Uncoated polyethylene RM acetabular component versus Müller cemented acetabular component

A 4- to 8-year follow-up study

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Summary. Comparable patient populations with 160 uncoated RM acetabular cups and 263 cemented Müller standard acetabular cups were submitted to survival-time analysis in a retrospective study with a mean follow-up of 5.3 years for the RM cup and 6.1 years for the Müller cup. After 7–8 years 12% of the RM cups and 4% of the Müller cups had been exchanged, 40% and 15% respectively were loose. The poor performance of the RM cups is ascribed to additional external polyethylene wear, which leads to the formation of granulomas and destroys the weight-bearing osseous structures. Similar granulomas also develop on the proximal stem and thus endanger the same.

The RM cup implant has been in use since 1977. Up until 1982 8000 implants had been carried out [9]; since then the use of the RM cup has become more widespread.

As a result of the elasticity of the pelvis and the acetabulum, an elastic cup like the RM cup in contact with the subchondral bone can achieve a better natural distribution of forces than a rigid implant. The enlargement of the contact surface results from annular excavations. Two cones serve as rotatory protection; dowels or screws cause primary impact pressure and additional rotatory protection [10]. Following pressure forces developing in the cranial part of the acetabulum, undisturbed bony ingrowth into the grooves is expected, whereas underneath the acetabular equator traction forces arise, so that only fibrous fixation can succeed [10].

The convincing concept of the RM cup was supported by good early results. Follow-up spans between 6 months and 6 years showed 0% loosening [2, 11, 12, 15, 20]. Eight histological specimens demonstrated mainly fibrous incorporation, whereas subchondral bone was in contact with the polyethylene surface only sporadically [16]. Remarkable findings were fine birefringent particles in the compression zone, which were interpreted as showing biodegradation of polyethylene [16]. However, Eyerer considers oxidative degradation of polyethylene — caused by peroxidases — irrelevant and opposes this interpretation [6]. Recently, over 7.6% revisions after 5–10 years have been reported, as has loosening attributed to polyethylene abrasion following micro-movements [23].

A comparison between the RM cup with cemented cups is difficult, because very different results have been reported: for cemented Müller cups, for instance, incidences of loosening have been reported at 0.8% [14], 9.8% [1], and 29% [19] after 5.8–10 years. A comparison of survival-time curves is only possible with similar patient populations, and above all with periodic follow-up examinations [4, 5, 18]. These conditions are complied with in the present study; 80% of the RM cups were checked annually and X-rayed at least five times postoperatively.

Materials and methods

Between 1980 and 1984, 207 RM cups and 892 cemented Müller standard cups were implanted at the Department of Orthopaedic Surgery, Innsbruck. To ensure similar patient groups, the following criteria were employed for inclusion in the present retrospective study: (a) patient age must have been under 70 years at time of operation; (b) only Müller straight or standard stem components were acceptable; and (c) patients with small acetabular cups (44 mm) were to be excluded. These criteria were met by 160 patients with 173 RM cups. Of these 7 had died (4.4%), 2 had moved to an unknown location (1.3%), and 4 had not reappeared despite repeated requests (2.5%), so that 147 patients (91.9%) with 160 cups (92.5%) remained. The criteria were also met by 292 patients with 309 standard cups, of whom 24 (8.2%) had died, 17 moved to an unknown location (5.8%), and 15 had not reappeared for the follow-up examination (5.1%). Thus, 236 patients (80.8% with 263 cups (85.1%) remained in this group. Age and follow-up details can be seen in Table 1.

Twenty-six (16%) of the RM cups were 50 mm in size, 36 (23%) 52 mm, 40 (25%) 54 mm, and 26 (16%) 56 mm; 4 (3%) were smaller and 28 (17%) larger than these sizes. Of the cemented cups, 171 (65%) were 50 mm in size, 71 (27%) 54 mm, and 21 (8%) 58 mm.

The preoperative diagnoses are given in Table 2.
### Table 1. Preoperative hip diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Total no. of hips replaced</th>
<th>RM cup (n=160)</th>
<th>Müller cup (n=263)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primarycoxarthrosis</td>
<td></td>
<td>315 (74.5%)</td>
<td>132 (82.5%)</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td></td>
<td>28 (6.6%)</td>
<td>4 (2.5%)</td>
</tr>
<tr>
<td>and ankylosing spondylitis</td>
<td></td>
<td>25 (5.9%)</td>
<td>12 (7.6%)</td>
</tr>
<tr>
<td>Dysplastic coxarthrosis</td>
<td></td>
<td>20 (4.7%)</td>
<td>2 (1.1%)</td>
</tr>
<tr>
<td>Femoral head necrosis</td>
<td></td>
<td>104 (39.5%)</td>
<td>104 (39.5%)</td>
</tr>
<tr>
<td>Other conditions</td>
<td></td>
<td>179 (68.1%)</td>
<td>179 (68.1%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>423 (100.0%)</td>
<td>263 (100.0%)</td>
</tr>
</tbody>
</table>

### Table 2. Patient age at operation, length of follow-up, sex, and type of femoral component used with the acetabular component

<table>
<thead>
<tr>
<th>RM cup (n=160)</th>
<th>Müller cemented cup (n=263)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age at implantation (years)</td>
<td>57.3 ± 7.2</td>
</tr>
<tr>
<td>Mean follow-up (years)</td>
<td>5.3 ± 1.1</td>
</tr>
<tr>
<td>Sex:</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>65 (40.6%)</td>
</tr>
<tr>
<td>female</td>
<td>95 (59.4%)</td>
</tr>
<tr>
<td>Femoral component:</td>
<td></td>
</tr>
<tr>
<td>straight stem</td>
<td>158 (98.7%)</td>
</tr>
<tr>
<td>curved stem</td>
<td>2 (1.3%)</td>
</tr>
</tbody>
</table>

The patients were requested to come for a follow-up examination. The case history was taken and the clinical examination performed according to a standardized protocol. The operation reports, comments on the index cards, and X-rays taken at suitable intervals were evaluated.

The case history notes covered the following: satisfaction, pain, walking distance, activity, use of a walking device, requirement of analgetics. The following were evaluated clinically: mobility, gait pattern, pelvic presentation, Trendelenburg and Duchenne signs, pain on movement, weight.

The radiological evaluation of RM cup loosening was according to a classification by Russe [7]:

- **A**: Faint continuous marginal sclerosis
- **B**: Radiolucencies in the caudal third or faded contour
- **C**: Marginal sclerosis only around the cranial embodiment cone
- **D**: Continuously faded acetabular contour
- **E**: Definite migration

Intermediate stages are possible. To obtain comparability of these stages to those of Griffith et al. [8] for cemented cups, the following relations were assigned:

- **A**, **A-B** = stage I: tight
- **B**, **B-C** = stage II: at risk
- **C**, **C-D** = stage III: at risk
- **D**, **D-E**, **E** = stage IV: loose

The radiological evaluation of loosening of cemented cups was performed according to the method of Griffith et al. [8]:

- **I**: Demarcation confined to the superior and outer thirds
- **II**: Demarcation extends two-thirds around the cement to involve the superior and medial thirds
- **III**: Demarcation extends around the cement to the inferior aspect
- **IV**: Socket loosening, shown by migration of the socket in a medial or headward direction or by a change in the orientation of the cup. This is associated with demarcation more than 2 mm wide.

Migration of the RM cups was also measured using the EBRA system [17]. EBRA is a computer-aided method of analysing individual standard radiographs for the evaluation of acetabular spatial migration. To use it effectively, annual follow-up radiographs are needed.

The data analysis was performed on a personal computer. The statistical interpretation was carried out using the $\chi^2$ test, the $t$ test, and Kaplan-Meier survival analysis [4, 5, 18]. The follow-up radiographs were taken sufficiently frequently for the calculation of survival curves — in the RM cups, even at quite exact annual intervals.

## Results

### Intraoperative complications

In two hips (0.8%) with cemented cups, perforation of the acetabular bases occurred. In three hips (1.9%) with RM cups, a tendency to luxation was determined intraoperatively.

### Postoperative complications

One patient died on the 3rd postoperative day due to myocardial infarction. One patient suffered pulmonary embolism on the 13th postoperative day. Seven deep venous thromboses, seven nerve lesions, and 16 haematomas occurred, while thrombosis prophylaxis was carried out with dextran up to the 3rd postoperative day, followed by administration of anticoagulants. In three cases relapsing luxations developed, which in one case (RM cup) led to cup replacement after 3 months (for the purposes of this study, this is classified as a postoperative complication and not as a cup replacement).

### Subjective results

At the time of follow-up, 94.6% of patients with RM cups and 91.7% of patients with cemented standard cups were satisfied with the results; 5.4% and 8.3% respectively were dissatisfied (difference not significant).

Twelve patients with RM cups (8.2%) and 37 patients with standard cups (16.4%) could walk less than 1 km. Activity was definitely reduced in 8 patients with RM cups (5.4%) and in 20 patients with standard cups (8.9%).

### Clinical results

The range of motion — for example of flexion — with RM cups was significantly greater: $102° \pm 16.9°$, compared to $93° \pm 15.3°$ with standard cups ($t$ test: $P = 0.000$). The gain in flexion compared with preoperative findings was also greater in RM cups: $27° \pm 24°$ compared with $20° \pm 26°$ in standard cups ($t$ test: $P = 0.011$).

Pelvic obliquity was found with 26 (31.3%) of the RM cups and 71 (32.5%) of the standard cups. A Trendelenburg sign was present with 11 (7.5%) of the RM cups.