STRUCTURAL AND ULTRASTRUCTURAL COMPARATIVE STUDY OF TITANIUM AND ZIRCONIUM IMPLANTS IN RABBIT FEMUR

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Abstract

As years passed by, the use of biomaterials for implants in hard tissues became more commonly used. Since they are heterologous materials, it is extremely important that before using any implant material, it is minutely tested from different points of view. The implant has to display special characteristics so that it may be accepted by the body, even if it is perceived as a foreign object. At the same time, the implant has to allow the appropriate proliferation of the repairing tissues around it till it is totally incorporated in the hard tissue (bone). The incorporation has to be so well made so that the implant is stable/resistent to the mechanical demands (pressures, pulls, etc.) that will act upon the region where it shall be inserted. The implant material needs to display specific characteristics so that the body accepts it as best as possibile and incorporates it extremely well in the hard tissue. These properties refer especially to aspects of biocompatibility, implant construction and biomechanics (Osborn and Newesly, 1980).

Keywords *:* osseointegration , titanium, zirconium, scanning electron microscopy

INTRODUCTION

The osseointegration of implants is a complex process implying a relatively long period of time. Over time, the use of biomaterials for implants inserted in hard tissues has become more common. Since they are heterologous materials, it is extremely important that before using any implant material, it is minutely tested from different aspects [3]. The implant needs to display special characteristics so that it may be accepted by the body, even if it is perceived as a foreign object.[6] The speed of the process is pretty slow but it is not the same during the whole period of time, as one can notice significant differences from a period of time to another. Moreover, this speed may be greatly influenced by the characteristics of the implant used[1]. Taking into consideration these aspects, we found it appropriately to study the processes of osseointegration of a common implant in dentistry (titanium implant) compared with a brand new one (zirconium implant) which is more and more appreciated in recent years. In order to assess the results obtained during the experimental period of time, one may use the optical or electron microscopy, each with its specific advantages and limitations (Jansen, 2003).

MATERIAL AND METHOD

We chose the rabbit as an experimental animal based on certain objective criteria. Thus, the thickness of the dyaphysis of rabbit's femur is more than appropriate when it comes to testing these types of implants which are wholly inserted in bone and which get partly into the medullary cavity. These aspects are extremely important for tracing the processes of osseointegration, providing information on the tolerability of the host tissues to the implant, the speed of proliferation of tissues covering the implant and if the implant is partly or wholly wrapped in the newly-formed bone and on the segment surpassing the wall of dyaphysis towards the medullary cavity. The present study was performed on 8 crossbred rabbits, 7 months old, raised in the biological facility of the Faculty of Medicine and Pharmacy of Oradea. The materials used for this experiment were titanium and zirconium implants with the length of 5 mm and thickness of 2.5 mm which were inserted in the middle region of the femur, in the same femur of a rabbit, placed one next to another.

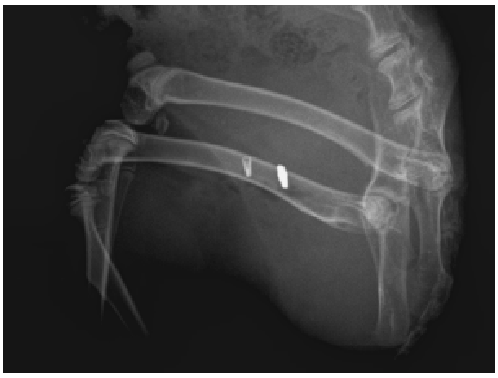

Figure1. Radiological aspect of the position of implants in the same femur

For conducting the necessary studies, by using the SEM electronic microscope and the stereo magnifying glass, the femur fragment harvested was placed in a glutaraldehyde solution 2.7%, in a phosphate buffer solution 0.1 M for two days, at room temperature; then they were dehydrated for 3 days, covered with Au and eventually examined.

RESULTS AND DISCUSSION

The animal was generally anesthetized after a procedure consisting in mixing the two substances. Ketamine 0.5 ml/kg and Xylasine 0.25 ml/kg were administered, while post-operative, it was administered an antibiotic, i.e. Enroxil 0.7 ml/kg for 5 days. The two types of implants were placed in the same femur at at distance of approx. 1.5-2 cm; an x-ray scan was performed as soon as the implants were inserted. The surgical procedure was chosen so that the implant inserted in the bone mass of femur had its end at the same level with the bone surface. The purpose of making use of this procedure was to underline to formation of the new bone tissue and the proliferation of the osteoblasts around the implant both at the surface of the bone and to the opposite part in the inner part of the medullary cavity. We analyzed and interpreted the results after 60 days from the day when performing the implant procedure. In this context, the purpose of the comparative study is to assess the nature of the chemical composition of the implant. The period of time chosen does not represent a standard point of reference. It may be arbitrarily chosen depending on the objective established.

The formation of the cancellous bone around the implants is illustrated by images obtained by electron microscopy. Figures 2, 3

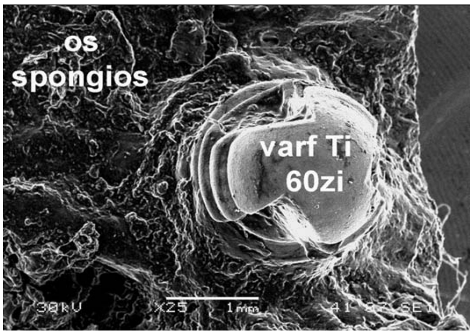

Fig. 2 Ti60day.The head of the implant introduced in the medullary cavity surrounded by cancellous bone tissue

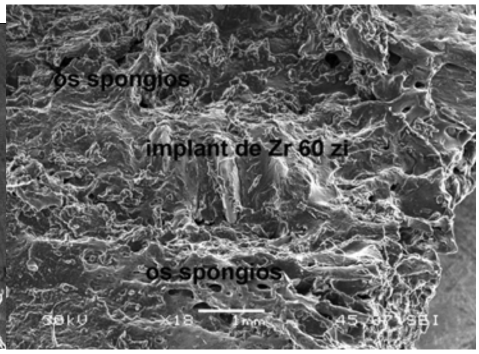

Fig.3 Zr60day. The Zr implant after 60 days in the medullary cavity, completely covered by the cancellous bone tissue

The compact tissue is covered with spongy tissue towards the medullary cavity. Due to this technique, we could highlight on the windings of the two implants the formation of the bone structure and their position at the surface of windings.

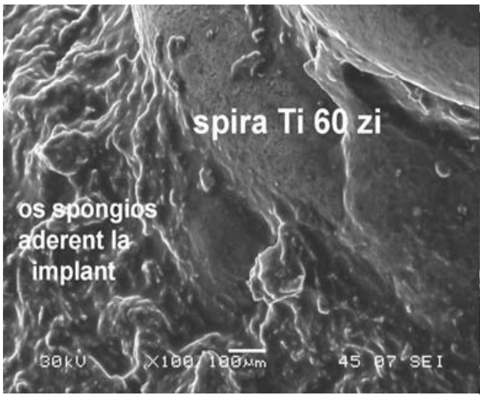

Fig4 Ti60day Detail from the exit zone of the implant in the medullary cavity

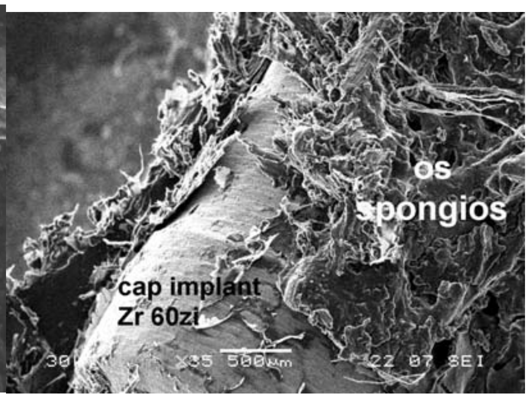

Fig5 Zr60day Firm adherence of the cancellous bone tissue at the surface of the implant

Furthermore, we shall illustrate the same processes of evolution and the newly formed bone structures but using, this time, the stereo magnifying glass.

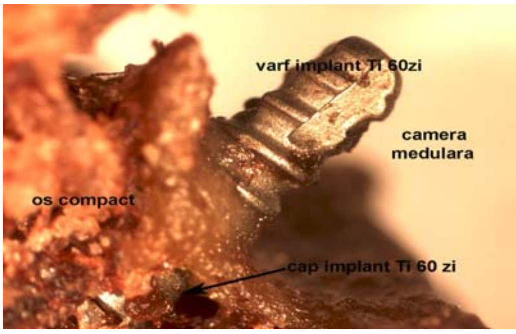

Fig 6Ti 60day Head of implant Ti 60 day observed in the medullary cavity ob. 1,5xintim

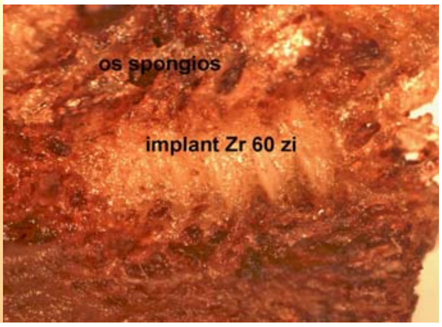

Fig 7 Zr 60day The implant is completely covered and surrounded by cancellous bone tissue 1x

The examens performed with the SEM microscope and with the stereo magnifying glass allow only the observation of the surfaces of the structures studied, without the characterization and the details of the histological and cell structures. Both implants are very well integrated and firmly fixed by the surrounding newly formed bone tissue, mentioning that the Zr implant, after 60 days from its insertion turns out to be better fixed in the newly formed bone mass.

CONCLUSIONS

Our studies underline a good incorporation in the bone mass of the two types of implants that were studied. The comparative study performed by electron microscopy outlines that the Zr implant is much better fixed in the newly formed bone mass compared to the Ti implant, ensuring thus a long-term stability of the implant.

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