The Gamma nail – a significant advance or a passing fashion?

According to a report from the Royal College of Physicians (1989) there were, in 1985, in the United Kingdom 46 000 proximal femoral fractures taking up 20% of the nation’s orthopaedic beds. If the age-specific incidence continues to rise at its current rate the number will be 117 000 by the year 2016. Approximately half are peritrochanteric fractures and almost all are treated by reduction and internal fixation to allow early mobilisation of the patient (Hornby, Grimley Evans and Vardon 1989).

In the United Kingdom the usual device for internal fixation of such fractures is a sliding hip screw. It has a higher success rate than fixed-angle devices but, nevertheless, there is a mechanical failure rate of between 10% and 20% (Wolfgang, Bryant and O’Neill 1982; Nunn 1988; Simpson, Varty and Dodd 1989). The most common problem is cutting-out of the screw from the femoral head (Davis et al 1990), but others include separation of the plate from the femoral shaft, plate breakage and disengagement of the implant components. Failure is related to instability of the fracture, inadequacy of reduction, inaccurate placement of the screw within the head and osteoporosis.

If the implant fails then the primary objective of the operation has not been achieved, and the large number of patients means that even failure rates of low percentage create a serious problem in terms of medical resources. The potential commercial gains for the manufacturer who produces the most popular device are also large. These factors, combined with the current vogue for closed intramedullary fixation of diaphyseal fractures, made it almost inevitable that an implant such as the Gamma nail would be developed, combining intramedullary fixation in the femoral shaft and a screw in the femoral head. The implant can be inserted by a closed technique and allows sliding between the two parts to permit controlled collapse of the unstable fracture, as with the sliding hip screw. The smaller exposure required may be associated with lower blood loss, shorter operating time and less wound morbidity. In addition, there may be mechanical advantages, the more medial position of the distal fixation resulting in a shorter lever arm and a lower bending moment on the device.

Three reports in this issue of the Journal focus on the use of the Gamma nail for the treatment of peritrochanteric fractures. The article by Rosenblum et al on page 352 describes the biomechanical properties of the nail and produces some surprising results. As they say in their introduction, it might be expected that intramedullary fixation would provide more efficient load transfer through the calcaneus than the sliding hip screw. In fact, however, calcaneal loading was reduced as fracture stability decreased. By contrast, the sliding hip screw gave increasing calcaneal compression with increasing instability. They hypothesise that the difference results from the inherent stiffness of the Gamma nail but quite rightly state that the consequences are uncertain. It is also interesting that the distal locking screws appeared to have no significant effect on load distribution along the proximal femur.

It is possible to criticise biomechanical studies such as this on the grounds that the testing has been done under static rather than dynamic conditions; the authors themselves make this point. It does provide a valid comparison, however, between this new device and the current standard implant. Their final conclusion is that the significance of their laboratory findings will be more clear when the results of clinical trials become available.

Two such trials are reported in this issue. The first is by Halder, who was responsible for the original design of a device similar to the Gamma nail. It was based on the Zickel nail but inserted by a closed technique. His design has been modified and combined with that of a similar device, independently developed in Strasbourg, to result in the current Gamma nail. His results with this nail, reported on page 340 are good in terms of ability to fix the fracture and to allow early mobilisation. His series,
however, is not a comparative one, and it is to be expected that someone involved in the development of an implant or prosthesis will achieve good results.

The most important test of any new device is for other surgeons to compare it, in a prospective, randomised and controlled trial, with the standard device. Such a trial is reported on page 345 by Leung et al. The findings in this well-constructed study suggest that the Gamma nail requires shorter screening time, shorter incisions and lower intra-operative blood loss than the dynamic hip screw. There was no significant difference in the duration of operation, the ease of insertion, the final clinical outcome or the incidence of varus displacement. Except for the lower blood loss these results are very similar to those of a previously published prospective randomised trial comparing these two implants (Bridle et al 1991).

Leung et al reported that the patients treated by the Gamma nail were able to achieve full weight-bearing in a significantly shorter time, although by only four days. Others who have used the Gamma nail have commented that the patients feel more secure about early weight-bearing (Lindsey et al 1991); this is consistent with the biomechanical finding that the Gamma nail becomes more load-bearing with increasing fracture instability.

If the final clinical results are similar for the two groups then the incidence of complications becomes important. Certain types of complication are the same in both; for example, overall mortality, which depends more on the general medical condition of the patient rather than on the choice of implant. There are similar incidences of varus collapse and of superior cutting-out of the screw. The latter depends on the ability of the surgeon to place the screw accurately in the head as well as on bone quality.

The overall incidence of complications with the two implants is much the same but the pattern is different. There was a slightly higher incidence of wound infection and of haematoma with the sliding hip screw (Bridle et al 1991; Leung et al 1992; Radford, Needoff and Webb 1992), but in no published trial has this reached statistical significance. This difference may be expected because of the smaller exposure and less soft-tissue dissection for the Gamma nail. Intra-operative complications have been more common with the Gamma nail, but this may be the result of a learning curve, and greater familiarity with the new implant is likely to reduce the incidence of this type of complication. New surgeons are always being trained, however, and it is important that operations are taught and learned consistently. It may also be that the modifications in design suggested by Leung et al (1992) will reduce this problem.

One type of complication seems to be specific to the Gamma nail: that of femoral shaft fracture, which may be either intra-operative or postoperative. An intra-operative fracture may occur at the base of the trochanter; this does not affect fracture healing, stability or the long-term result. The other type of intra-operative fracture, through the lateral cortex more distally, is probably related to technical error and makes distal locking necessary even for stable fractures. The incidence of intra-operative fracture can be reduced or eliminated by always using hand introduction and never hammering the implant.

The second type of femoral shaft fracture occurs postoperatively, around the nail or at its tip. All reported series to date have included at least one such fracture, the incidence varying from 2% to 12% (Bridle et al 1991; Halder 1992; Leung et al 1992; Radford et al 1992). This complication is more serious because it usually requires another operation in an elderly patient. Rosenblum et al (1992) suggest that compressive loads around the end of the Gamma nail may be a factor in producing these fractures, while Radford et al (1992) hypothesised that the shape of the nail caused pressure on the medial cortex in the subtrochanteric region and on the lateral cortex at the tip of the nail. The current Gamma nail has a 10° valgus angle; it may be that a smaller angle than this will produce a better fit and less local load concentration.

Conclusions. The Gamma nail, a new device for the fixation of proximal femoral fractures, appears to combine the advantages of intramedullary fixation with those of a sliding screw and can be inserted by a closed technique. Theoretically it is, therefore, very appealing. It is still evolving and its place has yet to be completely defined. It has certain advantages for the management of complex peritrochanteric fractures such as those with subtrochanteric extension. It has not, as yet, been shown to be better than the sliding hip screw for unstable peritrochanteric fractures. For a stable fracture almost any implant will be satisfactory; the unstable fractures are the problem.

The aim is effective fixation, good enough to permit early unprotected weight-bearing in an elderly group of patients. Further studies, which must be prospective and randomised, will eventually define more precisely the best design and the indications for the use of this new implant.

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REFERENCES


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Ceramic hips

Sir John Charnley (1979) concluded from the results of the McKee–Farrar metal-on-metal total hip replacement that high friction was the cause of failure. In the early sixties, he had introduced the concept of low-friction arthroplasty based on a small head articulating with an ultra-high-molecular-weight polyethylene cup (UHMWP), all components being cemented. He foresaw that the plastic would wear at about 0.1 mm per year, but he thought that the consequences would be minor. Ten years later, however, concerns about UHMWP wear began to be expressed. Rose et al (1979) reported very precisely the mechanical behaviour of this material in laboratory tests, and in 1990 Willert, Bertram and Buchorn described the foreign-body reaction in vivo to wear particles and cement debris. The relative importance of these materials was not clear at this time, mainly because it was difficult to differentiate between them and to compare their effects. As more information became available, the cystic formations and areas of bone osteolysis around cemented stems gave rise to the concept of 'cement disease'. However, when trials of the use of uncremented components were undertaken in France by Judet et al (1978), Lord et al (1988) and others, similar cystic formations were described around uncemented femoral stems and, to a lesser extent, around uncemented acetabular cups. Histological examination of these cases suggested that UHMWP particles could be responsible for the foreign-body reaction. Many experimental and clinical results have confirmed this hypothesis. Goldring et al (1983) described the osteolytic effect of the synovium-like membrane which surrounds loose prostheses. In vitro, UHMWP particles are even more powerful than cement in provoking macrophage reactions which lead to the stimulation of inflammatory mediators. In clinical practice, the high failure rate in heavy, active, young, male subjects correlates with excessive socket wear. Biochemically, it has been shown by Kim et al (1990) that prostaglandin E2 and collagenase concentrations are similar in the tissues surrounding failed prostheses whether they are cemented or uncemented. 'Cement disease' may be, in fact, 'UHMWP disease', with the plastic wear debris acting as the weak link in long-term joint replacement in young, active subjects.

The use of alumina ceramics in endoprostheses began in 1970 when Boutin (1972) implanted an alumina-on-alumina total hip into a patient. From its applications in dentistry, the material was already known to be highly biocompatible and strong. Of special interest were its sliding characteristics due to its hardness and wettability. It was possible to obtain a very smooth surface which resulted, with appropriate clearance between the components, in low friction characteristics and very little wear debris.

The first clinical trials achieved only fair results, the initial difficulties including poor quality control of the alumina with respect to purity, density, and grain size. There were also problems in the design of the head–stem fixation system and mistakes in surgical technique. Some failures were unjustly attributed to the ceramic, as in the case of the Mittelmeier prosthesis, reported by Mahoney and Dimon (1990), in which many of the stem and cup failures were related to other aspects of the design.

Now, with more than 20 years' experience of its use, it is possible to manufacture safe, high-quality, resistant alumina ceramic implants. Some limitations remain: the size of the femoral head must not be too small or it may break and the articular surfaces must be very accurately designed, with a clearance of 15 to 40 μm between the two alumina components. The surgeon must not hammer the ceramic head and he must accurately position the acetabular cup. Hammering may result in stress risers; positioning of the cup too vertically may cause point contact between the two components which could lead to dramatically increased wear. If these pitfalls are avoided the alumina-on-alumina hip prosthesis will produce about