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Letters

To the Editor:

Re: Kandziora F, Pflugmacher R, Scholz M, et al. Bioabsorbable Interbody Cages in a Sheep Cervical Spine Fusion Model. Spine 2004; 29:1845–55.

The authors reported on an experimental study comparing an autologous tricortical iliac crest bone graft with 2 different bioabsorbable cages (*i.e.,* a 70/30 poly[L-lactide-co-D,L-lactide] [PLDLLA] cage and a polymer-calciumphosphate composite [PCC] cage), both filled with autologous cancellous bone graft in a cervical spine interbody fusion model. Kandziora *et al* concluded that the PCC cage showed significantly better outcomes than the other two devices. In addition, the authors reported that the early appearance of large osteolysis and tissue reaction associated with the use of the PLDLLA material allowed skepticism regarding the clinical value of this bioabsorbable implant. We do agree with this conclusion concerning the implant. However, we do not agree with the remarks about the PLDLLA material.

To date, modern polymer technology allows the tailor-made design of devices with specific characteristics. For example, in orthopedic surgery, considerable experimental and clinical experiences have been gained with bioabsorbable osteosynthesis devices using various polymers with excellent results.[1–5] Specifically for spinal interbody fusion, Toth *et al*[6] and our group[7,8] reported on the use of two different polylactides (70/30 PLDLLA and PLLA, respectively) used as cage material. These long-term studies (24 and 48 months, respectively) have shown good-to-excellent results regarding fusion rate, degradation rate, mechanical behavior, and tissue response. However, by contrast, Kandziora *et al* observed implant failures and grades I–III foreign body reactions in all animals of the PLDLLA group after a follow-up of only 12 weeks. What causes these striking differences? We agree with the authors that an explanation for the results reported is a very rapid breakdown of the polymer material. They attributed this accelerated degradation to the amorphous PLDLLA homopolymer structure of the material. However, information about this parameter as well as other relevant information explaining the breakdown is not provided in their study. Therefore, we will discuss them.

1. The description of the materials used is inadequate. Kandziora *et al* mention only the chemical component of the experimental PLDLLA cage. There is no information about the PCC cage regarding the polymer used and the composition of the calciumphosphate. In addition, there is no description of the chemical characteristics of the PCC or PLDLLA material as raw material after the fabrication processing, after the sterilization process, and after the experiments. Biochemical parameters influencing the degradation rate, such as molecular weight, molecular weight distribution, crystallinity, inherent viscosity, glass transition temperature, residual monomer, and the presence of additives or impurities, may differ considerably in raw material and as a result of processing and handling.[2,9–12] For example, the "thermal history" of the polymer, which includes the fabrication and sterilization process, significantly affects the mechanical and physical properties of polymer based devices.[2,10] In addition, the use of poor raw material or of not optimal processing (fabrication) techniques can result in high amounts of residual monomers, which increase both the degradation rate and the crystalline degradation products, leading to a microporous structure in only a few weeks.[2] Obviously, under-loading conditions, an early collapse of the polymer device, and an adverse tissue response can occur.[11,12] Thus, detailed knowledge of the fabricating and physicobiochemical parameters of the bioabsorbable material as raw material after processing and after conducting experiments is essential for interpretation of the results presented by the authors. None of these data are provided in the present study or in the authors' previous studies.[13,14]
2. The used cage designs are different and inadequate. Kandziora *et al* compared cages with different materials and different designs. This is a serious methodological drawback because one cannot tell whether the differences in result are caused by the material, design, or both. One effect of a different cage design is that the mechanical stability of the operated spinal segment and, thus, the loading regime of the cage are different. The latter is known to influence the degradation rate of a polymer. In addition, it has also been shown that polymer degradations kinetics is influenced by the implant design itself.[15–17] Specifically, higher (wall) thickness of a polymer device leads to a faster degradation

rate as a result of a heterogeneous hydrolysis (the rate of degradation being higher inside the polymer than at the surface).[7,15] Degradation causes an increase in carboxylic chain ends that autocatalyse the ester hydrolysis.[17] These carboxylic chain ends can diffuse from the surface of the cage, but those located well inside the matrix maintain entrapped and contribute completely to the autocatalytic effect, enhancing the degradation rate.[15] Kandziora *et al* used PLDLLA cages with a significantly higher (wall) thickness (approximately 5 mm) compared to the cages used in the experiments performed by Toth *et al*[6] and our group.[7,8] A (wall) thickness of this magnitude provides another possible explanation for the premature degradation of their cage, eventually resulting in cage collapse, foreign body response, and osteolysis. Thus, polymer cage design is an important parameter that should be considered when planning and performing experimental studies.

The authors briefly refer to the early human clinical experiments with a 70/30 PLDLLA cage.[6,18] Recently, a much longer clinical follow-up with this PLDLLA cage has been reported, apparently without catastrophic results and having high fusion rates.[19] The suggestion that the PLDLLA material used in the authors *in vivo* animal study is comparable to the PLDLLA used in these clinical and preclinical studies is, based on the arguments discussed previously, unfounded and, therefore, misleading. In fact, the results of Kandziora *et al* strongly suggest that the material, cage design, and/or loading conditions differ considerably. Their material failed for yet unknown reasons and should not be used clinically. In this respect, we agree with the authors that carefully planned and scientifically sound designed, long-term animal studies are needed to evaluate properly select and processed polymers as basic material to be used as interbody fusion cages.

In conclusion, we would like to highlight the importance of an accurate description of the dimensions, chemical composition, and degradation parameters of bioresorbable polylactide devices in any future *in vivo* and *in vitro* studies, before and after the experiment. Reporting these parameters enables a comparison between studies, and provides vital information about the material and the relation between material behavior and tissue response. Coverage of this information will lead to a more effective, further development and prudent application of these materials as the principle component of interbody fusion cages.

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