New cements for vertebral lesions

February 7 2008

A number of researchers at the Department of Polymer Science and Technology at the Chemistry Faculty from San Sebastian at the University of the Basque Country, led by Ms Isabel Goñi and Ms Marilo Gurrutxaga, are studying new formulae for acrylic copolymers and compounds in order to obtain efficacious, multiuse bone cements with reduced side effects.

Acrylic bone cements based on polymethylmetacrylate (PMMA) have been traditionally used in hip replacements in order to set the prothesis inside the bone. On the other hand, with new techniques such as vertebroplastia, the cement is injected into an affected vertebra by means of long and narrow needles, visualized with X rays.

Vertebroplastia is mainly applied in the treatment of vertebral fractures due to osteoporosis or bone tumours, with the aim of reinforcing the bone and alleviating the pain. It is a minimally invasive and rapid technique (~ 40 min/vertebra) and efficacious in alleviating pain (80-90% in 72 h) due to the mechanical reinforcement provided by the cement. Nevertheless, the risk of migration of the cement and of bone necrosis has to be taken into account given the exothermia of the polymerisation reaction and the toxicity of the monomer. Researchers at the Department of Polymer Science and Technology at the University of the Basque Country (UPV/EHU) focused on this, amongst other items, in this study.

Viscosity and radiopacity

The formulae used for the cement in vertebroplasty consist basically of the monomer, PMMA pearls and a radiopaque agent. This last ingredient is what enables the visualisation of the cement mass during the injection. These formulae have to comply principally with the following requisites: appropriate viscosity and high radiopacity. The cement has to have a certain consistency so as not to drip, and sufficient fluidity to be injected, as well as being highly visual with X rays, so that the surgeon can see what is being injected.

In order to adapt the traditional formulae to new applications, surgeons usually modify the cements when operating, in order to facilitate their injection, either adding more monomer in liquid phase to reduce viscosity and increase the time for working or, otherwise, increasing their visibility for the X rays by the addition of more radiopaque agents. All these changes affect the properties of the cement and its toxicity. This is why researchers at the Department of Polymer Science and Technology at the UPV/EHU are seeking to develop new formulae for acrylic bone cements designed specifically for injectable use and which provide what could possibly be an additional therapeutic action.

The UPV/EHU researchers have seen that it is possible to obtain injectable bone cements with rheological properties and with suitable selection of PMMA pearl particle size. Given that the greater the size of the pearls, in some way the heat produced during polymerisation is dissipated more and not so much exothermia is produced in the polymerisation reaction, thus producing a greater heating of the tissue.

Once the PMMA pearl particle size is selected, certain radiopaque and/or therapeutic agents are incorporated that can intervene in the process of curing and quantify the effects produced in the properties of the cement. On the one hand, bismuth salicylate has been added, combining the analgesic effects of salycilic acid with that of the bismuth, a metal easily visible using X rays. Thus, the results reflect a

suitable radiopacity provided by the bismuth, a therapeutic effect of the salycilate and less toxicity and good compatibility overall.

Also, acrylic cements are formulated by adding bioactive elements, the idea being to obtain the interaction between the cement and the biological tissue, in some way causing the fixing of the tissue (osteoregeneration). In fact, strontium hydroxiapatite has been incorporated in order to combine the visibility of strontium and the immediate fixing of acrylic cement with the long-term fixing of the bioactive ingredient.

Finally, thanks to collaboration with other research centres, the EHU-UPV researchers carried out in vitro and in vivo biocompatibility studies. The studies undertaken to date have not given any more problems than cements with traditional commercial formulae.

Source: Elhuyar Fundazioa