Fragility fractures of the ankle occur predominantly in elderly, osteoporotic women.¹ The pattern of the fracture is either bi- or tri-malleolar at the level of the ankle, or supra-malleolar of the tibia and fibula just proximal to the syndesmosis (Fig. 1). The mechanism of injury, if recalled, is often trivial.

The incidence of fractures of the ankle caused by low-energy trauma in the elderly is increasing.¹² Kannus et al² showed that in Finland, between 1970 and 2000, there was a threefold increase in the incidence of fractures of the ankle in patients older than 70 years of age. In particular, the more severe Lauge-Hansen³ supination-eversion stage 4 (SE 4) fracture has increased in proportion to the more stable supination-eversion stage 2 (SE 2) pattern in the elderly, particularly in women.¹ Bauer et al¹ showed that between 1954 and 1984 in women older than 50 years of age, the SE 4 to SE 2 ratio increased from 0.63 to 0.98. They noted that this age and gender pattern of incidence of SE 4 fractures is typical of a fragility fracture.

Fragility fractures of the ankle are inherently unstable and this, combined with osteopenia, makes their treatment extremely difficult. There is a paucity of literature on the subject. Hence, their optimal treatment is uncertain and controversial. Indirect stabilisation of unstable fractures of the ankle in the elderly, using intramedullary transarticular Steinmann pins, with or without additional fixation, is well documented.⁴⁻⁸ We report a modification of this technique using the Fixion IM expandable intramedullary nail (Disc Orthopaedic Technologies Inc, New Jersey). This is the first reported use of an expandable nail for this pattern of fracture.

Patients and Methods
Between October 2002 and December 2003, we treated 12 consecutive patients with fragility fractures of the ankle (Table I). All were women with a mean age of 84 years (75 to 95). None of the fractures was open. Seven were malleolar and five were supramalleolar; the malleolar fractures all being classified as Lauge-Hansen³ SE 4. All six malleolar fractures had lateral talar shift of greater than 2 mm on the anteroposterior (AP) radiograph. The four supramalleolar fractures were angulated more than 15° on at least one view.

All patients were treated primarily by stabilisation, using the Fixion expandable intramedullary nail inserted retrogradely through the calcaneum and talus into the tibial shaft.

Operative technique. Using templates and plain AP and lateral radiographs, the narrowest nail which would fill the medullary canal at the isthmus of the tibia when fully expanded was selected. The 8.5 mm diameter humeral nail was used in all cases; it expanded up to a max-
imum of 13.5 mm and had a proximal angulation of 5°. The procedure was performed with the patient supine, under fluoroscopic control and without a tourniquet. A single 1.5 g intravenous dose of cefuroxime was given at the induction of anaesthesia.

An incision of 1 cm was made on the heel, a guide wire was passed perpendicular to the sole of the foot, and directed towards the centre of the dome of the talus. An approximate guide for this skin incision was the intersection of the transmalleolar axis and the axis of the second ray. With blunt dissection the inferior surface of the calcaneum was identified. A large (> 3 mm) guide wire was drilled through the calcaneum across the subtalar joint and into the subchondral bone at the centre of the talar dome.

The fracture was reduced closed and the guide wire advanced across the ankle under fluoroscopic control. Reduction of the fracture and a plantigrade ankle joint were confirmed before using one-piece reamers to create a channel through the calcaneum, talus and subchondral bone of the distal tibia, 1.5 mm wider than the diameter of the unexpanded nail. The guide wire was removed and the unexpanded nail driven up into the isthmus of the tibia. The angled end of the nail was orientated to point laterally in order to maintain the normal hindfoot valgus. The inferior end of the nail was left flush with the plantar cortex of the calcaneum. The nail was expanded with saline up to a maximum of 50 to 70 atmospheres of pressure (Fig. 2). Stability was checked manually before applying the end cap. The incision was closed using a single half-inch Steri-strip (3M, St. Paul, Minnesota).

Post-operatively, the patients were mobilised fully weight-bearing either in a removable air-cast boot (Aircast, Summit, New Jersey) or wool and crepe bandages, depending on the patients’ preference, under the supervision of a physiotherapist. They were followed up at two and six weeks, at three, six and 12 months and then at yearly intervals. Once the fracture had united the nail was removed using the extractor device under general anaesthesia.

**Results**

Our main findings are summarised in Table II. There were no intra-operative complications. All patients began full weight-bearing, with a walking frame, one day after surgery. All wounds healed within seven days without complications. There were no cases of plantar nerve injury. One patient (case 3) developed a deep-vein thrombosis, requiring treatment with warfarin. Three further patients died from causes unrelated to their surgery at 40, 78 and 90 weeks after surgery.

There were no cases of delayed union, nonunion, or talar shift. Five nails were removed at a mean of 12 weeks. Six patients refused removal of the nail, despite our recommendation. They stated that they felt more stable than before their fracture.
All the patients were satisfied with their outcome. On the day of admission the functional score of Olerud and Molander was used to determine their pre-injury function, with a mean score of 69.6. Assessment at a mean of 67 weeks after surgery gave a mean score of 61.4. More specifically, nine of the 11 patients followed up returned to their pre-injury mobility and had no pain. The other two required a walking frame outdoors, whereas previously they had needed only a stick, and experienced mild pain from their ankle with excess activity only. There was no radiological evidence of degenerative joint disease related to insertion of the nail (Fig. 3).

**Discussion**

There are two distinct patterns which occur in fragility fractures about the ankle, either just above or just below the level of the syndesmosis. Because it is stronger than the surrounding bone, the syndesmosis remains intact. The fractures are inherently unstable i.e. through the tibia and fibula at the same level, in bone of low mechanical strength. This makes stabilisation difficult. In addition, the patients are often unable to comply with weight-bearing instructions after stabilisation, thus either jeopardising their outcome, or remain immobile until union of the fracture occurs. There is little in the literature against which to compare our results.

The supramalleolar type of fracture is too distal for an antegrade tibial nail, being within 4 cm of the ankle. We could find no reports on the results of external fixation and/or open reduction and internal fixation (ORIF) for these patients. Burman described a supramalleolar type of fragility fracture in an 87-year-old woman, treated by manipulation and a plaster cast for ten weeks. The fracture healed but there was no mention of the pre-injury or post-operative mobility.

Malleolar fragility fractures are a subgroup of unstable fractures of the elderly, but there are no reported results of the treatment of this subgroup. However, several authors have highlighted the difficulty of obtaining a satisfactory outcome. Manipulation and immobilisation in a cast are consistently reported to give unsatisfactory results. Rates of malunion or nonunion are as high as 48% to 73% in patients older than 60 years of age. Buckingham et al found that 17 of 25 patients treated in this way reported chronic pain at a minimum follow-up of one year. A correlation between malalignment of the ankle mortise and pain is well established. The results of ORIF are less consistent. Buckingham et al reported malunion in 19% and persistent pain in 56% of patients older than 60 years of age. Litchfield reported a rate of malunion or nonunion of 19% in patients older than 65 years of age with 42% of patients not satisfied with the results of their surgery. Beauchamp et al had a rate of wound complications of 20% in 71 patients older than 50 years of age, and noted an overall complication rate for women of 61% compared with 27% for men. They attributed this to the higher proportion of women with appar-
ently osteoporotic bone at operation (56% vs 18% of men), leading to difficulty with internal fixation.

Studies have been reported of fractures treated by ORIF with lower rates of complications.\textsuperscript{21-23} Leach and Fordyce\textsuperscript{23} found a rate of malunion of 8% and a rate of wound complications of 7% in 76 patients aged over 50 years. However, only three patients had a medial malleolar fracture. Ali et al\textsuperscript{21} reported a rate of malunion or nonunion of 10% in 50 patients older than 60 years of age, with 95% satisfied with their outcome. However, they excluded patients with severe problems of mobility. These are the patients who typically suffer from a fragility fracture. Anand and Klenerman\textsuperscript{22} reviewed 35 patients older than 60 years of age who had unstable ankle fractures treated by ORIF. There were three serious complications: deep infection, nonunion and talar shift in an 86-year-old diabetic man; loosening of the implant and medial malleolar malunion in a 92-year-old patient; and talar shift with instability in an 82-year-old woman.

The differing rates of complications between these series may reflect differences in the selection of patients. An unsatisfactory outcome in patients treated by ORIF has been attributed to poor bone quality,\textsuperscript{4,6,8,12-15} comorbidity,\textsuperscript{5,6,8,15} age,\textsuperscript{7,8} limited mobility before injury,\textsuperscript{4,8,15} and poor soft tissues.\textsuperscript{4,6,8} Many patients have these risk factors in addition to a highly unstable pattern of fractures.

We believe that the degree of mobility before the injury is very important in deciding on the method of treatment. Litchfield\textsuperscript{4} commented that the most encouraging predictor of a patient who would do well from ORIF, was whether they were active before injury. It is accepted that increasing age should not be a contraindication to ORIF in patients with no impairment of mobility before their injury,\textsuperscript{17,21,22,24,25} However, all the patients in our series had impaired mobility, but were not immobile before their injury. It is these patients who should be considered for stabilisation with an expandable nail.

Temporary transarticular stabilisation across the ankle and subtalar joints has been used either as sole\textsuperscript{5,6} or supplemental internal fixation,\textsuperscript{4,8} in addition to immobilisation in a cast. Childress\textsuperscript{5} stabilised 24 such patients older than 65 with limited life expectancy and weight-bearing potential, using a Steinmann pin for approximately six weeks. Oblique Steinmann pins across the ankle avoiding the subtalar joint have also been recommended.\textsuperscript{26,27}

The advantage of using an expandable nail rather than a solid pin is that the stability conferred on the site of the fracture once it is expanded is sufficient to allow immediate unrestricted weight-bearing without a cast. The exposure to radiation and operating time are reduced when using the expandable nail which does not require locking screws. The risk of iatrogenic nerve injury and stress riser effects in the bone from the insertion of locking screws are removed. The ability of an expandable nail to adapt to varying inner cortical dimensions, thus avoiding the need for cortical reaming, has been proposed as an advantage over traditional locked nailing, particularly in osteoporotic bone.\textsuperscript{28}

The potential long-term complications from this technique include arthritis of the ankle and subtalar joint. Childress\textsuperscript{5} found no radiological evidence of articular degeneration relating to the use of a 1/8 inch Steinmann pin, in 92 patients at a follow-up of one to 16 years. We have seen no clinical or radiological evidence of degenerative joint disease relating to the nail in our patients at a mean follow-up of 67 weeks. This period represents a meaningful proportion of the life expectancy of this group in which four of the 12 patients died at 3, 40, 78 and 90 weeks after the operation. Fracture around the prosthesis or of the nail are other potential complications. Hence we advise the removal of the implant after healing of the fracture. However, our experience shows this may be refused since the patients feel more stable with the nail in place than they did before injury.

Maintaining mobility in these frail patients is crucial in helping to prevent comorbidity and loss of social independence\textsuperscript{29} and, given the rising incidence of these fractures, to reduce their potentially enormous socioeconomic burden. We recommend stabilisation of these fractures using an expandable intramedullary nail as it has a low risk of complications and allows an immediate return to full weight-bearing.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


