Relevance to Musculoskeletal Conditions

Morsellized impacted allografts are used in arthroplasty revisions. This study addresses the biological events specific for this method.

Introduction

The use of morselized impacted cancellous allografts for hip arthroplasty revision surgery shows results which seem to differ dramatically from other kinds of allografting (1,2). In structural cancellous allografts, bone ingrowth is usually limited to 2-3 mm (3), whereas the whole of morselized impacted grafts seem to be remodelled in several cases as judged by radiography (1,4). In a previous study (5), we found that impaction of cancellous bone grafts in a bone chamber in rats leads to decreased ingrowth of new bone after 6 weeks as compared to unimpacted grafts. In the present study we analyze whether this decrease represented a final loss of ingrowth or just a delay, and if it was possible to reverse the decrease by adding a bone morphogenic protein (OP-1).

Materials and Methods

The Bone Conduction Chamber (6) consists of a titanium screw with a cylindrical interior space, with holes for tissue ingrowth only at one end. Thus, the tissue ingrowth distance from the holes towards the other end of the chamber can be measured. Bone grafts were taken from the proximal tibia of 200 g male Sprague Dawley rats. The grafts were frozen for 24 h. After thawing, some grafts were taken aside to become unimpacted controls and the rest were packed in an impactor in which two cancellous bone cylinders were compressed into approximately the size of one. The interior of the impactor was cylindrical, having the same diameter as the inside of the BCC. A piston in the impactor compacted the graft along its longitudinal axis. A pressure of 25 MPa was applied for two minutes during which fat and fluid could escape. The graft could be taken out as a bone pellet ready to be inserted in the chambers.

For the time study the impacted graft was compared to an unimpacted one in each animal. For the OP-1 study both sides had chambers containing impacted grafts. In order to enable absorption of the OP-1, the grafts were freeze-dried. Just prior to implantation, each graft was allowed to absorb 8 µL of an OP-1 solution diluted in an acetate buffer corresponding to 1 µg OP-1 per graft. The control sides were treated with buffer alone. The sides for experiment and control were changed for each rat.

Surgical procedure: Male Sprague-Dawley rats served as graft recipients. The proximal tibial metaphyses were exposed and the chambers were screwed into position so that the bone ingrowth holes were placed at cortical level.

Evaluation: The rats were killed after 6 and 12 weeks for the time study and 6 weeks for the OP-1 study. The specimens were sectioned along the axis of the chamber so that the ingrowth distance could be visualized. The area of the new ingrown bone was measured by using the Videoplan™ equipment at 40 x screen magnification. This enables the calculation of a mean ingrowth distance. The results were tested using Student’s paired T-test.

Results

Histology: After harvest, the unimpacted grafts all showed a newly formed marrow cavity behind an ingrowth front of woven bone. Almost all graft bone behind the ingrowth front was resorbed. In the compacted grafts at 6 weeks, the ingrowth distances were less, and usually no coherent marrow cavity had formed. The impacted grafts at 12 weeks and the ones treated with OP-1 at 6 weeks, showed an ingrowth similar to the unimpacted with a large marrow cavity and ingrowth of new bone far into the chambers.

Histomorphometry: Time study: At 6 weeks the ingrowth of new bone into the graft was less (0.7 mm) in the impacted grafts compared to the unimpacted controls (1.7 mm). At 12 weeks the bone ingrowth distance was similar in impacted (2.0 mm) and unimpacted grafts (2.3 mm).

OP-1 study: In the OP-1 treated grafts the ingrowth distance at 6 weeks was 2.7 mm compared to 1.2 mm in the controls without OP-1.

Discussion

Clinically, the ingrowth distance of the new bone into impacted bone appears larger than that seen in structural grafts. This does not seem to be due to better osteoconductive properties of impacted grafts. On the contrary, a decreased ingrowth was found at 6 weeks (5). In the present study, using the same model, we show that the ingrowth was delayed rather than decreased, i.e. a decrease was again found at 6 weeks but at 12 weeks the ingrowth distance seemed not affected by the impaction.

We do not know whether the delay is due to biochemical factors such as accessibility and circulation of growth factors or physical factors such as size and numbers of pores. The positive effect of OP-1 might indicate that physical factors were less important or at least possible to overcome.

The use of OP-1 in the clinical situation might be advantageous if a faster remodelling is desired.

References


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