is clear on operative exploration through the standard lateral approach which is described, and it is difficult to see how the preoperative classification influences management. The authors cite sustentacular comminution as the main contraindication to surgery, but this part of the fracture is not included in their classification.

We consider that the figures for displacement mean little or nothing, and that no case has been made for yet another classification of calcaneal fractures. Further advances in management require a randomised prospective trial of the treatment method described; this is how management of this fracture will be advanced.

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Eastwood DM, Gregg PJ, Atkins RM. Intra-articular fractures of the calcaneum. Part I: Pathological anatomy and classification. *J Bone Joint Surg [Br]* 1993; 75-B:183-8.

Eastwood DM, Langkamer VG, Atkins RM. Intra-articular fractures of the calcaneum. Part II: Open reduction and internal fixation by the extended lateral transcaneal approach. *J Bone Joint Surg [Br]* 1993; 75-B:189-95.

Authors' reply:

Sir,

Thank you for sending us the letter from Messrs Triffitt and Parmar. They comment on both the methodology and on the implications of our classification.

We accept that the measurements that we made are not easy; we found them, however, to be reproducible in the overwhelming majority of cases. As Triffitt and Parmar suggest, some of the early images from Leicester were blurred. This affected measurement reproducibility in only four cases: these fractures were excluded from our study. We would be happy to discuss our methods in detail with anyone who contacts us. The measurements took about 45 minutes for each of 100 cases.

In answer to some of the specific questions, angles from curved surfaces were measured by constructing appropriate tangents. Measurements were made on the CT cuts which best showed the appropriate fragment; normally they are at the level of the lateral malleolus and sustentaculum tali as indicated in Figure 4 (p 185). In the absence of comminution of a fragment, the angular displacements of one fragment will not differ between cuts, but clearly a single planar scan can only measure displacement in that plane. All measurements were made on at least three consecutive cuts; each measurement was taken twice and averaged.

The pathological anatomy of the fracture is a more important question. Our Figures 1 and 2 do not conclusively demonstrate rotation of the lateral joint fragment about the transverse axis with respect to undisplaced parts of the calcaneum. We would be glad to see objective scientific data concerning such rotation, but reiterate the importance of the fundamental concept that the lateral joint fragment is very rarely depressed from the talus. Attempts at elevation will fail and will not reduce the fracture.

We agree that the primary fracture line crosses the posterior facet of the subtalar joint obliquely from posterolateral to anteromedial. The articular surface of the posterior facet, however, also has this oblique orientation. Therefore the primary fracture line separates a roughly quadrilateral portion of the joint surface on the lateral fragment and we have confirmed this at many operations. Our estimate of the proportion of the subtalar joint on the lateral joint fragment was made from the cut at the level of the sustentaculum tali; at this level both medial and lateral edges of the subtalar joint can

be seen (see Fig. 4, p 185). When the subtalar joint was clearly seen on more than one cut, measurements were made on each image and the average used. We found little variation between measurements made on different cuts in the same case.

The purpose of our classification is clearly stated in the paper. It is to help the surgeon plan the operative approach and to concentrate attention on the composition of the lateral wall. It was not intended to indicate whether the fracture should be fixed; this decision must be made on standard clinical lines taking into account the surgeon's experience, the needs of the patient, the displacement of the fracture and the size and fixability of the fragments. If the fracture is approached in the manner which we have suggested, the surgeon must be prepared to deal boldly with the lateral wall depending entirely on the evidence of the CT scan. The true composition of the lateral wall may be difficult to assess at the initial approach especially for those with less experience. We continue to use the classification for this purpose.

Finally, we are in wholehearted agreement that further scientific study is needed of methods of reduction and fixation of this difficult fracture. We hope that enthusiasm will be translated into appropriate collaboration for future multicentre studies.

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WEAR PARTICLES AND LYMPHADENOPATHY

Sir,

The paper in your March 1993 issue by Shinto et al on 'Inguinal lymphadenopathy due to metal release from a prosthesis' (1993; 75-B:266-9) included sections shown under both plain and polarised light (Fig. 3). The polarised light view clearly shows multiple small polarisable intracellular particles, as noted by the authors. They also state in the text that "Polyethylene usually appears as colourless spicules or shards that are strongly birefringent on polariscopy, but we detected none". There appears to be some confusion about exactly what is responsible for the birefringent particles in this case.

Metallic debris can cause obvious tissue discoloration, is easily identified in tissue sections, and can more readily be isolated, studied and quantitated. For these reasons, there has been a significant amount of work quantitating metal debris associated with prosthetic joint implants. Great care is needed, however, in studying the tissues from around a reconstruction with a polyethylene-bearing surface. Most polyethylene wear particles are less than 1 µm in diameter; the commonly recognised larger spicules or shards of polyethylene are actually in the minority. The presence of these very small polyethylene particles is often not appreciated (Schmalzried, Jasty and Harris 1992; Schmalzried et al 1993).

Birefringence with polarised light occurs when two rays of light vibrate in perpendicular planes and travel at different velocities through asymmetrical or laminated molecular structures, producing both a fast and a slow ray. It is a property of the material regardless of the size of the particle. Because the wavelength of visible light is 0.4 to 0.7 µm, particles in the submicron size range are not clearly resolved with the light microscope. The fine, diffuse, intracytoplasmic birefringence displayed in Figure 3b is uniformly present in tissue sections taken from around total hip replacements with a polyethylene bearing, and our investigations indicate that this type of birefringence is caused by multiple submicron particles of polyethylene.

On plain light microscopy, small metallic particles appear

as dark spots because of the density of the material. Under polarised light, these dark spots become more refractile, due to light diffraction around the edges of the particles, but not birefringent. Small polyethylene particles are colourless and transparent in routine histological sections and are therefore 'invisible' with plain light. With polarised light, however, they appear as small bright spots (birefringent) in previously 'void' areas. This is an important distinction for the correct identification of small particles.

For these reasons, I urge caution in attributing the lymphadenopathy in this case fully to the metal debris. Figure 3 demonstrates that there are many small particles of polyethylene in this tissue.

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Schmalzried TP, Jasty M, Harris WH. Periprosthetic bone loss in total hip arthroplasty: polyethylene wear debris and the concept of the effective joint space. *J Bone Joint Surg [Am]* 1992; 74-A:849-63.

Schmalzried TP, Jasty M, Rosenberg A, Harris WH. Light microscopic identification of intracellular polyethylene wear debris using oil red O stain. *J Appl Biomater* 1993; 4:119-25.

Shinto Y, Uchida A, Yoshikawa H, et al. Inguinal lymphadenopathy due to metal release from a prosthesis: a case report. *J Bone Joint Surg [Br]* 1993; 75-B:266-9.

Author's reply:

Sir,

Thank you for the opportunity to reply to Dr Schmalzried's letter. We agree that there is an important distinction between refraction and birefringence.

Our histological sections showed many dark particles in the inguinal lymph nodes; these particles showed refraction under polarised light, but not birefringence. We found no 'polarisable' particles outside the areas discoloured by metallic debris. We are willing to provide slides for independent assessment.

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MEASUREMENT OF POLYETHYLENE WEAR

Sir,

We read with interest the article in your March 1993 issue entitled 'Polyethylene wear in cemented metal-backed acetabular cups' by Cates et al (1993; 75-B:249-53). This involved measurements on plain radiographs to 0.05 mm, but we question this claimed degree of accuracy.

Interfaces on plain radiographs do not have distinct borders, and are affected by grain size, density, and thickness of film. In addition, physiological edge enhancement, the Mach effect (Lane et al 1976), can make these borders appear to be more distinct by an optical illusion. RSA studies have measured accurately to 0.2 mm (Albrektsson et al 1992) and we have been able to measure objectively to 0.1 mm from magnified radiographs (Maxwell et al 1993).

The increasing sophistication and accuracy of measuring devices need greater clarification of the relevant limits in each case: the diameter of a megakaryocyte is 0.1 mm (McDonald et

al 1968), but we would not consider measuring it by unaided visual methods.

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Albrektsson BEJ, Carlsson LV, Freeman MAR, Herberts P, Ryd L. Proximally cemented versus uncemented Freeman-Samuelson knee arthroplasty. *J Bone Joint Surg [Br]* 1992; 74-B:233-8.

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Maxwell H, Sampath SA, Hardinge K. Computer-assisted and visual measurements of lucent zones. *J Bone Joint Surg [Br]* 1993; 75-B:502-3.

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Authors' reply:

Sir,

Thank you for inviting us to comment on Maxwell and Sampath's letter. They point out the imprecision of measuring standard radiographs to the level of accuracy that we reported. Our methods were identical to those described by Livermore et al (1990). A single observer measured the radiographic interfaces in question with a caliper, rounding the results to the nearest 0.05 mm. We agree that for any one radiograph these numbers are meaningless. In our study, however, the pre-operative and most recent postoperative radiographs of many cases were measured and later used to calculate the actual distances, with adjustment for magnification, providing means for groups. Livermore et al (1990) reported an average accuracy of 0.075 mm and suggested that their technique required 80 patients in each group to approach statistical validity.

Our comparison groups fulfilled these criteria: there were 134 hips in the metal-backed group and 99 in the all-polyethylene group. Radiographic accuracy must improve significantly with longer follow-up, and our mean follow-up exceeded six years in both groups. We agree that radiographic measurements at this level of recording are not as accurate as direct retrieval studies, but large numbers of retrievals are impractical.

We feel strongly that our measurement of polyethylene wear using the technique of Livermore et al (1990) is an accurate method. A second independent observer has measured all of our radiographs: his results gave identical wear rates. We have also been able to substantiate this radiographic method by comparison with several retrieved specimens. We feel that the 37% increase in average linear and volumetric polyethylene wear rates seen when metal-backing is added to a cemented acetabular socket is a reproducible finding.

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Livermore J, Ilstrup D, Morrey B. Effect of femoral head size on wear of the polyethylene acetabular component. *J Bone Joint Surg* 1990; 72-A:518-28.