Reactions of Surrounding Tissue to the Cementless Hip Implant Ti-6Al-4V After an Implantation Period of Several Years

Autopsy Studies in Three Cases

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Summary. Three femoral endoprosthetic stems implanted without cement, made of Ti-6Al-4V alloy, with implantation periods of between 2 and 4 years were examined histologically in the form of undecalcified thin ground sections after having been split into segments and embedded in plastic. During the implantation period total osseointegration in the metaphyseal region takes place, while in the proximal area reaction forms with direct contact between metal and bone on the one hand and with an interposed membrane of connective tissue and adjacent secondary bony shell on the other must be distinguished. The osseointegration of the stem is the result of a primary healing of the bone and is due to the biocompatibility of the metal alloy and to the primary stability obtained by the press-fit method.

It is the purpose of every endoprosthetic joint replacement to obtain stability between the implant and the bony bed in order to meet the objective of primary bone healing. The implant technique helps to accomplish this task either by means of so-called acrylic cements or by fixing the implant without cement. One possibility of cementless fixation is a method called "press-fit": after appropriate preparation of the bony bed, the implant is anchored in the shaft and fitted exactly in order to reach immediate primary stability. Owing to the shape of the prosthesis, the use of bioinert materials, and the special surface structure, it should be possible to keep the material in vivo over quite a long period of time. It is difficult, however, from the point of view of technical possibilities to consider the individual state of the skeleton of each patient, especially the bony beds. Patients not only differ in age and thus suffer from different physiological bone modifications due to their age [2], but also present various anatomical shapes and very often pathological modifications of the bone structure, such as osteoporosis.

As far as can be judged up to now, there seems to be a basic difference in the healing and rebuilding process between cemented and cementless implants. Interposed, rigid layers between implant and bone, as used with acrylic cement, do not exactly favor the continuous ingrowth and resorption processes because of the formation of fibrous connective tissue and foreign-body giant cell layers between the cement and the bony bed [4, 5].

The few existing morphological examinations of implants anchored without cement, however, give hope of better perspectives for the future [6]. This is especially true for the physiological accommodation of the bone during the constant rebuilding process.

In the following we will try to show the phaselike course of these morphological accommodation processes over a period of 2–4 years by means of a series of three patients.

Patients and Methods

Three femoral endoprosthetic implants were examined. In two cases, the time in vivo could be clearly determined (2 and 3 years). We received the third implant from an external prosector without any specific indication regarding the operation date.
Case 1

The female patient, S.J., died at the age of 69, two years after implantation of her endoprosthesis, due to a mitral vitium. The TEP on the right side (Fig. 1) was implanted because of a severe coxarthrosis. The patient was able to move freely and without pain until she died.

Fig. 1. Femoral endoprosthesis implanted without cement, 2 years after implantation. Note the stable implantation of the prosthesis, with direct contact to the bone and pronounced enlargement of the cortical bone in the top region of the prosthesis.

Fig. 2. Femoral endoprosthesis implanted without cement, 3 years after implantation. Stable implantation and direct bone contact are seen all over the metadiaphysial region. Note the subtle, thin double outline in the proximal part of the prosthetic stem, indicating the formation of a secondary bony shell (arrows).

Fig. 3. Femoral endoprosthesis implanted without cement, 3-4 years after implantation. There is stable implantation, with excellent contact between metal and bone. Pronounced enlargement of the cortical bone in the region of the distal third of the prosthetic stem is seen, resembling a spindle-shaped bulge. Note the subtle double outline in the proximal part of the stem, pointing to a secondarily formed bony shell (arrows).

Case 2

The male patient, K.A., died at the age of 65, three years after implantation of his endoprosthesis, with signs of cerebral edema with severe alimentary diabetes and arterial embolism following a bypass operation. He had received the TEP on the left side (Fig. 2) because of severe coxarthrosis. Despite the very severe basic illness, the patient was able to walk well and without pain and could load the prosthesis without any restriction.

Case 3

The female patient, P.A., died at the age of 78 after a cerebral infarct. The TEP on the left side (Fig. 3) was implanted because of severe coxarthrosis. There were no further indications as to clinic or time of the prosthesis in vivo.

All three patients had been supplied with a Zweymüller-Ti-6Al-4V stem implanted without cement [8-10]. Twice, the stem articulated with an Endler polyethylene socket (patients K.A. and P.A.) and once with a Morscher polyethylene screw socket (patient S.J.).

The femurs were fixed in an 8% formalin buffer solution immediately after removal and after preparation of roentgenogram of the specimen. They were then cut up into ten transverse slices of almost the same thickness by means of a sawing and grinding system [3], embedded in plastic [6], ground down to approximately 10-20 μm on a rotating grinder using wet ab-