The Effect of the Type of Cement on Early Revision of Charnley Total Hip Prostheses

A Review of Eight Thousand Five Hundred and Seventy-nine Primary Arthroplasties from the Norwegian Arthroplasty Register*

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ABSTRACT: We studied the survival of 8579 Charnley prostheses, in 7922 patients, according to the different types of cement that had been used. All of the patients had had a primary total hip replacement for primary coxarthrosis. The mean duration of follow-up was 3.2 years (range, zero to 6.4 years). The data were collected from the national Norwegian Arthroplasty Register.

The duration of survival was defined as the time to revision due to aseptic loosening. The Kaplan-Meier estimate of survival at 5.5 years for the 1226 femoral components that had been implanted with low-viscosity cement was 94.1 per cent (95 per cent confidence interval, 92.1 to 96.2 per cent), compared with 98.1 per cent (95 per cent confidence interval, 97.5 to 98.6 per cent) for the 6589 components that had been implanted with high-viscosity cement ($p < 0.0001$). The remaining 764 femoral components had been implanted with Boneloc cement, which was classified as neither high nor low-viscosity, and these components were considered as a separate group in the analyses. The Boneloc cement had been used for only three years, and the two-year survival rate of these prostheses was 95.5 per cent ($p < 0.0001$).

The cement contained an antibiotic in 2801 (42 per cent) of the hips in which the femoral component had been implanted with high-viscosity cement, compared with only thirty (2 per cent) of those in which it had been implanted with low-viscosity cement. With restriction of the comparison to cement without an antibiotic, and with adjustment for the age and sex of the patient, with use of the Cox proportional-hazards model the femoral components that had been implanted with low-viscosity cement had a rate of revision that was 2.5 times greater (95 per cent confidence interval, 1.6 to 3.8 times) than that for the components that had been implanted with high-viscosity cement, and those that had been implanted with Boneloc cement had a rate that was 8.7 times greater (95 per cent confidence interval, 5.1 to 14.8 times).

The addition of an antibiotic to the high-viscosity cement improved the Kaplan-Meier estimate of survival, at 5.5 years, from 97.7 to 98.7 per cent for the femoral components ($p = 0.06$) and from 99.2 to 99.6 per cent for the acetabular components ($p = 0.07$).

The rate of survival of the acetabular components at 5.5 years was higher than 99 per cent in association with all types of cement. There was no significant difference in the rates of failure between the low and high-viscosity cement. However, the acetabular components that had been implanted with Boneloc cement had a cumulative rate of revision of 1.2 per cent at two years, compared with 0.2 per cent for the other components ($p < 0.001$).

The nationwide Norwegian Arthroplasty Register was established in September 1987 by the Norwegian Orthopaedic Association. The purpose of the register is to aid in the assessment, and to help improve the quality, of hip-replacement operations in Norway[8].

The register has shown the over-all results of total hip replacement to be better with use of cement than without its use[7]. Although many different types of cement have been introduced onto the market[8], there have been few reports on the clinical results associated with these various types of cement. The aim of the current study was to compare, with use of data from the national register, the results of total hip arthroplasty with respect to the different types of cement, to the viscosity of the cement, and to the addition of an antibiotic to the cement. We present the results for patients who received a Charnley prosthesis because of primary coxarthrosis.

Materials and Methods

Since the establishment of the Norwegian Arthroplasty Register, all members of the Norwegian Ortho-

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TABLE I

DATA ON THE SEX AND AGE OF THE PATIENTS AND THE DURATION OF FOLLOW-UP WITH RESPECT TO THE DIFFERENT TYPES OF CEMENT

	No. of Hips	Men *(Per cent)*	Age *(Yrs.)* Min.	Age *(Yrs.)* Mean	Age *(Yrs.)* Max.	Median Durat. of Follow-up *(Yrs.)*	No. of Hips at Risk at 5.5 Yrs.
Femoral components							
All	8579	30	40	72	96	2.9	768
High-viscosity cement	6589	30	40	71	96	3.2	629
CMW 1	2309	30	40	71	96	3.3	321
CMW 2	7	14	60	69	75	3.2	2
CMW 1 with gentamicin	18	17	64	74	92	0.7	0
Palacos	1037	26	45	72	93	3.3	81
Palacos with gentamicin	2775	31	43	71	91	3.0	249
Simplex	435	29	56	72	89	3.3	66
Simplex with erythromycin	8	37	62	70	78	2.1	0
Low-viscosity cement	1226	32	48	71	93	3.1	139
CMW 3	1193	32	48	71	93	3.1	139
CMW 3 with gentamicin	30	43	59	73	85	1.9	0
Palacos E-Flow	3	33	59	68	77	2.8	0
Boneloc	764	29	47	72	94	1.4	0
Acetabular components							
All	8579	30	40	72	96	2.9	768
High-viscosity cement	7307	30	40	71	96	3.2	718
CMW 1	2786	31	40	71	96	3.3	305
CMW 2	7	29	60	69	77	4.9	2
CMW 1 with gentamicin	21	19	64	73	92	0.7	0
Palacos	1268	27	49	72	93	3.3	98
Palacos with gentamicin	2783	31	43	71	91	3.0	249
Simplex	434	29	56	72	89	3.3	63
Simplex with erythromycin	8	25	62	71	80	2.4	0
Low-viscosity cement	512	30	52	73	91	2.7	50
CMW 3	492	30	52	73	91	2.8	50
CMW 3 with gentamicin	18	39	59	73	85	1.4	0
Palacos E-Flow	2	50	67	72	77	2.4	0
Boneloc	760	29	47	72	94	1.4	0

paedic Association have agreed to provide data on all primary total hip replacements and revisions to the register[8]. All sixty-four hospitals where total hip arthroplasties are performed in Norway (population, 4.3 million in 1994) have participated. The operations are reported individually, on a form filled out by the surgeon immediately after each procedure. For primary arthroplasties, the diagnosis, type of implant, and type of cement are recorded. The revision arthroplasties are classified on the basis of their type and the reason why they were performed. The collection of the data has been reported on previously[8].

The revisions were linked to the primary operations with use of the patient's national social security number. During the first six years, 29,068 primary total hip replacements and 4618 revisions were registered. The current investigation comprised 7922 patients (8579 hips) who had had implantation of a Charnley total hip prosthesis (Thackray, Leeds, England) for primary coxarthrosis and had not had any previous operations on the index hip (Table I). Of the 7922 patients, 6304 had had the operation on only one hip and 1618 patients (2275 prostheses) had been operated on bilaterally. For 961 of the patients who had had a bilateral operation, only one hip could be included in the study, as the other hip had been operated on before 1987 or a type of implant other than the Charnley prosthesis had been used. Separate analyses were done to examine the impact of bilateral compared with unilateral replacement on the result.

The trade names of the cement were Boneloc (Polymers Reconstructive A/S, Farum, Denmark); CMW 1, CMW 2, and CMW 3, with and without gentamicin (CMW Laboratories Dentsply, Exeter, England); Palacos, with and without gentamicin (Schering-Plough International, Kenilworth, New Jersey); and Simplex, with and without erythromycin (Howmedica, London, England) (Tables I and II). Five brands had been used in less than 100 patients each; these brands were therefore excluded from the survival analyses based on the brands of cement, but they were included in the other analyses.

The brands of cement were classified into three main types[16] — low-viscosity, high-viscosity, or neither (Boneloc) — according to the information provided by the manufacturer. Boneloc cement, which was introduced in 1991, is produced with use of a new formulation based on methylmethacrylate/n-decyl-methacrylate/isobornyl methacrylate[11], and cannot be classified as high or low-viscosity. The high and low-viscosity groups

TABLE II

CUMULATIVE SURVIVAL (UNTIL REVISION DUE TO ASEPTIC LOOSENING) OF THE COMPONENTS WITH RESPECT TO THE DIFFERENT TYPES AND BRANDS OF CEMENT, ACCORDING TO THE KAPLAN-MEIER ANALYSES

	Viscosity of Cement	No. of Hips	No. of Revisions	Cumulative Survival at 5.5 Yrs. *(Per cent)*	95 Per Cent Confidence Interval
All femoral components		8579	127	97.2	96.8 to 97.5
Types of cement					
High-viscosity with antibiotic		2801	19	98.7	98.1 to 99.4
High-viscosity without antibiotic		3788	47	97.7	96.9 to 98.5
Low-viscosity without antibiotic		1196	38	94.1	92.1 to 96.2
Brands of cement*					
CMW 1	High	2309	34	97.4	96.3 to 98.4
CMW 3	Low	1193	38	94.1	92.1 to 96.2
Palacos	High	1037	10	98.0	96.4 to 99.6
Palacos with gentamicin	High	2775	19	98.7	98.1 to 99.4
Simplex	High	435	3	98.3	96.2 to 100
Boneloc†		764	23	‡	
All acetabular components		8579	33	99.3	99.0 to 99.6
Types of cement					
High-viscosity with antibiotic		2812	5	99.6	99.2 to 100
High-viscosity without antibiotic		4495	21	99.2	98.8 to 99.6
Low-viscosity without antibiotic		494	1	99.7	99.1 to 100
Brands of cement*					
CMW 1	High	2786	15	99.0	98.4 to 99.6
CMW 3	Low	492	1	99.7	99.1 to 100
Palacos	High	1268	5	99.4	99.0 to 100
Palacos with gentamicin	High	2783	5	99.6	99.2 to 100
Simplex	High	434	1	99.7	99.2 to 100
Boneloc†		760	6	‡	

*Only brands that had been used in more than 100 hips were included in the survival analyses.
†Boneloc cement had been used for only three years.
‡Cumulative survival could not be estimated.

were subdivided according to whether or not they contained an antibiotic. The duration of follow-up ranged from zero to 6.4 years (mean, 3.2 years).

Survival analyses[13] were performed separately for the femoral and acetabular components. The duration of survival was defined as the time between the arthroplasty and the revision. Exchange or removal of the index component because of aseptic loosening was the end point because aseptic loosening was considered to be the reason for revision that was most closely related to the cement. The durations of survival of components that were revised for reasons other than aseptic loosening and of those in patients who had died or had emigrated from Norway were censored. (These data are presented in the Results section.) Patients who had died or had emigrated were identified from files provided by the Central Bureau of Statistics in Oslo.

Two-sided log-rank tests[15] were performed to determine if differences were significant.

The Cox proportional-hazards model[3] was used to assess the influence of an antibiotic in the cement, of the viscosity of the cement, and of the age and sex of the patient on the survival of the prosthesis. Age was considered according to four groups: less than sixty years, sixty to sixty-nine years, seventy to seventy-nine years, and more than seventy-nine years. The influence of age on revision was evaluated with a test for linear trend across the four age-groups. The trend test is sensitive to increasing or decreasing rates of revision with increasing age. The analyses were done with use of the BMDP statistical package (BMDP Statistical Software, Los Angeles, California) and S-PLUS (Statistical Sciences, Seattle, Washington).

Results

Only small differences related to the age and sex of the patient were found between the different types and brands of cement; however, the duration of follow-up for the patients in whom the prosthesis had been implanted with Boneloc cement was only zero to three years, compared with zero to 6.4 years for the other groups of patients (Table I). The operations had been done in forty-four different hospitals. The use of low-viscosity cement differed between the femoral and acetabular components. Low-viscosity cement had been used for the insertion of 1226 (14 per cent) of the femoral components and 512 (6 per cent) of the acetabular components. Of the eleven different brands of cement that had been used, only CMW 1, CMW 3, Palacos, Palacos with gentamicin, Boneloc, and Simplex had been employed in more than 100 patients each. These six brands were included in the survival analyses based on the brand of cement (Fig. 1). Of the low-viscosity cements, only CMW 3 without an antibiotic was used in more than 100 patients. Low-viscosity cement with an antibiotic had been used for only thirty femoral and eighteen acetabular components; therefore, survival analyses were not done for this group.

Femoral Components

The over-all cumulative rate of survival of the femoral components at 5.5 years was 97.2 per cent, but there were significant differences according to the types of cement that had been used ($p < 0.0001$) (Fig. 1 and Table II).

The components that had been implanted with low-viscosity CMW 3 cement had an estimated probability of revision, at 5.5 years, of 5.9 per cent (95 per cent confidence interval, 3.8 to 7.9 per cent), compared with a rate of less than 3.0 per cent for the components that had been implanted with any brand of high-viscosity cement. The components that had been implanted with Boneloc cement had a revision rate of 4.5 per cent at only two years (Fig. 1).

The components that had been implanted with high-viscosity cement with or without an antibiotic had an estimated cumulative survival rate of 98.7 and 97.7 per cent, respectively, at 5.5 years, compared with 94.1 per cent for the components that had been implanted with low-viscosity cement ($p < 0.0001$) (Fig. 1 and Table II).

The pattern of results was the same when the analyses were done for the subgroups of men and women who were less than and more than sixty-five years old.

The survival rate, at 5.5 years, for the components that had been implanted with high-viscosity cement that contained an antibiotic was 1.0 per cent higher than that for the components that had been implanted with high-viscosity cement that did not contain an antibiotic, and the difference almost reached significance ($p = 0.06$) (Table II). With use of the Cox proportional-hazards model, with adjustment for the age and sex of the patient, the components that had been implanted with low-viscosity cement without an antibiotic had a rate of revision that was 2.4 times higher (95 per cent confidence interval, 1.6 to 3.8 times) than that for the components that had been implanted with high-viscosity cement without an antibiotic (Table III). The components that had been implanted with high-viscosity cement that contained an antibiotic had a rate of revision that was reduced to 59 per cent (95 per cent confidence

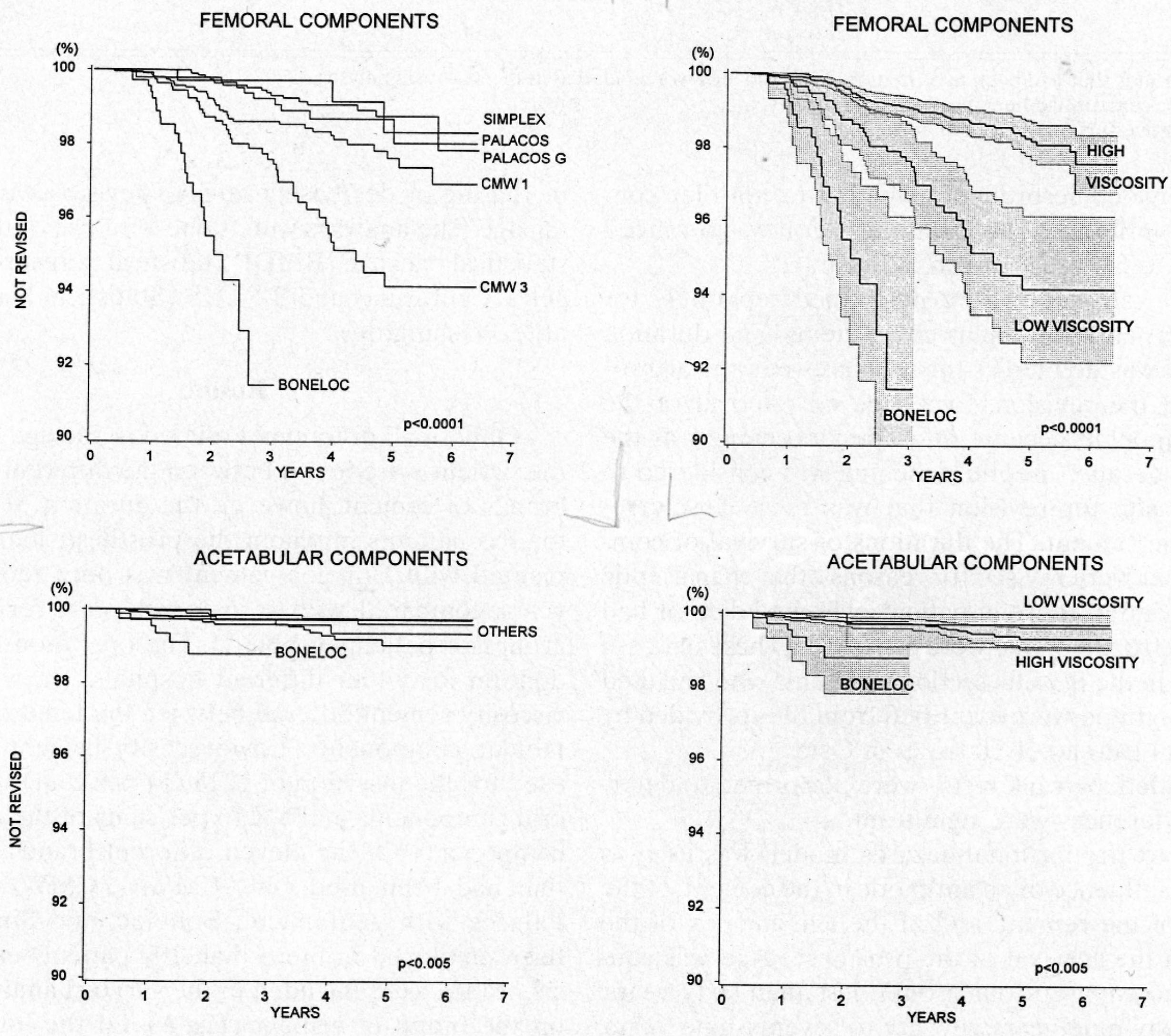

FIG. 1

Kaplan-Meier analyses of revision due to aseptic loosening in association with different types and viscosities of cement. The results for low-viscosity CMW 3 and Boneloc cement were significantly poorer ($p < 0.0001$) than those for the high-viscosity cement. (The area within the 95 per cent confidence limits is shaded.)

TABLE III

RELATIVE RATES OF REVISION (FAILURE RATE RATIO) DUE TO ASEPTIC LOOSENING, AS DETERMINED WITH USE OF THE COX PROPORTIONAL-HAZARDS MODEL

	No. of Hips	No. of Revisions	Unadjusted		Adjusted	
			Failure Rate Ratio	95 Per Cent Confidence Interval	Failure Rate Ratio	95 Per Cent Confidence Interval
Femoral components						
Type of cement*						
High-viscosity without antibiotic	3788	47	1		1	
Low-viscosity without antibiotic	1196	38	2.5	1.6 to 3.9	2.4	1.6 to 3.8
High-viscosity with antibiotic	2801	19	0.6	0.4 to 1.0	0.6	0.3 to 1.0
Boneloc	764	23	8.5	4.9 to 14.5	8.7	5.1 to 14.8
Sex						
Men	2575	64	1		1	
Women	5974	63	0.4	0.3 to 0.6	0.4	0.3 to 0.6
Age *(yrs.)*						
<60	449	11	3.1	1.2 to 7.9	2.7	1.1 to 7.1
60 to 69	2752	45	2.1	0.9 to 4.7	1.9	0.9 to 4.2
70 to 79	4230	64	2.2	1.0 to 4.9	2.1	0.9 to 4.5
>79	1118	7	1		1	
Acetabular components						
Type of cement*						
High-viscosity without antibiotic	4495	21	1		1	
Low-viscosity without antibiotic	494	1	0.5	0.1 to 3.6	0.5	0.1 to 3.6
High-viscosity with antibiotic	2812	5	0.4	0.2 to 1.1	0.4	0.2 to 1.1
Boneloc	760	6	3.9	1.5 to 10.2	4.0	1.5 to 10.6
Sex						
Men	2581	17	1		1	
Women	5980	16	0.4	0.2 to 0.8	0.4	0.2 to 0.8
Age† *(yrs.)*						
<70	3201	13	3.8	0.5 to 29.3	3.5	0.5 to 27.0
70 to 79	4241	19	4.7	0.6 to 35.3	4.5	0.6 to 33.5
>79	1119	1	1		1	

*Components that were implanted with low-viscosity cement containing an antibiotic were excluded from the analyses because of their small number (see Table II).

†Because no acetabular component failed in patients who were less than sixty years old, the age-groups were changed in the analyses of the acetabular components.

interval, 35 to 103 per cent) of that for the components that had been implanted with high-viscosity cement that did not contain an antibiotic (p = 0.05).

Because of the surprisingly poor results associated with the femoral components that had been implanted with Boneloc cement, some supplementary analyses were done. We thought that it was possible that these results were inferior because the surgeons in the hospitals where this cement had been used were less skilled. However, when the analyses were restricted to only those hospitals, the results remained significantly poorer than those for the components that had been implanted with high or low-viscosity cement (p < 0.0001). Because Boneloc cement and the new equipment for mixing it had been introduced onto the market during the study period, we wanted to correct for a possible problem with respect to the learning curve for this new technology. However, we found similarly poor results in association with the components that had been implanted with Boneloc cement after we had excluded the first twenty-five such components for each hospital (p < 0.0001). With use of the Cox proportional-hazards model, the components that had been implanted with Boneloc cement had a rate of revision that was 8.7 times higher (95 per cent confidence interval, 5.1 to 14.8 times) than that for the components that had been implanted with high-viscosity cement without an antibiotic.

With use of the Cox model, the rate of revision of the femoral components was reduced 41 per cent (95 per cent confidence interval, 29 to 59 per cent) in women compared with that in men. There was a tendency toward fewer revisions in the older age-groups, but this difference was not significant (p = 0.14, linear trend test) (Table III).

Acetabular Components

We found no significant difference in the results with respect to the different types of cement that had been used to implant the acetabular components. Each type of cement was associated with a revision rate of less than 1.0 per cent at 5.5 years (Fig. 1 and Table II). However, the components that had been implanted with Boneloc cement, and had been followed for a shorter duration (zero to three years), had a cumulative survival rate of only 98.8 per cent at two years, compared with a rate of 99.8 per cent for the other groups (p < 0.001). The difference in survival between the components that had been implanted with high-viscosity ce-

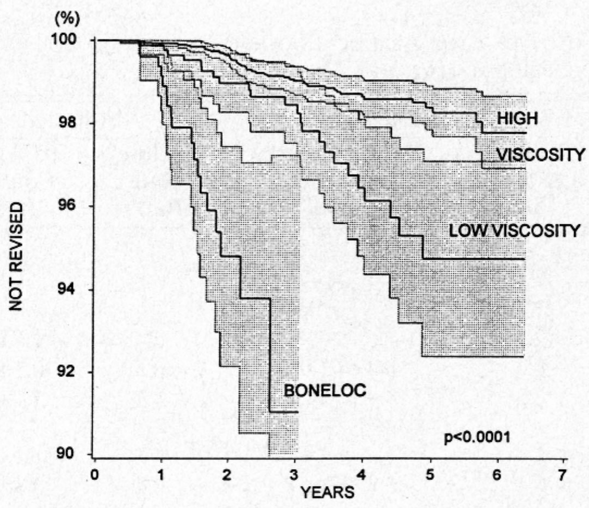

FIG. 2

Kaplan-Meier analysis of revision due to aseptic loosening of femoral components used in unilateral total hip replacements. The results were similar to those for the total patient population. (The area within the 95 per cent confidence limits is shaded.)

ment and those implanted with low-viscosity cement was negligible (Fig. 1 and Table II).

The results for the components that had been implanted with high-viscosity cement that contained an antibiotic were somewhat better than the results for the components implanted with high-viscosity cement that did not contain an antibiotic. These groups had rates of revision of 0.4 and 0.8 per cent, respectively, at 5.5 years; however, these differences were not significant.

With use of the Cox model, the viscosity of the cement had no significant effect on the survival of the acetabular components. The components that had been implanted with Boneloc cement had a rate of revision that was 4.0 times higher (95 per cent confidence interval, 1.5 to 10.6 times) than that of the components that had been implanted with high-viscosity cement (Table III). As was the case for the femoral components, the survival of the acetabular components in women was significantly better than that in men, with a rate of revision that was 40 per cent (95 per cent confidence interval, 20 to 79 per cent) that of the rate in men.

Unilateral Hip Replacement

The results for the patients who had had a unilateral operation were virtually the same as those for all patients who had had a total hip replacement (Fig. 2). The over-all results for patients who had had a unilateral operation were not significantly different from the over-all results for those who had had a bilateral operation ($p = 0.37$ for the femoral components and $p = 0.35$ for the acetabular components).

Revisions

Over-all, a total of 198 revisions were performed in this group of 8579 arthroplasties. Twenty-one revisions had been done for aseptic loosening of both components; 106, for aseptic loosening of only the femoral component; twelve, for aseptic loosening of only the acetabular component; thirty-seven, for infection; fourteen, for dislocation; and eight, for other reasons. The results of survival analyses with revision due to any cause as the end point were very similar to those of the analyses for revision due to aseptic loosening. The results associated with Boneloc and CMW 3 cement were poorer and significantly different from each other and from those associated with the other types of cement ($p < 0.0001$).

Discussion

As there had been few clinical studies on the types of cement that have been used in total hip operations, and as some surgeons had raised concerns about the results associated with use of the relatively new Boneloc cement, we investigated the effects of the brand and viscosity of the cement on the survival of hip prostheses. Although Boneloc cement had been in use for only three years at the time of our study, we considered it especially important to evaluate its clinical results, as it had been used in thousands of patients without those results being known.

The increased probability for revision of the femoral components implanted with Boneloc cement compared with the rate for the components implanted with low-viscosity CMW 3 cement, and the increased probability for the femoral components implanted with low-viscosity cement compared with that for the femoral components implanted with high-viscosity cement, cannot be explained by differences in the patient populations. The investigation comprised a homogeneous group of patients who had had only one type of prosthesis, one diagnosis, and no previous operations. As far as we know, no other large clinical study has addressed the impact of the cement on the results of hip arthroplasty. In a randomized clinical trial with five years of follow-up, Carlsson et al. found no difference in the results between femoral components that had been implanted with high-viscosity cement and those implanted with low-viscosity cement. However, the number of patients (226) in their study was small, and the power of the study to reveal differences of 4 per cent at a 5 per cent level of significance was less than 50 per cent. In addition, the operations in their study were performed during a period of only two years and only in hospitals where a so-called modern technique was used for application of the cement. Because the surgeons were experienced with this technique, better results could be expected with the low-viscosity cement although the technique is technically demanding. A study based on a nationwide register, such as the current one, can provide a more realistic picture of the over-all results with use of different types of cement because of the larger number of patients and the inclusion of many hospitals during a longer period of time.

The better results associated with the cement that contained an antibiotic are interesting, as revision because of aseptic loosening was the end point in the survival analyses. However, if some instances of aseptic loosening were actually due to subclinical infection, this may explain the better results. It is also possible that the addition of an antibiotic caused an alteration in the mechanical properties of the cement, such as an increase in the viscosity. However, for the femoral components inserted with high-viscosity cement, the difference in survival due to the addition of an antibiotic was only 1.0 per cent at 5.5 years. A larger number of patients or a longer duration of follow-up is needed to give more certainty about the clinical importance of this difference.

With respect to the acetabular components, no clinically important difference relative to the effect of the viscosity of the cement was found. This may be because, during cementing of the cup, it is easier (and probably common) to wait until the viscosity becomes high before the cup is inserted. Both the Kaplan-Meier analyses and the Cox proportional-hazards model demonstrated better results for the cups that had been implanted with cement containing an antibiotic. The rates of revision were less than 1.0 per cent for all groups of cups, and the clinical relevance of the positive effect of cement with an antibiotic is uncertain.

Boneloc cement was introduced in Norway in 1991. It became popular because of its lower toxicity, lower exothermic temperature, and closed system for application[4,11,12,20]. It had a new formula and a shorter handling time[22]. Problems related to learning to use the new equipment, and the shorter handling time of the cement, may have contributed to, but do not explain, the poorer results. However, a poor result is not surprising when a new product is introduced for hip operations. The impact of the Boneloc formula (50 per cent methylmethacrylate, 30 per cent n-decyl-methacrylate, and 20 per cent isobornyl methacrylate[11]), compared with that of the ordinary polymethylmethacrylate cements, should be further investigated. The manufacturer has since changed the formula, and Boneloc cement produced after December 1993 has a handling time more like that of the other types of cement[22].

The inclusion of patients who had had a bilateral operation might be questioned, as standard statistical methods assume independent observations[18]. Conceivably, failure in a patient who has had a bilateral operation is dependent. However, these patients constitute an important group who have hip prostheses. It should be noted that only negligible differences in the results were found between the total population of patients and the population who had had a unilateral procedure. The possible effect of a dependency within a patient who had a bilateral operation therefore seems to have been unimportant.

The present study was not randomized. Randomized trials of hip operations have generally been small, and the large number of patients in our study was an advantage. Because our study was not randomized, the possibility that certain types of cement were associated with other factors that affected the outcome cannot be excluded. For example, the surgeons who used low-viscosity cement or the new Boneloc cement might have been less experienced than the others. Such a bias is unlikely in Norway, however, as the choice of cement is generally made by the orthopaedic department and not by the individual surgeon.

Unfortunately, comparison of the different brands of low-viscosity cement was impossible, as only the low-viscosity CMW 3 cement was used in enough patients (Table I). However, the most important difference between the CMW 3 cement and the other types of cement is its low viscosity. Low-viscosity cement has been shown to have greater penetration into cancellous bone[21,23], and this may explain the superiority of low-viscosity cement in experiments[16]. However, the experimental results have not been supported by the results of clinical trials. On the contrary, some clinical investigations have shown inferior results for prostheses implanted with low-viscosity cement[9,10], and a study based on stereophotogrammetry revealed a greater rate of migration of femoral components that had been implanted with low-viscosity cement compared with those implanted with high-viscosity cement[17].

There may be several explanations for the poorer results associated with the femoral components that were implanted with low-viscosity cement. The principles of so-called modern techniques of cement application[16,19,24] are well known throughout Norway, but the way that these principles are put into practice may differ. The technique for the application of low-viscosity cement is more demanding. The maintenance of pressure throughout the cementing process is critical, especially when low-viscosity cement is used. During polymerization, low-viscosity cement has been shown to be more easily displaced from the irregularities in the bone by blood[1] and to provide a lower shearing strength of the bone-cement interface[14] than high-viscosity cement. The strength of low-viscosity cement has been shown to be high in laboratory tests[6], but contamination of fat and blood has been shown to decrease the strength of low-viscosity cement more than it decreases the strength of high-viscosity cement[1,5].

In summary, this prospective clinical study, based on a nationwide register, demonstrated an increased rate of revision due to aseptic loosening of femoral components that had been implanted with low-viscosity cement compared with the rate for those that had been implanted with high-viscosity cement. The first generation of Boneloc cement was associated with poorer short-term results than the other types of cement. A randomized study with a sufficient number of patients should be performed to confirm our results.

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