda N. A. & England J. P. S. (1987) Ultrasound in the diagnosis of scaphoid fractures. *Journal of Hand Surgery* **12b**, 43–5.