Metal type of the femoral stem in total hip arthroplasty

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Key words: *titanium stem, total hip replacement.*

Summary. *Objective. To compare the influence of two different cemented stems each made of different alloys on survival and outcome.*

Material and methods. We analyzed 341 total hip replacements performed in 1998–2001. Two types of prostheses were implanted. Biomet® Bi-Metric titanium stem, cobalt-chrome head and ultra high molecular weight all poly cup were implanted in 102 cases. Aesculap® Centrament cobalt-chrome stem, head and ultra high molecular weight all poly cup were implanted in 239 cases. All prostheses were cemented; Palacos® bone cement with gentamycin was used in all cases. Cementing technique was consistent in all cases. All data were collected prospectively. For every total hip replacement the form was filled in. The documental patients' data, implant type, cement type, cementing technique, intraoperative and postoperative complications were registered. All revision surgeries were registered; the patients' death dates were recorded from national register database up to December 31, 2004. Kaplan–Meier curves were used to calculate implant survival rates.

Results. The total implant survival for Biomet® Bi-metric prostheses was 98%, 7 years postoperatively. The total implant survival as Aesculap® Centrament prostheses were used was 98%, 6 years postoperatively.

Conclusion. The mid-term implant survival of Biomet® Bi-Metric titanium stems was the same as survival of Aesculap® Centrament cobalt-chromium stems.

Introduction

Primary and revision total hip replacement has proven to be the most successful procedure in orthopedics with reported good long-term results (1, 2). Different type metal alloys have been used for femoral stem production. The negative influence of cemented titanium (Ti) stems on the loosening rates has been described repeatedly (3–5). However, there are also a few reports with encouraging results using cemented titanium stems (6, 7). It is still a dispute in the literature regarding the influence of the metal type of femoral stem on implant survival rates after total hip replacement. The aim of this study was to evaluate the two different cemented hip stems each made of two different alloys concerning survival and outcome.

Material and methods

All our data were obtained from medical records. All information was registered prospectively. Surgical approach, cementing technique, cement type, implant information, intraoperative and postoperative complications were recorded. The national personal identification number was used to check if the patient had had subsequent hip revision surgery in another hospital at the time of follow-up, and if the patient had died – the date of death was recorded.

All patients were operated on with a posterolateral incision and posterior arthrotomy. All patients had spinal anesthesia; the same type of cement, Palacos® with gentamycin, was used. The cementing technique: distal plug, retrograde filling, syringe washing and vacuum mixing was consistent in all cases. We analyzed 239 Aesculap® Centrament total hip arthroplasties performed in 228 patients and 102 Biomet® Bi-Metric total hip arthroplasties performed in 98 patients. Biomet® Bi-Metric is a straight stem with collar made from Ti alloy; Aesculap® Centrament is a straight stem without collar made from cobalt-chrome (CoCr) alloy. All poly 28 mm diameter cups made from ultra-high molecular weigh polyethylene were used with both stems. For Biomet® Bi-Metric stems CoCr femoral heads were used.

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Biomet® Bi-Metric prostheses were implanted between March 1998 and May 1999, Aesculap® Centrament – between May 1999 and December 2001. Mean follow-up for Biomet® Bi-Metric total hip replacements was 5.68 years and for Aesculap® Centrament 4.38 years, respectively. The choice of implant type was a consequence of implant availability in hospital stock only. Three orthopedic surgeons did all hip replacements. Results were evaluated by one independent observer. Implant failure/revision was defined as an exchange of one or both prosthetic components. All death dates and revision cases were recorded up to December 31, 2004. No patients were excluded or lost to follow-up for the survival study.

The patients' data are presented in Table.

Statistical analysis

The cumulative revision rate was calculated with Kaplan–Meier statistics (8). NCSS software was used. The end-point was defined as revision, i.e. addition, exchange or removal of prosthetic component. When Cox regression was used, the regression model besides variable to be studied (stem type as categorical variable) included patient's age as a numerical variable.

Results

At the end of the follow-up 2 hip revisions were performed (one cup and one both components) because of aseptic loosening in titanium alloy stems group. Five revisions (1 femoral head, 1 cup, 1 stem, 2 both components) were performed in Aesculap® Centrament group. One patient was revised for recurrent dislocations, others because of aseptic loosening. From statistical analysis of implant survival we excluded the patient revised for dislocation because both components were stable at the time when revision surgery was performed. Survival analysis showed 98% survival for groups of both implants (Log-rank test $p \geq 0.05$). Kaplan–Meier survival curves are presented in Fig. 1 and Fig. 2. Cox regression showed that metal type of the stem and age had no influence on implant survival rates ($p \geq 0.05$).

Discussion

The theoretical benefits of titanium were lower Young's modulus of elasticity to reduce stress shielding of bone and its excellent reported biocompatibility (9). The reports regarding implant survival are controversial. C. Eingartner (6) reported a low rate of revision and incidence of radiolucency with a cemented, straight titanium stem and suggested that stem design was more important than the material used. As our study showed the implant survival of titanium straight stem was the same as implant survival of CoCr stem.

The cement type and cementing technique play an important role for implant survival of both CoCr and Ti alloys. M. Bowditch (10) reported excellent results – 100% survival of titanium straight collarless stem after mean follow-up of 7.5 years. The 3rd generation cementing technique was used for the stem fixation in this study. The thickness of cement mantle especially in proximal part of the prosthesis is crucial when titanium stem is used. The influence of cement fatigue caused by more elastic implant (titanium) is probably the most important factor for development of early stress fractures. In contrast, cement fatigue in the presence of stiffer CoCr implant is probably minimal. To prevent fatigue fractures of the cement for titanium stems cement mantle especially in proximal part of the femur should be 2–4 mm. The good quality stem cementing with cement mantle between 2–4 mm could be achieved when appropriate cementing technique is used. It is in concordance with our findings; the same 3rd generation cementing technique was used in both groups (Ti and CoCr) as in M. Bowditch (10) study. This also may explain good results of implant survival in our series.

Another important issue is a combination of Ti stem and CoCr head. Animal and laboratory studies have suggested that cobalt-chrome and titanium couple should be safe *in vivo* (11). However, in clinical use when implants are loaded, fretting of the softer titanium can remove its stable oxide layer. Because of

Table. **Patients' data**

Implant type	Age distribution (mean±SD)	Gender distribution (%)	Preoperative diagnosis n (%)
Titanium Biomet® Bi-Metric (n=102)	67±9	42 males 68 females	Osteoarthritis – 89 (87) Inflammatory arthritis – 4 (4) Femoral neck fractures – 9 (9)
Cobalt-chrome Aesculap® Centrament (n=239)	65±11	35 males 75 females	Osteoarthritis – 212 (87) Inflammatory arthritis – 5 (2) Femoral neck fractures – 22 (9)

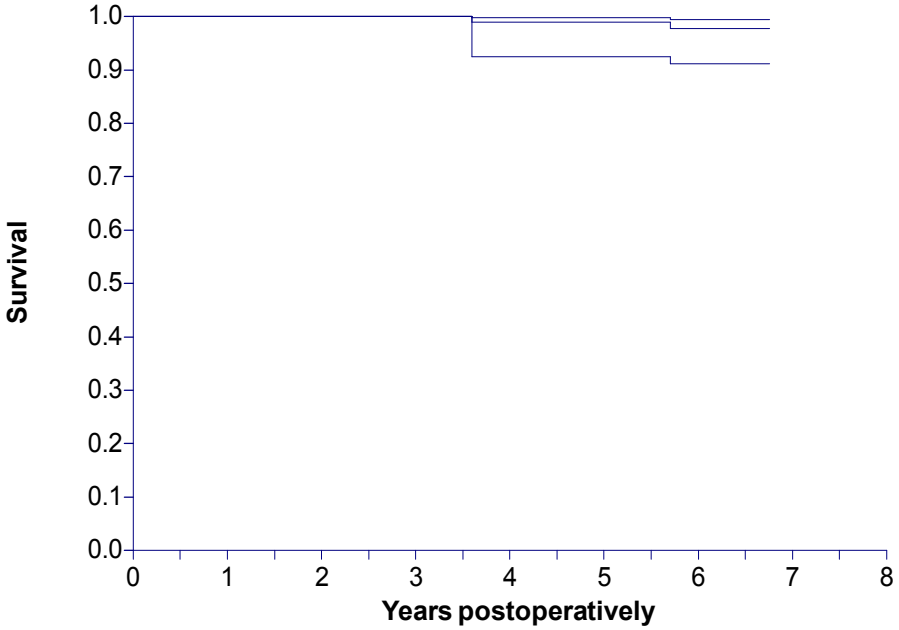

Fig. 1. **Kaplan–Meier implant survival curve with 95% confidence intervals for Biomet® Bi-Metric titanium stem**

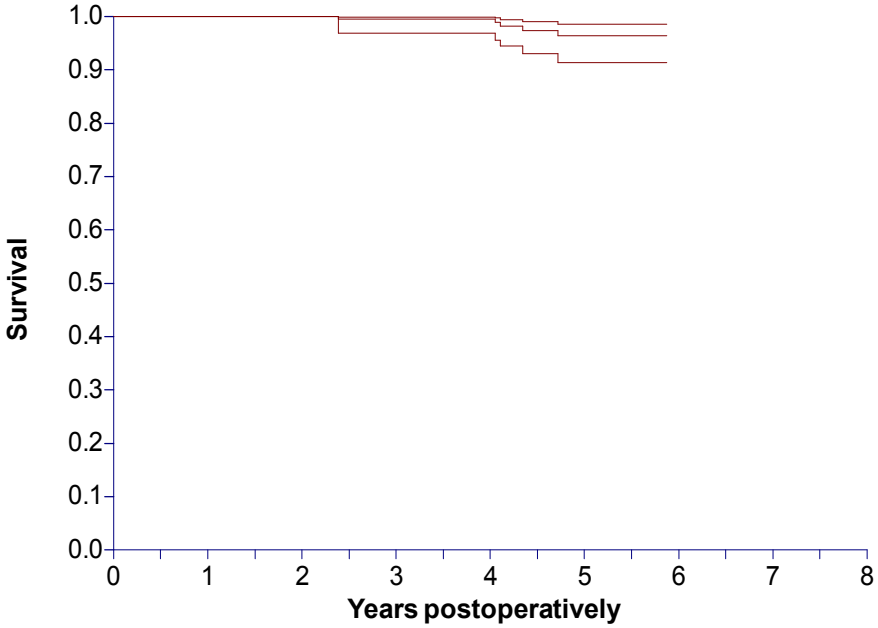

Fig. 2. **Kaplan–Meier implant survival curve with 95% confidence intervals for Aesculap® Centrament cobalt-chrome stem**

this, stem-head combination of titanium and cobalt-chrome in retrieved implants has shown signs of corrosion of the neck (12). It is still unknown how this femoral neck corrosion would affect implant survival. As in our series there are no hip revisions performed because of problems of corrosion between femoral neck and head.

The mean survival of titanium stem in our study is 5.68 years for Biomet® Bi-Metric titanium stems. As reported by A. Schweizer (13) the revision rate reaches a peak after 7–8 years postoperatively when titanium stem is used. This is a drawback of our study and reason for interpreting our results with caution. We will continue follow-up for both groups in the future and report results.

Conclusions

Biomet® Bi-Metric titanium stems showed good results of mid-term implant survival the same as Aesculap® Centrament cobalt-chrome stems.

Šlaunikaulio stiebo metalo rūšies įtaka implanto išlikimui

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Raktažodžiai: titaninis stiebas, klubo sąnario endoprotezavimas.

Santrauka. *Darbo tikslas.* Ištirti metalo įtaką implanto išlikimui. Tirti panašaus dizaino, bet dviejų skirtingų metalo lydinių šlaunikaulio stiebų vidutinės trukmės išlikimo rezultatai po klubo sąnario endoprotezavimo.

Tyrimo medžiaga ir metodai. Išanalizuota 341 klubo sąnario endoprotezavimo operacija, atlikta 1998–2001 metais. Buvo implantuojami dviejų tipų endoprotezai: „Biomet® Bi-Metric“ titaninis stiebas, kobalto-chromo šlaunikaulio galva ir didelės molekulinės masės polietileno gūžduobė, 102 atvejai bei „Aesculap® Centrament“ kobalto chromo stiebas ir galva bei didelės molekulinės masės polietileno gūžduobė, 239 atvejai. Visi endoprotezai buvo cementinio tvirtinimo. Atliekant visas operacijas, naudotas „Palacos®“ kaulinis cementas su gentamicinu. Duomenys buvo rinkti perspektyviai. Pildomos formos, kuriose buvo registruojami dokumentiniai duomenys, implanto tipas, cemento rūšis, cementavimo metodika, vietinės ir bendrosios komplikacijos. Registruotos pakartotinės operacijos. Remiantis nacionaliniu duomenų registru, nustatyti pacientai, mirę iki 2004 12 31. Išgyvenimas apskaičiuotas pagal Kaplan–Meier metodiką.

Rezultatai. Implanto išlikimas po endoprotezavimo „Biomet® Bi-Metric“ endoprotezu siekė 98 proc. praėjus septyneriems metams po operacijos. Implanto išlikimas po endoprotezavimo „Aesculap® Centrament“ endoprotezu siekė 98 proc. praėjus šešeriems metams po operacijos.

Išvados. Remiantis mūsų tyrimo duomenimis, Ti „Biomet® Bi-Metric“ šlaunikaulio stiebo išlikimas nesiskyrė nuo CoCr „Aesculap® Centrament“ stiebo.

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