Abstract  Background: The thrust plate prosthesis (TPP) is an implant with a metaphyseal fixation at the proximal femur that transmits the load forces of the hip onto the femoral neck. The osseous incorporation of the TPP and the adaptation of the bone to this force transmission depend on the bone quality, which is reduced to minor vitality and stability in patients with osteonecrosis of the femoral head. Depending on the etiology of the femoral head necrosis, the TPP might lead to early failures.  Methods: In a prospective study, 63 patients with 72 cementless TPP due to femoral head osteonecrosis were examined. A clinical and radiological evaluation was performed preoperatively, 3 and 6 months postoperatively, and every year thereafter. The average follow-up period was 4.8±1.3 years with a minimum of 3 years. The pathogenesis of femoral head necrosis included alcoholism (n=19), subsequent to renal transplantation (n=11), during cortisone therapy of other dyscrasia (n=9), preceding a polychemotherapy (n=4), diabetes (n=3), sickle cell anemia (n=1), and idiopathic osteonecrosis (n=25).  Results: The Harris Hip Score increased continuously from 50.0 points beyond 79.8 points after 3 months to 86.8 points within the 1st year, and subsequently remained stable at this level. Revision was necessary in six cases (8.3%). Of these, three had an aseptic loosening of the implant: 2 cases with renal transplantation and 1 of alcoholism. Radiolucent lines were found in 9 cases (12.5%), mostly in zones 1 and 2 underneath the TPP. Of these, 1 with an idiopathic osteonecrosis was assessed to be radiologically loosened. The overall failure rate was 9.7%, with a proportion of 36.4% in patients with renal transplantation. Excluding this specific patient group, the failure rate was 4.9%.  Conclusions: Femoral head necrosis following renal transplantation and extension of the necrotic area into the femoral neck are contraindications for TPP. Excluding these patients, the TPP shows comparable mid-term results to cementless stemmed prostheses and supplies advantages especially for younger patients, because of its metaphyseal, bone-preserving fixation. However, evaluation of the clinical impact of the TPP in comparison with other cementless femoral stem systems requires long-term examinations in the future.

Keywords  Hip replacement · Thrust plate prosthesis · Femoral head necrosis

Introduction

Aseptic osteonecrosis of the femoral head mostly involves younger patients aged around 40 years [12, 14, 36]. Commonly, it is diagnosed in an advanced stage, which results in poor prediction for joint-preserving treatments. Therefore, these patients ultimately pass over to a total hip replacement. Owing to their young age, a cementless implant is frequently used [4, 27, 28].  The thrust plate prosthesis (TPP) (Centerpulse, Winterthur, Switzerland) is an implant for a cementless fixation at the metaphysis of the proximal femur. On account of diaphyseal bone preservation, this implant is preferred by some surgeons especially in younger patients who most certainly will have to undergo a revision arthroplasty later on in their lifetime. At that time, the untouched diaphyseal bone supplies advantages for the fixation of a subsequent stemmed femoral implant [1, 16, 20, 26].
With regard to construction principles, the TPP transmits the load forces of the hip directly to the femoral neck, in particular to the cortical bone of the calcar [1, 19, 20]. According to the biomechanical experiments of Jacob et al. [21, 22] and Bereiter et al. [2], this force transmission is close to the physiological force transmission of the natural femur. Adaptation of the bone to this local force transmission, according to Wolf’s law, as well as good osseous incorporation were verified by the radiological and histological evaluations of Bereiter et al. [2] and Schenk et al. [32]. The first clinical results using the TPP were encouraging. Menge [26] examined 116 TPP of the second (1988–1991) and predominately third generation (since 1992) after a mean follow-up of 3 years and found a failure rate of 2.6%.

The survival rate of total hip replacements in patients with femoral head necrosis (FHN) depends greatly on its etiology [7, 13, 15, 33]. There were higher failure rates in patients with steroid-induced necroses or systemic bone lesions (renal osteopathy, sickle cell anemia) than in patients with idiopathic FHN [4, 6, 18, 23, 31]. This can be explained by alteration of the biological bone quality (bone turnover, biomechanical stability) dependent on the underlying etiology [15]. Owing to its force transmission on the femoral neck, alterations of the biological bone quality might affect the survival rate of the TPP. Therefore, early failures of the TPP may occur in patients with FHN depending on the underlying etiology.

This prospective study examined the mid-term experiences with the TPP in patients with FHN. The underlying etiologies of FHN were analyzed separately to identify specific pathogenetic entities of the osteonecrosis that may cause early implant failure.

**Patients and methods**

Seventy-two TPPs (7 of the second and 65 of the third generation) were implanted in 63 patients (19 female and 43 male) with aseptic osteonecrosis of the femoral head. The etiology of the osteonecrosis included 19 cases of alcoholism, 11 cases following renal transplantation, 9 cases with cortisone therapy of other dyscrasias [4 chronic obstructive lung disease (COLD), 2 aplastic anemia, 2 mononeuritis multiplex, 1 systemic lupus erythematosus], 4 cases preceding a polychemotherapy (3 acute lymphocytic leukemia, 1 non-Hodgkin’s lymphoma), 3 patients with diabetes, 1 patient with sickle cell anemia, and 25 cases of idiopathic FHN. At the time of hip replacement, the mean age was 47.3±12.2 years. Cementless press-fit acetabular components were used exclusively [52 Harris-Galante cups (Zimmer, USA), 20 Plasma cups (Asclup-lap, Germany)].

In a prospective study, a clinical and radiological evaluation was performed preoperatively, 3 and 6 months after surgery, and every year thereafter. The average follow-up was 4.8±1.3 years with a minimum of 3 years. The clinical findings were evaluated according to the Harris Hip Score. The radiomorphological parameters were evaluated on X-rays in anterior-posterior and lateral standard planes, focussed on radiolucencies in the zones shown in Fig. 1 as well as on possible changes in the angle of femoral shaft and the implant. In 13 patients with 16 prostheses, the questionnaire was completed by telephone. In these cases, the clinical examination was performed by an external orthopedic surgeon, who sent the X-rays for radiological evaluation.

**Results**

By implanting the TPP at a mean angle of 133.5°±3.5° to the femoral shaft, the preoperative femoral shaft neck angles changed by an average of 4.0°±2.5° in the valgus direction. The Harris Hip Score (HHS) increased from preoperatively 50.0±15.6 points to 79.8±16.9 points 3 months postoperatively. Six months after surgery, it increased to 82.0±14.9 points and subsequently remained stable at this level. Twelve months after surgery, the HHS averaged 86.8±10.1 points. After 24 months, we measured a mean of 88.3±12.1 points, and after 36 months 88.1±13.4 points were evaluated (Table 1). All patients with a follow-up of more than 2 years scored at this level continuously. Statistically, there was no difference in the HHS among the different etiologies of FHN. Also, there was no correlation between the clinical results and the initial femoral shaft prosthesis angle or the deviation to the preoperative femoral shaft neck angle.

However, six patients complained about pain on weight-bearing or pressure at the fishplate of the TPP. This pain remitted spontaneously in four cases around 9 months after surgery and in one case by local anesthetic infiltration therapy combined with cortisone injections after 12 months. In one case, the pain persisted.

After the 12- and 23-month follow-ups, two patients with osteonecrosis following renal transplantation and, after 4 years, another patient with an ethyl toxic FHN had aseptic loosening of the TPP (Fig. 2b,c). Therefore, aseptic loosening was found in 18.2% for patients with renal transplantation, 5.3% for patients with alcohol-related os-