

Exeter total hip arthroplasty with matte or polished stems

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Key words: matte and polished stem; sonography; prosthetic hip.

Summary. *Objective.* To compare implant survival rates after total hip arthroplasty with Exeter matte or polished stems and to determine the relationship of synovitis/joint effusion to signs of implant loosening and stem type.

Material and methods. The first part of the study included retrospective revision rate analysis of 118 primary hip replacements performed during 1991–1995. Two different designs of Exeter stems were used: matte surface stems during 1991–1995 (matte surface group – 47 cases), and polished stems during 1992–1995 (polished stem group – 71 cases).

During the second part of the study, 24 patients (11 in polished stem group and 13 in matte stem group) were prospectively examined with radiography and sonography. Sonography was performed in order to evaluate capsular distension, i.e. the distance between prosthetic femoral neck and anterior capsule. Capsular distension depends on synovitis and/or synovia in prosthetic hip. The relationship between capsular distension, stem type, and radiographic signs of loosening was assessed.

Results. For the first part of our study, total implant survival was 78% with matte stems and 61% with polished stems 13 years postoperatively ($P=0.27$). Stem survival was 82% for matte stems, and 88% for polished stems ($P=0.54$).

In the second part of study, a significant relationship between increased capsular distension and cup loosening was determined ($P=0.04$). We did not find significant difference in capsular distension when compared matte and polished stems.

Conclusion. Implant survival rates did not differ between the groups. The relationship between capsular distension and cup loosening was statistically significant.

Introduction

The Exeter[®] (Howmedica International, Staines, UK) stem was introduced in 1970, and studies on stem survival with good long-term results were published (1, 2). It has remained as a collarless double taper, but with the surface finish changed from polished to matte in 1976 and back to polished in 1986. In 1988, a modular stem was introduced, with the shoulder of the stem changed from flat to round. Increased loosening rates have been reported for matte stems (3). However, authors claimed that changed cementing technique was the main cause of this increase in failure rates (3).

At present, aseptic loosening in total hip arthroplasty is often described as a polyethylene particle-induced complex inflammatory process that results in bone resorption (4). Exactly how polyethylene wear debris influences the prosthetic joint, and how important the type of stem and stem cementing technique is in this process, is still poorly understood. It is hard to

assume that polyethylene particles are the main cause of osteolysis. Other factors with a more direct link to mechanical load must be involved. One such factor, the increased static and dynamic fluid pressure in the prosthetic hip joint, has been suggested (5, 6).

Though a seldom-used method in the examination of THA, sonography has proven valuable in diagnosing synovitis and infection (7, 8). U. Kesteris *et al.* has demonstrated a correlation between wear and radiographic loosening of the polyethylene cups and sonographically measured distance between the anterior capsule and the prosthetic femoral neck, i.e. distension of the capsule, in cemented THA (9).

Consequently, in the first part of our study, we investigated the revision rates with consistent surgical approach, bone bed preparation, cementing technique, and cement type used for both matte and polished stems.

In the second part of our study, we compared the capsular distension in the matte and polished stem

groups and determined whether there was any correlation between “capsular distension” and radiographic evidence of cup loosening.

Patients and methods

First part. From December 1991 to April 1995, 118 primary hip replacements in 111 patients were performed using the Exeter® stem and all-polyethylene cup. Matte stems were used in 47 hips, polished – in 71 hips. The preoperative diagnoses in replacements with a matte stem were osteoarthritis (44 hips, 93%), hip fractures and complications after hip fractures (3 hips, 7%), and in THA with a polished stem osteoarthritis (61 hips, 86%), rheumatoid arthritis (4 hips, 5%), hip fractures and complications of hip fractures (6 hips, 9%). The mean age was the same in both groups – 62 (SD 8.6) years.

All patients were operated on with a posterolateral incision and posterior arthrotomy. Surgical approach, cementing technique, cement type, implant type, intraoperative and postoperative complications were prospectively recorded. Two orthopedic surgeons performed all the hip replacements. All patients had spinal anesthesia. CMW® bone cement was used. Cementing technique consisted of hand mixing and finger packing; distal plug was used. Heads (30 mm in diameter) and the Exeter® cup were used in all cases. The choice of stem type was determined by implant availability in hospital stock only.

Implant failure/revision was defined as exchange of one or both prosthetic components. The 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 death dates and revision cases were recorded up to December 31, 2004. At the time of the follow-up study, 27 of the 111 patients were dead. No patients were excluded or lost to follow-up for the survival study.

Second part. Twenty-four of the 62 still alive and not revised patients agreed to participate in this part of the study. The remaining patients refused, or we were not able to contact them. Thus, 11 patients with polished stems and 13 with matte stems were examined in 2004. The sonographic examinations were performed in a sagittal plane, from the anterior aspect of the hip along the axis of the femoral neck (9). The capsular distension was defined as the distance between the anterior echo of the prosthetic femoral neck and the echo from the anterior surface of the anterior capsule (Fig. 1). The capsular distension was measured in all hips three times, and mean values were calculated.

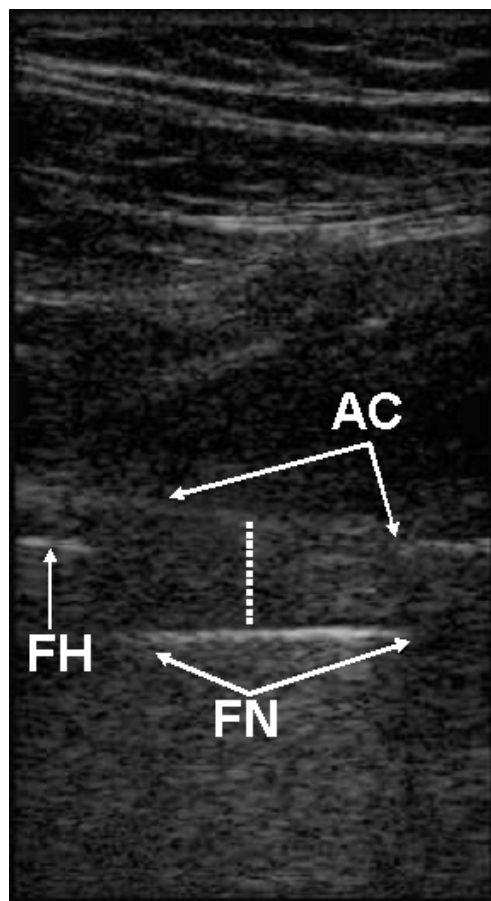


Fig. 1. Sonographic measurement of the capsular distance in total hip arthroplasty

AC – echo from the anterior surface of the anterior hip joint capsule; FN – echo from the anterior surface of the prosthetic femoral neck; FH – echo from the anterior surface of the prosthetic femoral head; Dotted line represents the distance between anterior capsule and prosthetic femoral neck.

All the 24 patients were also examined radiographically. Two of us evaluated the images for radiographic signs of loosening (10) and classified the implant as “loose” or “stable.” These two evaluations were then compared and found to be in full concordance except in one case. The relationship between stem types, signs of loosening, and capsular distension was assessed.

Statistical analysis. The cumulative revision rate was calculated with Kaplan–Meier statistics (11); log-rank test was used to test the differences. NCSS software was used. To assess the differences in the values of capsular distension between two groups, the t test was used.

Results

First part. At the end of the follow-up period, 8 (1 cup and 7 both components) out of the 47 primary arthroplasties with a matte stem and 18 (10 cups,

1 stem, 7 both components) out of the 71 primary arthroplasties with a polished stem had undergone revision. All revisions were performed due to aseptic loosening, except in one case due to recurrent dislocations.

Survival analysis, with revision arthroplasty because of aseptic loosening as the endpoint, was performed. The case with revision surgery because of recurrent dislocations was excluded from the survival analysis.

Total implant survival in the matte and polished stem groups was 78% and 61%, respectively ($P=0.27$) (Fig. 2). The stem survival rate in the matte stem group was 82%, in the polished stem group – 88% ($P=0.54$) (Fig. 3). The cup survival rate was 78% for matte stems, and 61% for polished stems ($P=0.28$) (Fig. 4).

Second part. The values of “capsular distension” and radiological evidence of loosening are presented in Table 1. Six out of 10 cups in the matte stem group

were radiographically loose as compared to 5 out of 14 in the polished stem group. Three out of 10 stems in the matte stem group were radiographically loose as compared to none out of 14 in the polished stem group. None of the patients with signs of radiographic loosening of the prosthesis required a revision surgery, as the radiographically loose hips had insignificant symptoms, and hip function was acceptable. In order to analyze the relationship between cup loosening and capsular distension and taking into account the fact that there were only 3 hips with loose stems of the 24, we excluded them from the statistical analysis. We assume that by eliminating loose stems we will remove the source of variation while comparing capsular distension in loose and stable cups with stable stems. There was a difference in capsular distension between THA with loose and stable cups ($P=0.04$), but no significant difference with matte or polished stable stems was found ($P=0.24$) (Table 2). We should

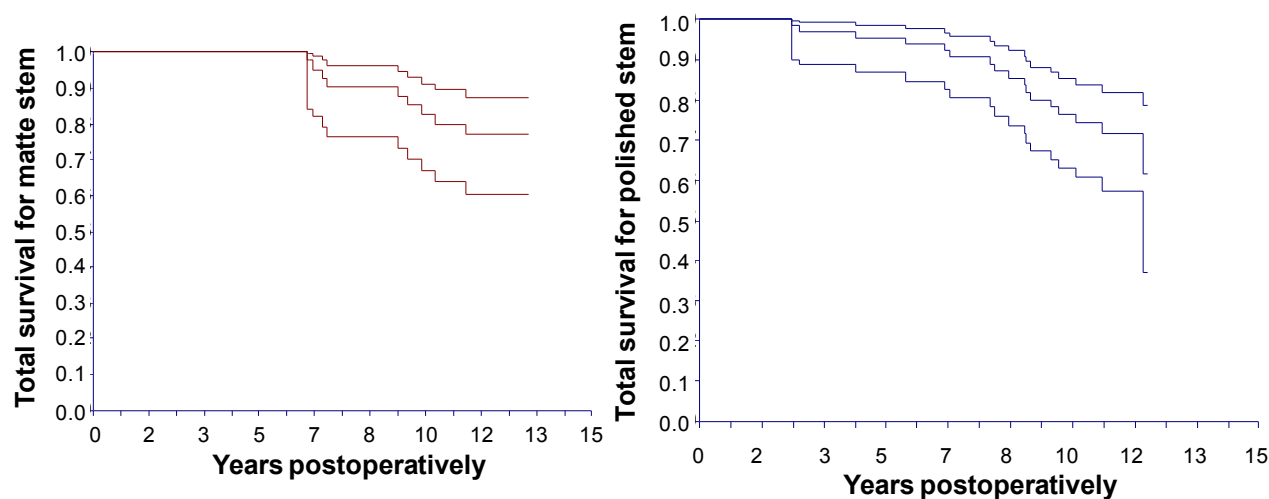


Fig. 2. Cumulative implant survival rate with revision because of aseptic loosening as endpoint with 95% confidence intervals

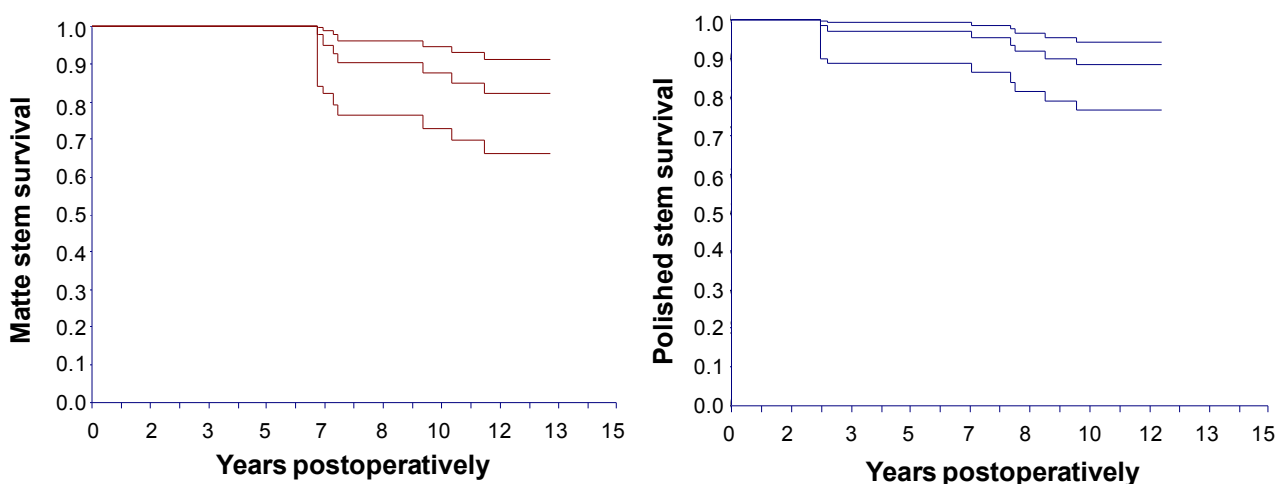


Fig. 3. Cumulative stem survival rate with revision because of aseptic loosening as endpoint with 95% confidence intervals

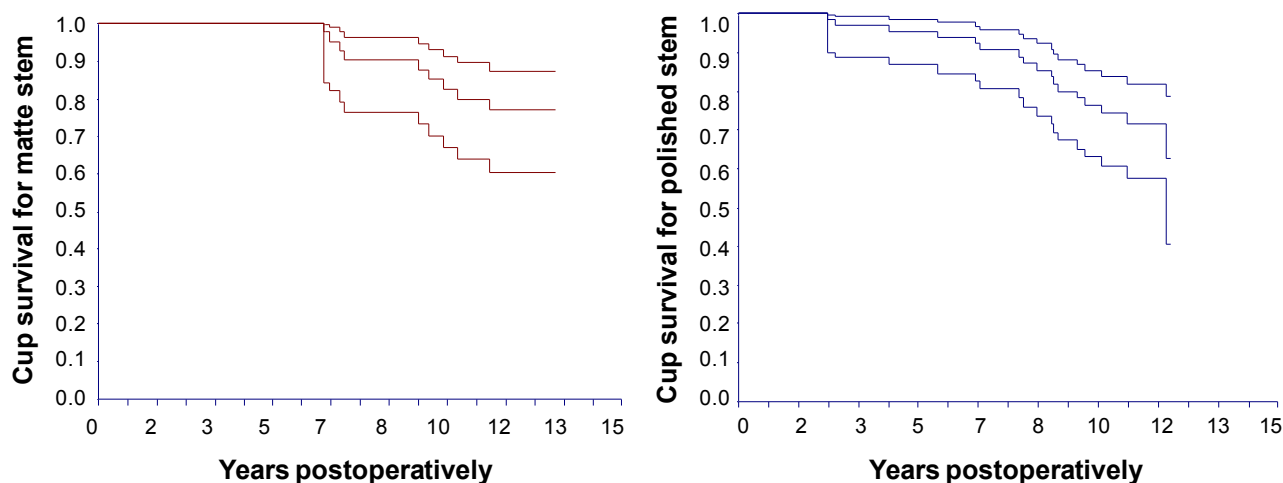


Fig. 4. Cumulative cup survival rate with revision because of aseptic loosening as endpoint with 95% confidence intervals

Table 1. Capsular distance and radiographic loosening

Case No.	Stem type	Capsular distance, cm	Cup loosening	Stem loosening
1	Matte	1.78	loose	loose
2	Matte	1.14	loose	loose
3	Matte	1.24	loose	loose
4	Matte	1.99	stable	stable
5	Matte	1.42	stable	stable
6	Matte	2.05	stable	stable
7	Matte	1.69	loose	stable
8	Matte	1.86	loose	stable
9	Matte	0.90	stable	stable
10	Matte	1.68	loose	stable
11	Polished	2.32	loose	stable
12	Polished	1.37	loose	stable
13	Polished	1.89	stable	stable
14	Polished	0.96	stable	stable
15	Polished	0.86	stable	stable
16	Polished	1.69	loose	stable
17	Polished	1.05	stable	stable
18	Polished	1.83	loose	stable
19	Matte	1.24	stable	stable
20	Matte	1.35	loose	stable
21	Polished	1.09	stable	stable
22	Polished	1.07	stable	stable
23	Polished	1.08	stable	stable
24	Matte	1.80	stable	stable

interpret the relationship of capsular distension regarding the stem type with caution because the presence of loose cups could influence the results.

Discussion

We studied the revision rate after primary THA

with matte or polished Exeter stems, with all other material and technical variables consistent. In this study, we did not evaluate the matte and polished stem differences in modularity and proximal part design changes. However, R. G. Middleton *et al.* reported that the changes of stem design with the introduction

Table 2. Measurements of capsular distance

Prosthesis analyzed	Capsular distance, cm
Loose cup, stable stem, n=8	1.72±0.30
Stable cup, stable stem, n=13	1.33±0.43
Stable matte stem, n=10	1.59±0.36
Stable polished stem, n=11	1.38±0.43
Loose matte stem, n=3	1.38±0.34

Values are expressed as mean ± standard deviation.

of the modular concept had no effect on loosening rates (12).

P. Rockborn *et al.* (3) have reported higher failure rates of matte stem as compared to polished stems and associated this with change in cementing technique. In our study, we also found that THA with matte stems had insignificantly higher stem revision rate as compared to polished stems, operated on using the same cementing technique. This may be due to the limited number of cases because every death and revision will thus dramatically affect the revision rate. Consequently, a larger group of patients would possibly provide similar but statistically significant results.

We assume that the lower stem and total implant survival rates in our series as compared with other studies (2, 13) were due to first-generation cementing technique and “learning curve” of the surgeons who were rather inexperienced in THA during 1991–1995.

The design of collarless, double-tapered, polished Exeter stem enables the stem to subside into the cement mantle (14) without causing progressive loosening. Theoretically, with matte stem the subsidence within cement mantle should be avoided due to better contact between the two. However, this can be true only in a scenario without any micromotion between the stem and cement, which on other hand is impossible because of the tapered form of the stem. Thus, even little subsidence will inevitably produce wear debris at the stem-cement interface because of the increased surface roughness. The presence of polymethylmethacrylate particles in the effective joint space may in turn lead to increased wear of polyethylene.

As shown by O. Robertsson *et al.* (15), increased intracapsular pressure is reflected in increased anterior capsular distension, which correlates with aseptic loosening of the implant. These findings are in accordance with our present findings; matte stable stems were associated with an increased capsular distension as compared to stable polished stems (1.59 cm *versus* 1.38 cm), and an increased proportion of radiologically loose cups in the matte stem group was also observed. We assume that the increased wear debris at the cement-stem interface in the matte stem group is a contributing factor in cup loosening and increased capsular distension, but due to very few or no clinical symptoms these cups were not revised.

It has been demonstrated that joint fluid can drain down to the femoral cavity via the bone-cement or cement-stem interface if loosening is present; polyethylene wear debris particles from the cup were found at this interface (16) and as far from the joint as in the distal metaphysis of the femur. This drainage of joint fluid and particles away from the joint into the femoral cavity may cause a decrease in intracapsular pressure and capsular distension in hips with loose stems. Such a mechanism of joint fluid drainage may be due to insufficient contact at the interface between matte stem and cement. This drainage mechanism would also explain why loose stems were associated with decreased capsular distension. It is likely that capsular tension with low elasticity and subsequent cyclic increases in intracapsular pressure to very high levels during gait functions as a pump that distributes particle-containing joint fluid along the route presenting least resistance (15), *i.e.* along the loose stem. On the contrary, the stable polished stem could act as a resistant route for the joint fluid to drain down to the femur, even with first-generation cementing technique. The subsequent increase in intracapsular pressure could explain why loose cups were more painful in the polished stem group and were more revised, what we observed in our survival study.

The relationship between capsular distension and cup loosening in our study is in accordance with previous findings (9, 15) and supports a role of synovitis and intracapsular pressure in aseptic implant loosening.

Klubo sąnario endoprotezavimas „Exeter“ matiniu ir poliruotu stiebu

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Raktažodžiai: matinis ir poliruotas stiebas, protezuoto klubo sąnario echoskopija.

Santrauka. *Darbo tikslas.* Palyginti implanto išlikimą po klubo sąnario endoprotezavimo „Exeter“ matiniu ir poliruotu stiebu. Koreliuoti echoskopiskai matuojamą protezuoto klubo sąnario „kapsulinį atstumą“ tarp stiebo tipų ir aseptinio gūžduobės nestabilumo požymių.

Tyrimo medžiaga ir metodai. Pirmoje tyrimo dalyje atlikta retrospektyvioji implanto išlikimo analizė, kurią sudarė 118 klubo sąnario endoprotezavimo operacijų, padarytų 1991–1995 metais. Implantuoti du skirtingo dizaino „Exeter“ stiebai: 1991–1995 metais matinis (matinio stiebo grupė – 47 atvejai) ir 1992–1995 poliruotas (poliruoto stiebo grupė – 71 atvejis).

Antroje perspektyviojo tyrimo dalyje 24 pacientams (11 – poliruoto stiebo grupėje ir 13 – matinio stiebo grupėje) po endoprotezavimo atliktos klubo sąnario echoskopijos. Echoskopiskai vertintas „kapsulinis atstumas“, matuojamas nuo priekinės klubo sąnario kapsulės iki šlaunikaulio kaklo. „Kapsulinio atstumo“ dydis priklauso nuo sinovito ar sinovijos išvešėjimo.

Rezultatai. Pirmoje tyrimo dalyje implanto išlikimas poliruoto stiebo grupėje siekė 61 proc., matinio stiebo grupėje – 78 proc. praėjus 13 metų po operacijos ($p=0,27$). Stiebo išlikimas siekė 88 proc. poliruoto stiebo grupėje ir 82 proc. matinio stiebo grupėje ($p=0,54$).

Antroje tyrimo dalyje nustatyta statistiškai reikšminga koreliacija tarp gūžduobės aseptinio nestabilumo požymių ir „kapsulinio atstumo“ ($p=0,04$). „Kapsulinis atstumas“ tarp matinio ir poliruoto stiebo grupių statistiškai reikšmingai nesiskyrė.

Išvados. Implanto išlikimas grupėse neišsiskyrė. Echoskopiskai matuojamas protezuoto klubo sąnario „kapsulinis atstumas“ statistiškai reikšmingai koreliavo su gūžduobės aseptinio nestabilumo požymiais.

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