The synthetic Bone Substitution Materials (BSM) have become an indispensable tool for the orthopedic surgeon who has to fill gaps left by cancer, osteoradionecrosis, fractures. They have a mineral composition similar to the human bone and they have the purpose of being a scaffold for the surrounding bone, a support on which they can grow osteoblasts, a network on which new bone can grow. Synthetic materials are a good alternative to the xenografts and allografts [1]. Xenograft and allograft are generally associated with potential infections and they require extensive and rigorous control before they are used in patients. Thus, interest in synthetic implant materials for bone grafting has been on the rise [2]. There are different classes of BSM which are very prominent in ceramic. The basis of these substitutes is usually calcium phosphate, due to its good biocompatibility because its similarity to the mineral phase of natural bone tissue, the materials with ceramic structure substitute in many cases the most widely used bone cement: polymethylmethacrylate (PMMA). PMMA has several drawbacks such as heat development and high allergenic potential [3]. Furthermore, the PMMA is not osteoconductive and has an elastic modulus very rigid. This alters the tribology of the bone, because in an elastic element is inserted hard as a stone. This “stone” is not absorbed and remains in place without integrating with the surrounding environment. In order to avoid these problems related to PMMA several cement material based on ceramic have been developed. Beside their good biocompatibility these materials are also osteoconductive. The basis of these substitutes is usually calcium phosphate. The search for better results has led to modifications in the sintering process by which these materials are formed. These modifications result in multiple forms of calcium phosphate materials, with variations in the calcium-to-phosphate rate and porosity, which can affect biocompatibility and mechanical resistance. One such variation is calcium sulphate/hydroxyapatite composite (Cerament™) [4]. The calcium sulphate graft had been completely resorbed and replaced by physiologically regenerated bone [5]. Hydroxyapatite is a bone mineral, which comprises 90% of the inorganic matrix of bone and is osteoconductive [6]. It is widely used in surface coating of joint replacements, as it facilitates direct bone ingrowth onto the prosthetic component [7,8]. It has also been used as a bone graft substitute but is poorly resorbed (compared to calcium sulphate) [9]. Calcium sulphate and hydroxyapatite have pure osteoconductive qualities, thus creating a suitable environment for new bone formation. The combination of calcium sulphate and hydroxyapatite enables rapid resorption of calcium sulphate but leaves a coral matrix of porous HA behind [10]. Cerament™ is an injectable synthetic bone graft substitute. The calcium sulphate is gradually resorbed during months, allowing for natural bone ingrowth, while the hydroxyapatite acts as a longterm scaffold embedded into the new bone [11]. It is designed to mimic the properties of cancellous bone in terms of stiffness and strength. It provides sufficient support while avoiding mechanical mismatch between the bone substitute and the surrounding natural bone. The Cerament™ is used to restore the bone gap in major failure in osteoporotic spinal surgery, in cancellous bone loss in fractures (i.e. fractures of the calcaneus and tibial plateau), to fill bone cysts.

The characteristics of the PMMA and the Cerament™ are clear and different. But are their functions really comparable? PMMA is widely used in the cementing of the prosthesis in order to unite the metallic prosthesis to the bone. This is a unique feature of the PMMA which acts as excellent glue. In short, the Cerament™ not have the ability to “paste”, but to fill and be replaced by new bone. The modern orthopedic prosthetic joint tends to restore diseased bone using this, pointing to natural osteointegration of the implant. However, when the bone is osteoporotic, the PMMA is essential in stabilizing prosthetic. But the PMMA used is always present between the bone and prosthesis without being absorbed. This can be a source of infection and loosening of the prosthetic implant. A useful and revolutionary research would develop a compound based on calcium sulphate to act as a primary stabilizer of the prosthesis and by promoter element of implant osteointegration with the bone. I now give the floor to biomedical engineers.

References


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