

K.-D. Kühn

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Bone Cements

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K.-D. Kühn

# Bone Cements

**Up-to-Date Comparison  
of Physical and Chemical Properties  
of Commercial Materials**

With 207 Figures, 190 in colour and 132 Tables



Springer

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## Foreword

Methyl methacrylate (MMA) is the basic component of bone cements. To use it, a dough is prepared from the liquid and powder by mixing right before application, which is normally done by the operating team. During its working phase the dough is then inserted into the tissue where polymerization is completed. Thus, the final implant polymethylmethacrylate (PMMA) is only created at the implantation site.

Besides methyl methacrylate, bone cements sometimes contain other methacrylates, such as butyl methacrylate. To achieve X-ray opacity, radiopacifiers (zirconium dioxide or barium sulfate) are added to the powder. Both the liquid and powder components contain additives (initiator and activator) that launch polymerization and control the setting when mixed together. Moreover, softener and emulsifiers are sometimes used. The addition of antibiotics to the powder component in order to prevent or treat infections has become especially important.

Commercial bone cements differ in composition and the course of curing. Some are designed for high and others for low viscosity. The way the user handles and applies the cement always crucially influences the quality of the implant.

This is why clear and comprehensive information about the cements should be available to show the user how all the relevant factors work together and how they depend on each other. It should also be possible to compare the different cements. Such information has not been readily available before and one can only obtain partial information by thorough study of the literature. Therefore, this book fills a definite gap and sets new standards at the same time!

The intention of the author, an excellent authority in this field, was to create a reference book on bone cements, and he succeeded. The book gives all information necessary in a clear manner. It starts with an explanation of polymerization with its associated phenomena, such as the setting characteristic, generation of heat, shrinkage or residual monomer; the relationship between molecular weight and mechanical strength is indicated, as well as the dependency of strength on the sterilization method. Then all the test methods used are presented, followed by individual chapters on all bone cements on the market. Their composition and chemical and physical properties are set forth in detail. Special emphasis is put upon the working characteristics. The packaging of the cements is described in detail and compared to the ISO 5833 requirements. All results are summarized and compared thoroughly.

Thus, this book is really a treasure for:

- the disciplines of orthopaedics, surgery, neurosurgery, cranial/facial surgery and others using bone cement,
- further examinations in the field of materials science,
- disciplines only occasionally occupied with bone cements with a need for special information (examination of allergic reactions, cases of failures of bone/joint implants).

I hope that the book is widely accepted and that it is used by people in many fields.

March, 2000

H. G. Willert

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## Preface

Until only a few years ago, all bone cements had to comply with the tough requirements of the German Drug Law (AMG). With the introduction of the Medical Device Law (MPG) bone cements are no longer classified as drugs but as medical devices, which facilitates the registration of new products. Unfortunately this means lowered requirements for the growing number of bone cements on the market.

Since all cements are based on the same chemical substance, methyl methacrylate, one could think that all cements are alike if further details are not taken into consideration. For the surgeon, his staff and, of course, for the patient, it is very important to make the optimal choice in order to assure the best long-term results for the patient.

For a scientifically based selection an extensive comparative examination of all cements in the market is necessary. These data were not available thus leaving the surgeon and the patient in an unsatisfactory situation. So we have performed this full comparison and compiled the results. We did not only apply tests according to the relevant standard but also developed other methods yielding worthy data about material properties of high importance for the surgeon and the patient.

Why was this work carried out in our company? We have followed the development of bone cements very closely ever since they were used, so we have gained a high competence in the field of methacrylate chemistry over some decades. Moreover, we had the unique chance to learn from Dr. W. Ege, a bone cement specialist known all over the world. It is him, a great scientist and a wonderful person, that I want to express especially my personal gratitude for helping me understand the exquisite matter of methacrylates. The cooperation of Heraeus Kulzer with the competent partners Biomet-Merck and Schering-Plough, well-tested for many years, also proved very successful.

Heraeus Kulzer GmbH & Co. KG will continue to be a center of competence in the field of bone cements.

All bone cements were tested according to ISO 5833/2. Additionally we examined the handling properties, release of antibiotic, content and release of residual monomer and the glass transition temperatures. On some products we also tested the fatigue strength to obtain indications of the long-term stability in the body.

The presented results show clearly that bone cements are not all alike.

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