

Experimental posterolateral spinal fusion with porous ceramics and mesenchymal stem cells

G. Cinotti, A. M. Patti, A. Vulcano, C. Della Rocca, G. Polveroni, G. Giannicola, F. Postacchini

From The University La Sapienza, Rome, Italy

Alternatives to autogenous bone graft for spinal fusion have been investigated for many years. It has been shown that osteoconductive materials alone do not give a rate of fusion which is comparable to that of autogenous bone graft. We analysed the effectiveness of porous ceramic loaded with cultured mesenchymal stem cells as a new graft material for spinal fusion in an animal model.

Posterolateral fusion was carried out at the L4/L5 level in 40 White New Zealand rabbits using one of the following graft materials: porous ceramic granules plus cultured mesenchymal stem cells (group I); ceramic granules plus fresh autogenous bone marrow (group II); ceramic granules alone (group III); and autogenous bone graft (group IV). The animals were killed eight weeks after surgery and the spines were evaluated radiographically, by a manual palpation test and by histological analysis.

The rate of fusion was significantly higher in group I compared with group III and higher, but not significantly, in group I compared with groups II and IV. In group I histological analysis showed newly formed bone in contact with the implanted granules and highly cellular bone marrow between the newly formed trabecular bone. In group II, thin trabeculae of newly formed bone were present in the peripheral portion of the fusion mass. In group III, there was a reduced

amount of newly formed bone and abundant fibrous tissue. In group IV, there were thin trabeculae of newly formed bone close to the decorticated transverse processes and dead trabecular bone in the central portion of the fusion mass.

In vitro cultured mesenchymal stem cells may be loaded into porous ceramic to make a graft material for spinal fusion which appears to be more effective than porous ceramic alone. Further studies are needed to investigate the medium- to long-term results of this procedure, its feasibility in the clinical setting and the most appropriate carrier for mesenchymal stem cells.

J Bone Joint Surg [Br] 2004;86-B:135-42.

Received 7 March 2003; Accepted after revision 15 September 2003

Posterolateral fusion with autogenous bone graft is commonly used in patients with developmental or degenerative spinal conditions which are unresponsive to conservative therapy. It has been shown that the procedure is safe and that, in properly selected patients, high rates of bony fusion and successful clinical outcomes can be obtained.¹⁻³ However, several limitations, including pseudarthrosis, pain at the donor site, the need for blood transfusion and prolonged operating times are known to be associated with the procedure.⁴⁻⁷

Alternatives to autogenous bone graft to achieve spinal fusion have been investigated over many years.⁸⁻¹⁴ It has been shown that bone morphogenetic proteins (BMPs) with adequate carriers may achieve similar, or even higher, rates of fusion compared with posterolateral fusion with autogenous bone graft.^{8,10,12,15} However, the cost of the dose of BMPs which is required is high and there are possible adverse effects of these growth factors.

Porous ceramic cylinders loaded with cultured mesenchymal stem cells have been tested as an alternative to autogenous bone graft in critical-sized defects of long bones.¹⁶ The results have suggested that healing of segmental bone defects was more likely to occur with porous ceramic loaded with cultured mesenchymal stem cells than with porous ceramics alone.¹⁶ Since the healing of a critical-sized defect of long bones is considered to be more challenging than that of other conditions, such as bone cavities, we hypothesised that porous ceramic loaded with cultured

G. Cinotti, MD, Orthopaedic Surgeon
G. Giannicola, MD, Orthopaedic Surgeon
F. Postacchini, MD, Professor of Orthopaedics
Department of Orthopaedics and Traumatology
A. M. Patti, MD, Biologist
A. Vulcano, Biologist
Department of Public Health Sciences
C. Della Rocca, MD, Associate Professor
Department of Experimental Medicine and Pathology
University La Sapienza, Piazzale Aldo Moro 5, Rome 00185, Italy.

G. Polveroni, Veterinary Surgeon
Veterinary Clinic, Via AM Ricci 109, 02100 Rieti, Italy.

Correspondence should be sent to Dr G. Cinotti at Piazza Acilia 4, 00199 Rome, Italy.

©2004 British Editorial Society of Bone and Joint Surgery
doi:10.1302/0301-620X.86B1.14308 \$2.00