Objectives

A surgical robot (ROBODOC) is used for total knee replacement (Fig. 51-1). The system has been used as clinical routine for total hip replacement at the Trauma Clinic of Trade Associations (BGU) Frankfurt, Germany since 1994. Since March 2000 it has also been used for total knee arthroplasty. This article is intended to give an overview of the system and the first clinical experiences.

Background

The results in conventional TKA have so far been very dependent on the surgeon’s experience and routine. The most common mistakes are varus and valgus mal-positionings as well as mal-rotations of the implant causing mal-alignment of the anatomical axis postoperatively. These mistakes often lead to untimely loosening of the implant.

Materials and Methods

The system enables to do a 3D preoperative planning of the correct axes and rotation as well as the correct implant size. The intraoperative execution is performed by the robot according to the preoperative planning.

The ROBODOC system consists of the three components:

- the preoperative planning workstation (Orthodoc),
- the surgical robot,
- the control unit which receives all the preoperative planning data and controls the robot’s actions.

Presently four titanium pins need to be implanted preoperatively, two in the distal femur and two in the proximal tibia. These pins serve as »landmarks« for the following steps. After pin implantation a CT scan of the femoral head, the distal femur, the proximal tibia and the ankle including all four pins is obtained (Fig. 51-2). An aluminium
rod is attached to the patient's leg to detect motion during the CT scan.

The data is transferred to Orthodoc using an optical disc (MOD) or a network.

Orthodoc shows a 3D view of the bone in the following aspects:
- a.p. level,
- lateral level as well as
- the cross-section (Fig. 51-3).

Moving the bone in one view automatically moves the other views as well.

The first step is to find the four pins on the CT-scan and to check their position. Then the femoral (FMA) and tibial (TMA) mechanical axes are created using four markers: the femoral head, the center of the femoral condyles, the center of the tibial plateau, and the center of the ankle. The femoral and tibial component are planned independently, then the FMA and the TMA are put together. To plan the femoral component, the axis and rotation of the bone are aligned, the right implant size is selected, and the implant is positioned. The rotation is found by using the epicondylar line. For the tibial component, the rotation is set using the tibial tuberosity and the notch. The implant is selected and positioned according to those landmarks. Finally, the tibial line is selected (Fig. 51-4).

When the planning is finished, a synthetic X-ray can be generated to virtually see the postoperative result. The X-ray shows the post-operative anatomic axis of the lower extremity. This way possible mistakes in planning can be corrected. The data is stored on a CD-ROM. Those data are loaded into the control unit of ROBODOC.

The patient's leg is positioned in a specially designed leg holder (Fig. 51-5). The knee should be flexed to about 70° to 80°. Draping is done in the conventional manner.