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# Microradiographic and histological analyses of 17 long standing human dental implants

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**Abstract**

**Objectives:** Dental implants are widely used nowadays in single-tooth loss or for anchoring a dental prosthesis. For a long standing the implant must be sufficiently osseointegrated. In anatomical specimens are to find increasingly dental implants which are useful to investigate.

**Methods:** Microradiographic and histological analyses were performed on 17 dental screw-type implants deriving from the mandibulae of five anatomical specimens aged from 69 to 87 years. For three individuals data were available by inquiring the relatives: implantation was 11, 10 and 7 years before death. One of the three cases was a tumor patient. The interforaminal part of the mandibula was resected 7 years before death and replaced by an iliac crest autograft, into which four implants had been inserted some time later. Each of the 17 implants was isolated by cutting the mandible into bone blocks. After embedding, cutting and grinding the sections were x-rayed and stained.

**Results:** With exception of the tumor patient, in all cases an intimate contact between compact and/or cancellous bone and implants was given. No translucent lines between bone and implant were detectable by microradiography. The threads and interspaces of the implants were in contact with mineralized, new compact bone, or spongy trabeculae reached the implants surface rectangulary. Bone resorption phenomena were observed in the crestal area only.

**Conclusion:** The results show that functional loading for even more than ten years is the basis for biomechanical integration of dental implants. Continuous bone remodeling seems to guarantee implant stabilisation independent from age.

**Key words:** dental implants; osseointegration; anatomic specimens

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## Introduction

Histological descriptions of osseointegrated human dental implants deriving from anatomical specimens are rare in literature. There exist some histomorphologic patient reports of one, two or three implants with evidence of osseointegration following several months until 4 years after implantation.[1-3] A greater number of implants, in place for 1-16 years, was analysed after their failure.[4-8] The authors were able to specify the causes of implant failure only by inspection of a very small sector of bone surrounding the implants.

Post mortem dental implants of healthy maxillae or mandibulae allow not only the analysis of the bone-to-implant contact (BIC) but also the integration of the implant into the cancellous and spongy bone framework. Successful osseointegration and functional stability of dental implants depend not only on the immediate bone-implant contact. There is an essential need of functional incorporation of the implant into the bending-free trabecular network. This basic principle was shown by Koebke et al.[9] for a new designed femoral short stem implant.

## Materials and Methods

In routine dissection courses five specimens (two males of 69 and 79 years; three females of 74, 78, 87 years) with dental implants (n=17: 7 x Brånemark, 4 x Pitt-Easy Bio-Oss, 4 x TPS, 2 x IMZ) were found. All implants were placed in the interforaminal region of the mandibula, serving for connective suprastructures. For three individuals data were available. Implantation was performed 11, 10 and 7 years before death. One of these three cases was a tumor patient with operation 7 years before he died. The interforaminal part of the mandible was resected and replaced by an iliac crest autograft, into which four implants had been inserted some months later. Tested by finger grip, all implants were mechanically stable. The interforaminal part of the mandibles was isolated and x-rayed in labio-lingual direction (Faxitron Cabinet X-Ray System, Hewlett-Packard, USA). Then the mandibles were cut into bone blocks, each containing one implant. After embedding (Technovit 7200, Kulzer, Norderstedt, Germany) cutting and grinding, the sections (thickness 60-80 micrometers) were stained (Masson Trichrom Goldner). The staining allowed to differentiate old and newly formed osteons. From each in situ-implant 3-4 sagittal sections were obtained. Microradiographs were made from all sections (Agfa Structurix film; Faxitron Cabinet X-Ray System, Hewlett-Packard, USA).

## Results

Although only for three of the five individuals data were available, we deduce from the types of implants used that the implantation generally was several years before death. With exception of the tumor patient, in all cases an intimate contact between bone and implant was given. Bone resorption phenomena were observable in the crestal area of all implants **(Figures 1A, B; 2A; 3A; 4A, B,** and **C).** The apical tip of the implants often is settled on dense and close-packed lamellar bone **(Figures 1A, C; 2A** and **3A).** The threads and interspaces of the implants were in contact with mineralized, new compact bone, or spongy trabeculae reached the implants surface rectangulary **(Figures 1A, C, D** and **2B).** There are typical signs of remodeling and new bone formation **(Figures 2A, B; 3A** and **B).**

In the tumor patient, for two of the Brånemark implants the osseointegration was satisfactory; the others

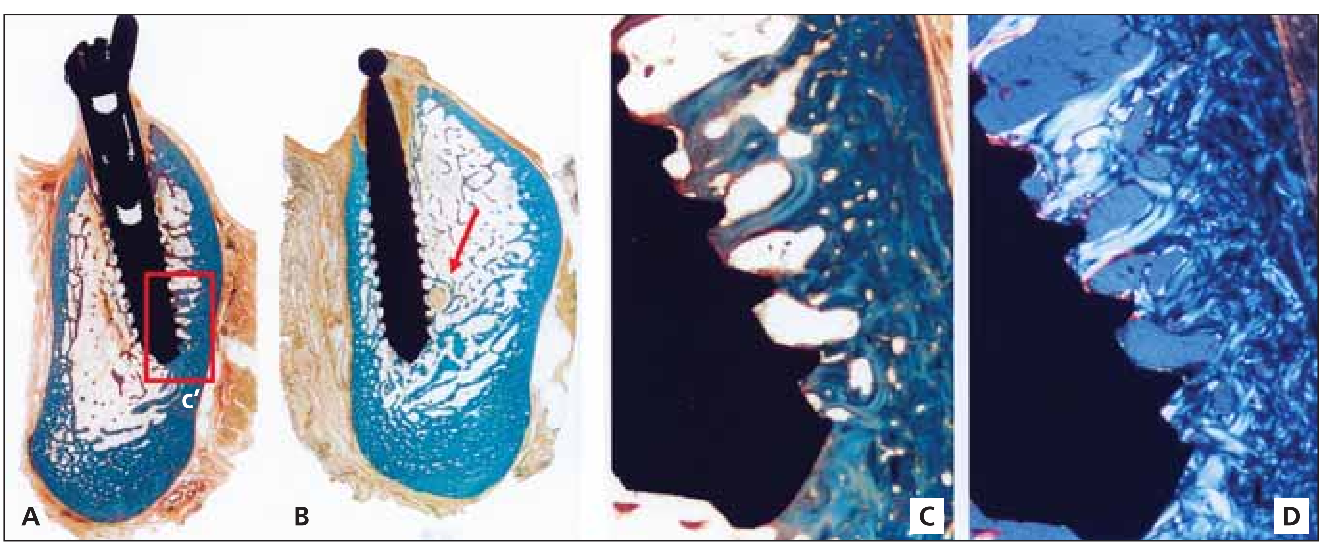


**Figure 1. A:** Median-sagittal section of a Pitt-Easy Bio-Oss implant and anterior mandibula (male, 79 years; implantation 11 years before death); Masson Trichrom Goldner. **B:** Paramedian-sagittal section of a Pitt-Easy Bio-Oss implant (bicortical screw type), same individual; **arrow** shows an interforaminal, lingual ramus dentalis inferior; Masson Trichrom Goldner. **C:** Enlarged section **c'** (from **Fig. 1A**) with rectangular trabeculae in contact with the threads; magnification x20. **D:** Enlarged section **c';** polarized light reveals dense and parallel-orientated collagen fiber-bundles indicating stress-transmission; magnification x20.

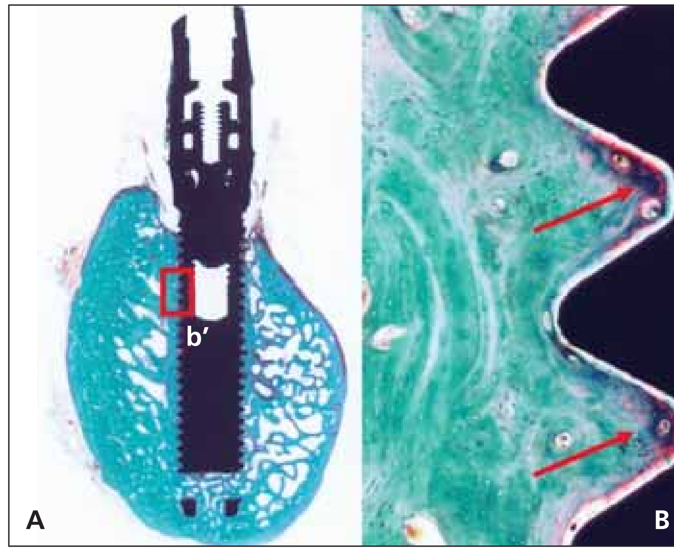


**Figure 2. A:** Sagittal section of the anterior mandibula with a Brånemark implant (female, 78 years; date of implantation unknown); extensive and compact osseointegration of the implant; Masson Trichrom Goldner. **B:** Enlarged section **b′;** higher magnification (x 100) showing the threads filled with small, newly formed red-coloured osteons (**arrows**) indicating mineralization process.

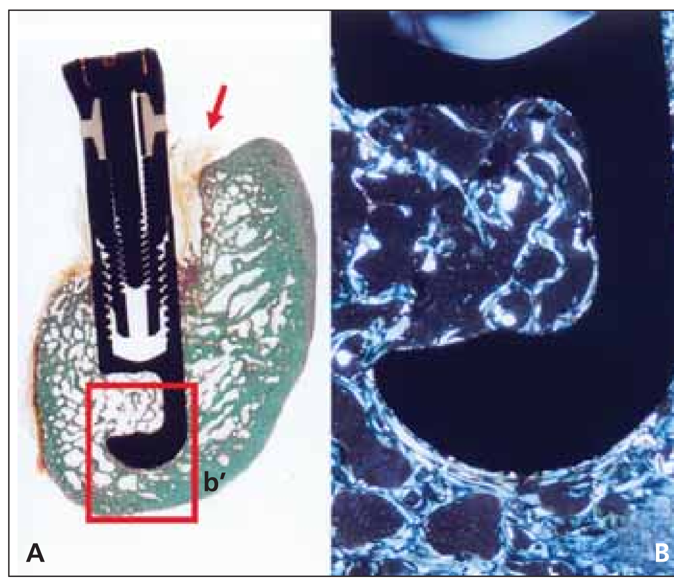


**Figure 3. A:** Sagittal section of the anterior mandibula with an IMZ implant (female, 87 years; implantation 10 years before death). Progedient resorption of lingual crestal bone (**arrow**); Masson Trichrom Goldner. **B:** Enlarged section **b′;** adaptive lamellar bone formation around the apical tip of the implant, polarized light; magnification x20.

were partly sheated by a layer of fibrous tissue **(Figures 4A, B** and **C).** This layer correponds to the translucent line in the microradiograph **(Figure 4B).**

## Discussion

The biological fixation of endosseous dental implants is a matter of great interest, mostly due to the increase in the use of many types of implants in clinical practise. Bone ingrowth results from a complex process, in which mechanics and biology play a major role. A wide variety of diverse factors can affect the development of the process, such as the properties or geometry of the implant surface, the mechanical stimulation or the initial cell conditions.[2,4]

In general, adaptation of bone to functional demands can result in loss of bone in situations of reduced loading, or in increase in bone when functional strains are exceeded. These adaptations can occur throughout the skeleton or within one limb, one bone, or even at a specifically defined site within a bone. The mandible as the only bone in the skull that is freely movable relative

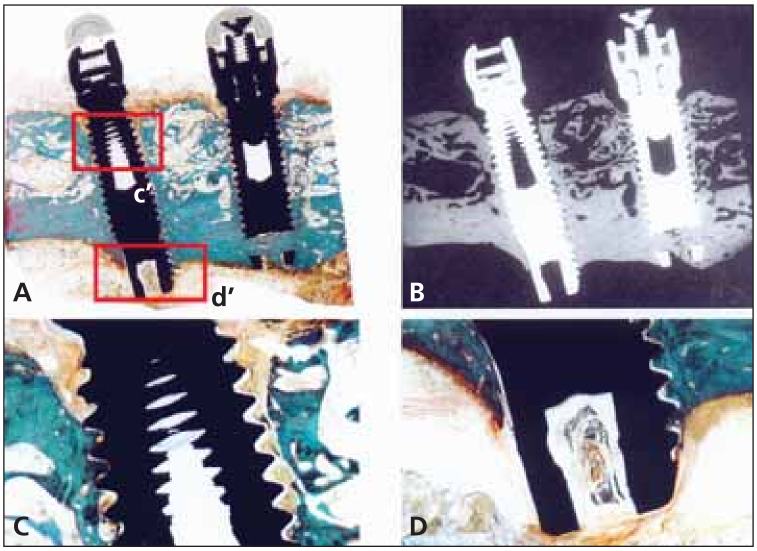


**Figure 4. A:** Frontal section of the iliac crest allograft with two Brånemark implants (male tumor patient, 69 years; implantation 7 years before death. The left implant perforates the inferior cortical bone; Masson Trichrom Goldner. **B:** Microradiograph of the same section, showing crestal bone resorption and translucent lines for the left implant. **C:** Enlarged section **c';** with a fibrous tissue layer between bone and implant; magnification x20. **D:** Enlarged section **d';** the free apical tip of the implant is encapsulated by fibrous tissue; magnification x20.

to the rest of the skull bones, is functionally stressed by bending forces. In holding the lower row of teeth, mastication evokes pressure and tensile stresses acting on the trabecular network of the mandible. The architecture of the spongious bone is functionally adaptated, the trabeculae are arranged like the pattern of main stress trajectories.[6]

For a long-term loading the functional integration of dental implants into the trajectorial pattern of the trabecular elements is essential. That means, the surface structure, i.e. the threads have to be in contact with spongious trabeculae rectangularly. By this an immediate strain flow from the implant to the spongious network is possible in a physiological way.

Even in case of an allograft (iliac crest) osseointegration of implants generally follows the same principles.

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