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PŮVODNÍ PRÁCE

Experience with the Mayo® Conservative Hip System

Zkušenosti s „konzervativním“ kyčelním systémem Mayo

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ABSTRACT

PURPOSE OF THE STUDY

In the development of cementless total hip arthroplasty wear, loosening as well as stress shielding are considered as major issues. New results in literature specify survivorship of THA over 97%. Consequently the implant loosening and wear especially can be considered as almost solved. Therefore, it is essential to use bone preserving primary implants that allow for a physiological load transfer and cause no or only slight stress shielding at the proximal femur. The MAYO conservative hip stem with a wedge design ensuring immediate primary fixation of the stem with metaphyseal load transfer.

MATERIAL AND METHODS

A retrospective study was performed to review the first consecutive 316 MAYO® conservative hip stems implanted at the Martin-Luther-University of Halle-Wittenberg (Germany). 85.4% (270 MAYO stems) were radiographic analysed and classified according to the HHS.

RESULTS

The mean HHS improved from 44.79 preoperatively to 93.58 postoperatively. 1.85% (5 MAYO stems) had to be replaced because of aseptic loosening. Furthermore the DEXA scans revealed the metaphyseal load transfer with increased bone density in the calcar region.

CONCLUSION

As especially younger patients will require one or more hip revision procedures during the course of their life due to their life due to their age and activity level. These patients should receive a primary implant with proximal load transfer. Only these implants can avoid stress shielding of the proximal femur. The minimally invasive implantation of these implants can also ensure an enhanced periprosthetic bone density an optimized postoperative rehabilitation phase.

INTRODUCTION

In everyday life the hip joint is exposed to significant biomechanical stress. Thus, it is often subject to early joint degeneration. For the treatment of advanced cox arthrosis several implant designs and materials as well as fixation techniques were developed. In the development of total hip arthroplasty implant loosening and implant wear as well as resulting osteolysis are considered as major problems. However, the development in the past decades has shown that with modern bone cement systems in combination with appropriate cementing techniques a long-term fixation of shaft and cup components is achieved. Furthermore, cementless systems with specific materials and coatings are now available for press fit fixation and bony ingrowth of the implant surface. Moreover, further development and improvement of tribological properties of the bearing materials lead to a significant reduction of material wear.

MATERIAL AND METHODS

The authors have gained substantial experience in more than 1,000 implantations of the MAYO® Conservative Hip System (Zimmer Inc., Warsaw, USA). This shaft system was developed in 1985 at the Mayo-Clinic (Rochester, USA) for the treatment of younger patients. Morrey et al. [6] demonstrated that the intra and postoperative blood loss is reduced significantly with these implants and that the shaft shows excellent long-term results (fig. 1). The MAYO® Conservative Hip System is a cementless short stem hip prosthesis with a wedge design in A/P and M/L plane (fig. 2) ensuring immediate primary fixation of the prosthesis in the bone. It is available in 8 sizes (fig. 3) and made of Tivaniumr, a Titanium-Aluminum-Vanadium alloy (Ti-6Al-4V). In addition, it provides a partial fibre-mesh-structure (fig. 4) and is partially coated with hydroxylapatite.

We favour this implant for younger patients (< 70 years) with good bone quality and normal anatomical

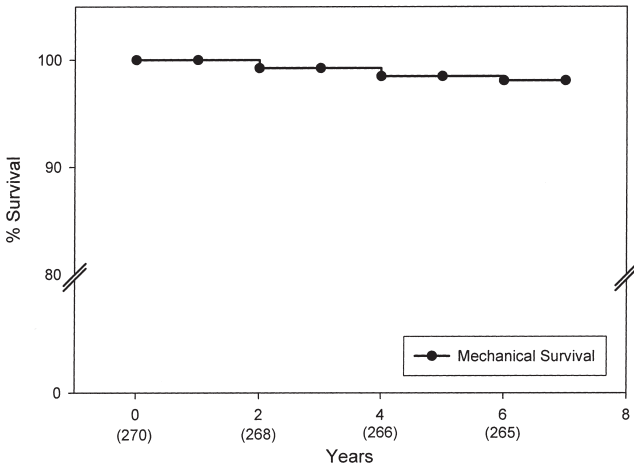


Figure 1. Results 7 year-survival-rate of the Mayo® Conservative Hip System

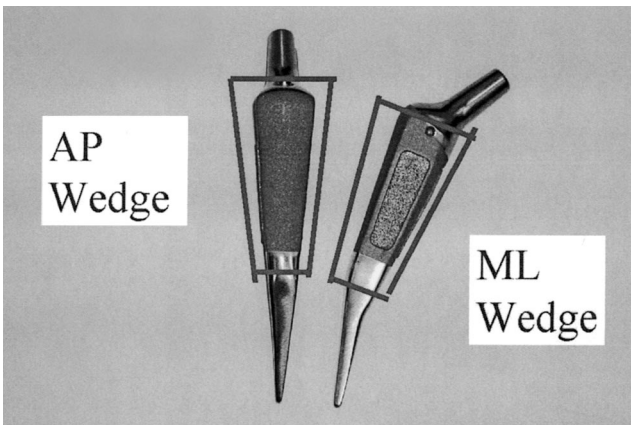


Figure 2. Anterior-posterior plane of the MAYO prosthesis (AP Wedge) mediolateral plane of the MAYO prosthesis (ML Wedge)

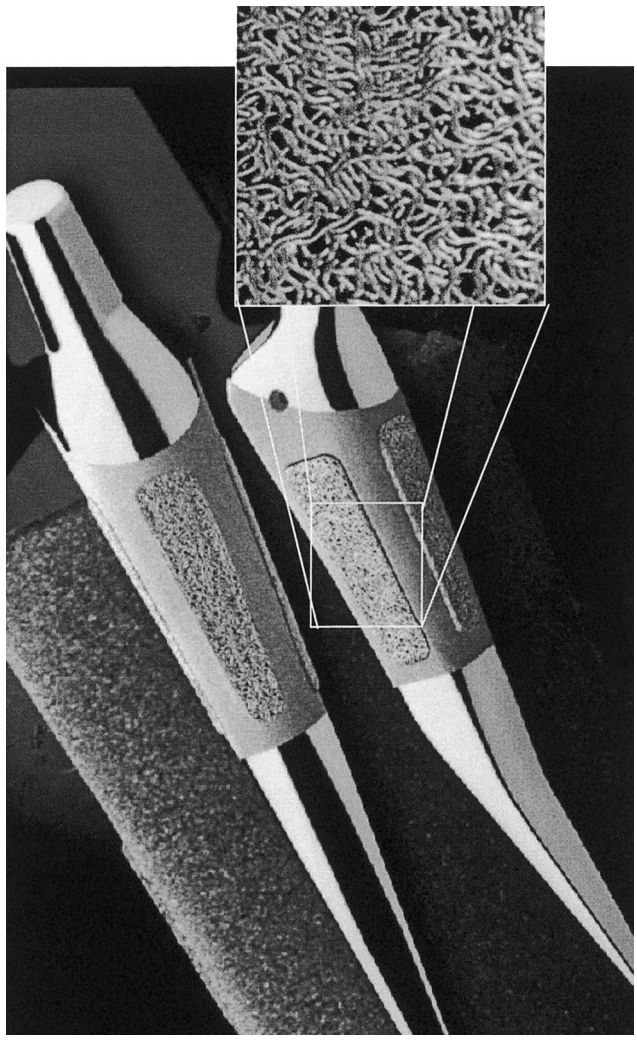


Figure 4. MAYO prosthesis with fibre-mesh and hydroxylapatite coating (source: Zimmer Inc. Warsaw, USA)

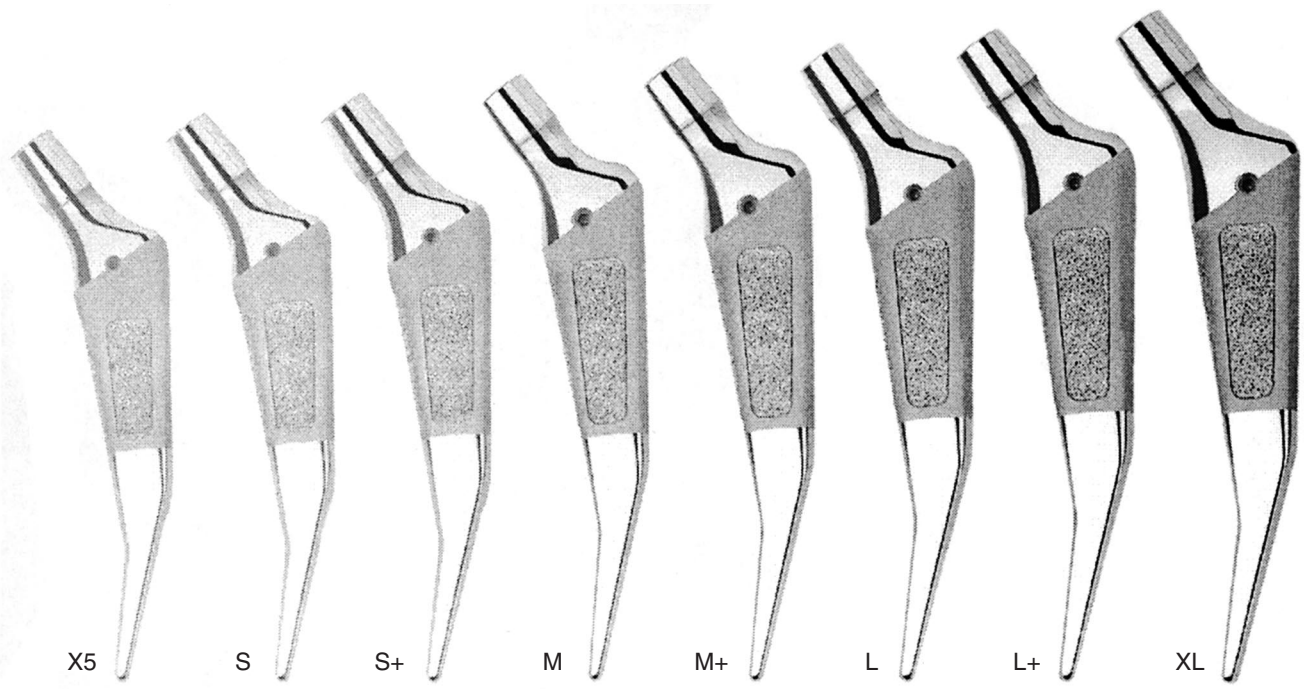


Figure 3. MAYO Conservative Hip System (Source: Zimmer Inc. Warsaw, USA)

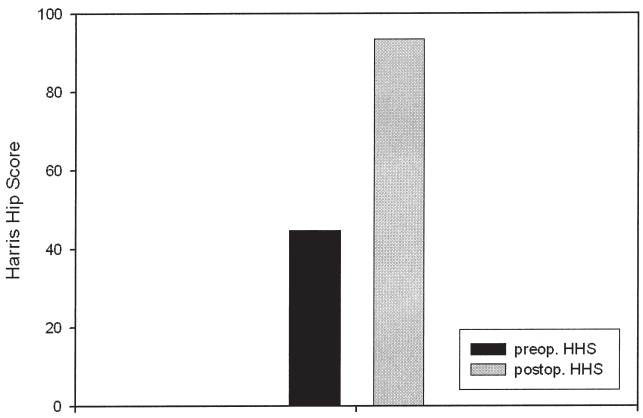


Figure 5. Comparison of the pre- & post operative Harris Hip Score

conditions. Due to the metaphyseal load transfer no or only slight stress-shielding occurs at the proximal femur. This is especially important in case of a shaft revision, because after removal of the implant a metaphyseally / diaphyseally anchored anatomical or only diaphyseally anchored shaft system can be used.

A retrospective study was performed to review the first consecutive 316 MAYO® Conservative Hip stems implanted at the Martin-Luther-University of Halle-Wittenberg clinically and radiographically. At the end of this study a total of 85,4% (270 MAYO® stems) of the prosthesis, which had been implanted between 1999 and 2002, were radiographic analyzed and classified according to the Harris-Hip-Score.

RESULTS

The mean HHS improved from 44,79 preoperatively to 93,58 postoperatively (fig. 5) whereby 92,4% of the patients showed very good or good results. Fourteen fractures (5,2%) occurred during surgery in the region of the calcar femoris, which have been treated by a wire cerclage followed by mobilization with limited weight bearing for 6 weeks. In the postoperative course 5 MAYO® short stems (1,85%) had to be replaced because of an aseptic loosening. The average survival rate at 83,6 months was 98,1% (fig. 1). Furthermore the analysis of the radiological osteodensitometric measurements (DEXA) revealed the positive effect of the proximal load transfer, thus avoiding stress-shielding in the calcar region (Zone 7 by Gruen et al.).

DISCUSSION

New results presented in literature specify survivorship of total hip prostheses of appropriate implants at 97 % for the cups and 100 % for the shaft after 10 years (1). Consequently, the afore-mentioned problems in total hip arthroplasty like implant loosening and wear especially in older patients can be considered as almost solved. However, until now these results can only be achieved with cemented or diaphyseally anchored shaft systems. Due to the distal load transfer more or less significant bone loss (stress-shielding) of the proximal femur can be observed regularly (fig. 6).

Until now there are hardly any alternatives to total hip arthroplasty in the treatment of advanced cox arthrosis and the number of implanted total hip prostheses increases annually. In 2005, 144,000 primary hip prostheses were implanted and 19,000 revision procedures performed in Germany (source: BQS Bundesgeschäftsstelle Qualitätssicherung*). In the US the quantity of operated patients is estimated to triplicate within the next 10 years. The causes are manifold, including changes in the age pyramid with an increasing mean age of the population. Furthermore, an increased activity level of the patient leads to an increasing number of younger patients receiving an artificial hip joint.

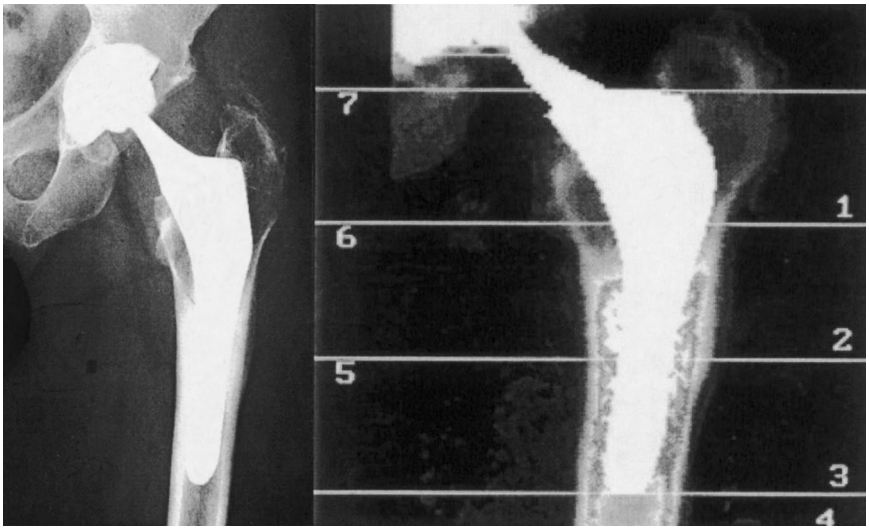
Taking into account the excellent long-term results due to the decreasing mean age of the patients at the time of primary implantation an increasing number of revision procedures is expected. Therefore, it is essential to use bone preserving primary implants that allow for a physiological load transfer and cause no or only slight stress-shielding at the proximal femur. These primarily implant specific properties are mandatory to create optimal initial conditions for a subsequent revision procedure. Furthermore, the choice of the surgical approach to the hip joint and the resulting extent of soft tissue damage have an impact on stress-shielding due to the preservation of muscle and tendon insertions (2).

Hip resurfacing systems are very bone preserving with regard to the proximal femur and allow for an almost physiological load transfer. They were rediscovered especially for young, active patients and use metal-on-metal bearings made of first-class durable materials. Clinical results of modern hip resurfacing systems are therefore many times better than those of the Wagner Resurfacing, a hip resurfacing system developed in the 1970ies (3, 4). Major advantages include the preservation of the proximal femur without stress-shielding, enhanced joint stability and mobility due to the larger head diameter. Disadvantages include increased bone loss in the area of the acetabulum (due to the larger head diameter), stress caused by released metal ions that are suspected to be carcinogenic, increased occurrence of neck fractures and restricted use for patients with femoral head necrosis (5).

Moreover, patients may develop a postoperative head necrosis caused by intraoperative irritation of the vascular supply of the remaining femoral head (mainly the A. circumflexa femoris medialis).

Unlike hip resurfacing prostheses short stem hip prostheses involve the resection of the femoral head and parts of the femoral neck (fig. 7). Besides, they also have an almost physiological metaphyseal load transfer to the proximal femur. Therefore, there is no bone atrophy in this area as seen in shaft prostheses with distal fixation (6).

* Translator's note: German Agency for Quality Assurance



a b

Figure 6. A: Postoperative X-rays of the left hip joint in the anterior/ posterior (a/p); plane after implantation of an ABG prosthesis (Stryker) using the Bauer approach. B: Dexa scan of the ABG total hip prosthesis shown in figure 1 with diaphyseal load transfer.

Figure 7. Postoperative X-rays of the left hip joint in the anterior/ posterior (A/P) plane after minimally-invasive implantation of a cementless total hip prosthesis (Trilogy® cup, MAYO® prosthesis) using the modified Watson-Jones approach. ▲

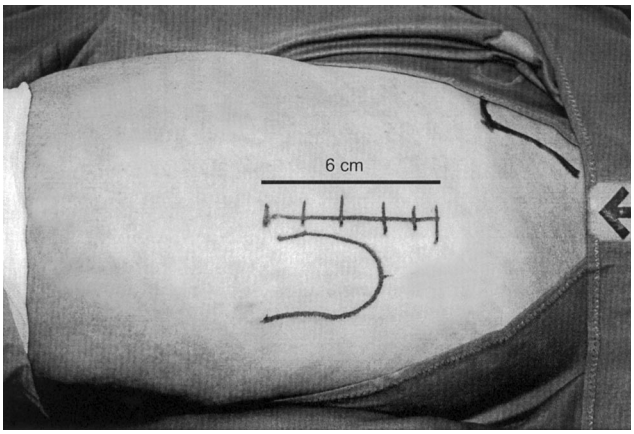


Figure 8. Lateral picture of the left proximal thigh. The patient is placed supine. The skin incision for the modified Watson-Jones approach is marked in relation to the greater trochanter and anterior superior spine.

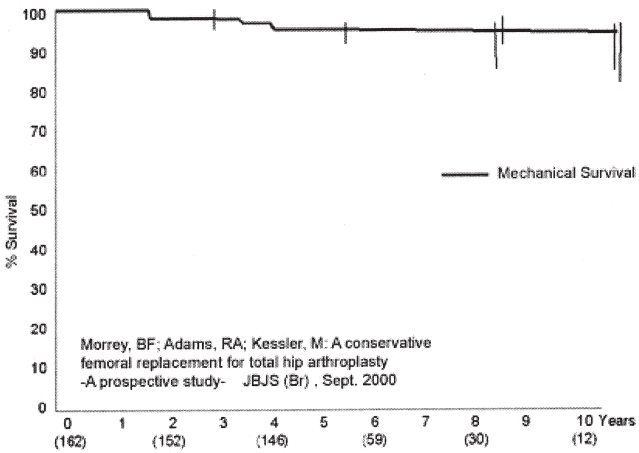


Figure 9. Long-term clinical success of the Mayo® Conservative Hip System (6)

Influence of the surgical approach on the postoperative outcome: Independent of the used implant the choice of surgical approach is important for the periprosthetic bone density (2) and early postoperative rehabilitation phase (7). In previous studies we demonstrated that minimally-invasive approaches enhance mobilisation and rehabilitation in the early postoperative phase. However, depending on the surgical approach an increased complication rate can occur (7). Using an anterior minimally-invasive approach (modified Smith-Peterson approach) in 6 of 27 patients (22 %) a temporary damage of the N. cutaneus femoris lateralis was observed (7). If a minimally-invasive anterolateral approach was used (modified Watson-Jones approach) (fig. 8) these complications did not occur.

Using the existing interval between M. tensor faciae latae and tractus iliotibialis the tractus and gluteal muscles do not have to be dissected.

In modern total hip arthroplasty numerous so-called minimally-invasive approaches were developed or rediscovered respectively. However, there is still no standard definition of the term "minimally-invasive" in joint replacement. Comparing scientific literature, authors evaluate minimally-invasive approaches in total hip arthroplasty quite differently.

Especially in the Anglo-American countries the term minimal-invasiveness in total hip arthroplasty is often only defined by the length of the skin incision. Incisions smaller than 10 cm are referred to as "minimally-invasive" or "mini incision technique" (7).

State-of-the-art treatment concepts: In addition to the general principles of primary total hip arthroplasty

modern soft tissue sparing surgical techniques ensure a rapid rehabilitation of the patient.

Only the combination with implants using an almost physiological load transfer proximally allow for a sufficient long-term treatment and rapid rehabilitation of the patient. As short stem hip prostheses can be implanted without major damage to the soft tissue and muscles compared to hip resurfacing prostheses, we prefer the MAYO® Conservative Hip System in combination with a modified Watson-Jones-approach and the patient placed supine (fig. 9).

Moreover, detailed information and consultation of the patient and if desired his/her family before surgery is also very important in our opinion. In our clinic we provide information about the forthcoming surgery during pre-inpatient admission approx. 3 to 5 days preoperatively. Besides medical support our nursing staff, physiotherapeutic department and socio-medical service also provide intensive support and consultation. This helps answer upcoming questions and settle problems before surgery and thus relieve any fears.

In addition to an active and passive mobilisation of the treated joint the patient receives the first physiotherapeutic treatment at the day of surgery, including getting up and first walking exercises (if appropriate). From the first postoperative day the patient starts an intensive training programme complementing the traditional physiotherapeutical treatment with sports therapeutic concepts. These also include walking on the treadmill as well as exercises on the ergometer and stepper. Besides the medical treatment strategies our facilities have a hotel like atmosphere which is very much appreciated by our patients. This treatment concept enables us to discharge patients from inpatient care at the 5th postoperative day already and refer them to outpatient or follow-up rehabilitation.

CONCLUSION

Until now, early loosening and wear were considered as major concerns in total hip arthroplasty. With the development of special fixation techniques in combination with specific implant materials and coatings as well as optimization of various bearings these problems have almost been resolved.

Due to an increasing number of implantation cases and the decreasing mean age of the patients we expect a drastic increase of revision procedures in future.

As especially younger patients will require one or more hip revision procedures during the course of their life due to their young age and their higher activity demand, these patients should receive a primary implant with proximal load transfer. Only with these implants an increased stress-shielding of the proximal femur can be avoided and the proximal femoral bone structures can be preserved for subsequent revision procedures. The implantation should be soft tissue and muscle sparing (minimally-invasive) to ensure an enhanced periprosthetic bone density and optimized postoperative rehabilitation phase. Only that way optimal conditions are created to ensure stable bony conditions for the fixation of the next shaft and allow for repeated revision procedures.

ZÁVĚR

Při vývoji necementovaných náhrad kyčelního kloubu je za největší problém považován otěr, uvolnění a koncentrace stresu na malé plochy, tzv. stress shielding. Nové výsledky publikované v literatuře uvádějí životnost totální endoprotézy kyčelního kloubu vyšší než 97 %. Problém uvolnění implantátu a zejména otěru lze tak považovat za téměř vyřešený. Proto má zásadní význam používání primárních implantátů zachovávajících kost a umožňujících fyziologický přenos zatížení, aniž by docházelo k „stress shielding“ v oblasti proximálního femuru.

Na pracovišti autorů byla provedena retrospektivní studie prvních 316 implantovaných Mayo „konzervativních“ dříků. Celkem 85 % (270 Mayo) dříků bylo podrobeno radiologické a funkční analýze (HIS).

Průměrné předoperační HHS 45 se po operaci zvýšilo na 94. Pro aseptické uvolnění muselo být revidováno 5 dříků, tj. necelá 2 %. DEAXA sken prokázal metafyzární přenos tlakových sil se zvýšenou kostní denzitou v oblasti Adamsova oblouku.

Zvláště u mladých pacientů lze vzhledem k věku a fyzické aktivitě předpokládat jednu či více revizních operací jejich primární náhrady kyčelního kloubu. Tito pacienti by měli být primárně ošetřeni dříkem umožňujícím přenos tlakových sil na proximální femur. Pouze tyto implantáty totiž mohou zabránit „stress shielding“ v této oblasti. K udržení či zvýšení denzity kosti sousedící s implantátem může přispět minimálně invazivní technika při jejich zavádění.

References

1. PIERINGER, H., AUERSPERG, V., GRIESSLER, W., BOHLER, N.: Long-term results with the cementless Alloclassic brand hip arthroplasty system. J. Arthroplasty, 18: 321–328, 2003.
2. PERKA, C., HELLER, M., WILKE, K., TAILOR, W. R., HAAS, N.P., ZIPPEL, H., DUDA, G. N.: Surgical approach influences periprosthetic femoral bone density. Clin. Orthop., 432: 153–159, 2005.
3. AMSTUTZ, H. C.: Innovationsin design and technology: The story of hip arthroplasty. Clin. Orthop., 378: 23–30, 2000.
4. KNECHT, A., WITZLEB, W. C., GUNTHER, K. P.: Oberflächenersatz am Hüftgelenk. Orthopäde, 34: 79–89, 2005.
5. SHIMMIN, A. J., BACK, D.: Femoral neck fractures following Birmingham hip resurfacing: A national review of 50 cases. J. Bone Jt Surg., 87-B: 463–464, 2005.
6. MORREY, B. F., ADAMS, R. A., KESSLER, M.: A conservative femoral replacementm for total hip arthroplasty. A prospective study. J. Bone Jt Surg., 82-B: 952–958, 2000.
7. WOHLRAB, D., HAGEL, A., HEIN, W.: Vorteile der minimalinvasiven Implantation von Hüfttotalendoprothesen in der frühen postoperativen Rehabilitationsphase. Z. Orthop., 142: 685–690, 2004.

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