

**The Effects of Technique Changes on Aseptic Loosening of the Femoral
Component in Hip Resurfacing.
Results of 600 Conserve[®] Plus With a 3 to 9 Year Follow-up**

Harlan C. Amstutz, MD
Michel J. Le Duff, MA
Patricia A. Campbell, Ph.D
Frederick J. Dorey, Ph.D

Joint Replacement Institute at Orthopaedic Hospital

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Correspondence to:

HC Amstutz

Medical Director, Joint Replacement Institute

Orthopaedic Hospital

2400 S. Flower Street, Los Angeles, CA 90007

(213) 742 1075

E-mail: hamstutz@laoh.ucla.edu

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ABSTRACT

The purpose of the present study was to determine the effectiveness of modifications in the surgical technique on loosening of the femoral component in the first 600 consecutive Conserve[®] Plus metal-on metal hybrid resurfacings. These modifications were gradually introduced over time but all the changes were implemented after the first 300 hips.

Average age of the patients was 48.9 years and 74% were male. Average follow-up was 70.5 months for the first 300 hips and 42.4 months for the second 300 and there was a significant improvement ($p=0.016$) of the second 300 hips over the first 300 in a time-dependant analysis using as an end point the time to appearance of a radiolucency suggesting potential femoral component loosening. None of the components with cemented stems showed femoral radiolucencies or were revised for aseptic loosening.

Adding fixation holes in the dome and chamfered areas and cleansing and drying using a suction tip in the dome hole were significantly related to the improvement of the results.

Positioning the femoral component in a more valgus position did not show any effect as an independent variable.

1 **INTRODUCTION**

2 Surface arthroplasty of the hip using metal-on-metal (MOM) bearings was
3 introduced in the 1990's [1-4]. The first detailed analysis of the MOM hybrid surface
4 arthroplasty with Conserve[®] Plus (Wright Medical Technologies, TN, USA)
5 implantations identified loosening of the femoral component as the main mode of
6 failure[5] just as had been the case with the first generation of metal-on-polyethylene
7 resurfacings[6,7]. Unlike polyethylene resurfacings, however, osteolysis secondary to
8 debris was not identified as a risk factor for the development of radiolucencies (insecure
9 femoral fixation) and loosening, presumably because the wear has been only a few
10 microns per year and the debris has a lower inflammatory response[8]. Unlike metal-on-
11 polyethylene bearings, the increased diameter of the femoral ball does not adversely
12 affect the wear of metal-on-metal components [9,10].

13 Our initial risk analysis for loosening highlighted the association of clinical
14 failures and radiographic signs of loosening with a small area of fixation, the presence of
15 femoral head cysts greater than 1 cm in size, and a varus positioning of the femoral
16 component[5,11,12]. The quality of bone preparation was not specifically addressed in
17 that analysis. However, the review of the intra-operative photographs taken after
18 preparation of the femoral head lead to subsequent changes in bone cleaning, drying, and
19 an increase in the contact area between bone and cement with additional drill holes. The
20 purpose of this review was to compare the occurrence of loosening and radiographic
21 signs of loosening of the femoral component between the first and second 300 hips of a

1 consecutive series of over 900 metal-on metal hybrid surface arthroplasties and relate the
2 results to technique changes instituted.

3 METHODS AND MATERIALS

4 Between November 1996 and March 2003, 600 hips in 519 patients were
5 implanted with Conserve[®] Plus resurfacing components (Wright Medical Technologies,
6 TN, USA) after hospital institutional review board approval, and as part of a Food and
7 Drug Administration clinical trial. The details of the patient demographics, including the
8 distribution of etiologies and diagnoses, are presented in Table 1.

9 The initial surgical technique has been described in detail elsewhere [5,13,14].
10 Briefly, the femoral head is prepared by cylindrical reaming, removing the femoral dome
11 bone with an oscillating saw and chamfering the head. Cystic material and necrotic bone
12 were removed with curettes and a high-speed burr. The system was designed to provide a
13 one mm cement mantle. Photographs of the prepared femoral head were made prior to
14 cementation. Since the initiation of the series, several modifications have been made to
15 the surgical technique as a consequence of our previous radiographic and loosening
16 analysis. Not all the changes took place at the same time and some proceeded from a
17 gradual process. However by case 300 all these changes had been initiated, and we will
18 refer to the first 300 cases as 1st generation femoral fixation technique (group 1) and the
19 next 300 hips the 2nd generation femoral fixation technique (Group 2). The changes
20 pertaining to the two generations of femoral fixation techniques are summarized in Table
21 2.

1 Surgical changes

2 Initially the head was cemented after chamfer reaming without further preparation
3 or just drilling a few three-millimeter fixation holes to a depth of three to five millimeters
4 in the dome area. The addition of drilled holes into the femoral head affects the bone-
5 cement contact area in a very effective manner as shown in Table 3. We increased the
6 number of holes drilled and the area in which these holes are drilled, adding the
7 chamfered region of the prepared femoral head. Table 4 shows the evolution of the
8 number and position of the drill holes throughout the series.

9 A suction tip was placed in the central hole to dry the femoral head after jet
10 lavage and during cement pressurization of the cylindrically reamed head. This
11 improvement was made after the first 100 cases.

12 The review of the retrieval and intra-operative photographs of the early failure
13 cases suggested that an incomplete removal of all cystic material could be related to
14 loosening. A more meticulous preparation of the bone surface was implemented to
15 remove all debris utilizing a high-speed burr, and better clean and dry the bone prior to
16 cementation. An example of these technical changes is shown in figure 1.

17 The orientation of the femoral component in the frontal plane also evolved
18 throughout the series as the target stem shaft angle shifted from anatomic (stem aligned
19 with the neck axis) to a greater valgus of 140 degrees. This modification was effective
20 after the first 100 cases. Table 5 shows the evolution of the stem shaft angle by series of
21 100 consecutive hips.

22 The metaphyseal stem, originally designed to be left uncemented and ensure
23 proper component alignment, was cemented in 161 hips. In nine of the first 300 hips the

1 stem was cemented because of severe neck osteopenia or especially large defects such as
2 those resulting from previous coring or hemisurface arthroplasty. In the next 300 hips, 152
3 were cemented-in to better evaluate the effects of cementation as an improvement of initial
4 fixation, and to evaluate any possible negative consequences such as femoral neck stress
5 shielding. This included series of 100 hips in which 92 stems were cemented in
6 irrespective of bone quality and cyst formation. The remaining eight were not cemented
7 because of an oversight (4 cases) or the decision to match the technique with that of the
8 previously operated contralateral hip in 4 bilateral patients.

9 Outcome Evaluation

10 For this study the UCLA 10 point pain, walking, function and activity scores were
11 calculated^[15] pre-operatively and at last follow-up along with SF-12 physical and mental
12 scores as an evaluation of quality of life^[16]. Harris hip scores^[17] were computed post-
13 operatively as an element of comparison with other studies.

14 Radiographic analysis

15 All of the patients had antero-posterior, modified table-down lateral, and Johnson
16 cross-table lateral radiographs of the pelvis taken preoperatively and, where possible,
17 during each follow-up. The radiographic analysis system previously described was
18 utilized to analyze femoral fixation by critically scrutinizing the presence or absence of
19 radiolucencies in three zones around the short metaphyseal stem^[5]. The metaphyseal
20 stem/femoral shaft angle was measured from the post-operative antero-posterior radiographs
21 as an assessment of femoral component positioning.

1 Radiographs have been evaluated preoperatively and postoperatively at three to
2 four months, one year and at yearly intervals. Three patients (four hips) died at twenty-
3 one, twenty-three and seventy months postoperatively of causes unrelated to the surgery.
4 Three patients (0.5%) were lost to clinical follow-up. Eighteen hips (3.8%) failed to
5 provide 2-year minimum radiographs and the radiographic analysis was based on 582
6 cases.

7 Statistics

8 The comparisons between the two groups were made using survivorship
9 techniques (log rank test for comparing Kaplan-Meier survivorship curves) to account for
10 the differences in follow-up time. The time to first appearance of substantial stem
11 radiolucencies was used as end point. The Cox multivariate proportional hazards model
12 was used to evaluate the effects of the various technical changes and adjust comparisons
13 for previously identified pre-operative risk factors^[5], in particular the surface
14 arthroplasty risk index (SARI)^[11]. Student's t-test was used in the comparison of clinical
15 outcome results.

16 RESULTS

17 Clinical results

18 The average duration of follow-up was 82 months (range, 69 to 109) for group 1
19 and 54 months (range, 33 to 69) for group 2. The outcome study results (UCLA hip
20 score, Harris Hip score and SF-12 scores) are summarized in Table 6. The post-operative
21 UCLA function score and HHS showed a significant ($p < 0.05$) improvement from group 2
22 over group 1.

1 Radiographic Results

2

3 At this time there are substantial femoral metaphyseal stem radiolucencies in 13 hips
4 (2.2%) that have not been revised. Only one patient was symptomatic at the time of last
5 follow-up before being lost to follow-up. Combining hips converted to THR for femoral
6 loosening and asymptomatic hips with a radiolucency, the average time of first
7 appearance of these radiolucencies was 25.4 months (range, 9 to 50) and 93.5% (19 out
8 of 31) were evident by 3 years, the minimum follow-up period of Group 2.

9 The average pain and activity scores of the group with radiolucencies at the time
10 they were identified were not statistically different from the rest of the cohort.

11 Group 1 and group 2 were compared using the time to first appearance of a
12 metaphyseal stem radiolucency as the end point. For this analysis, we excluded the
13 components in which the stem had been cemented because most of the cemented stems
14 are part of group 2 and the cementing of the stem was not a permanent technical change
15 (the indication for cementing the stem varied throughout the series as mentioned in the
16 Methods section). Group 1 was at greater risk ($p=0.016$) of developing a radiolucency
17 than group 2 (Figure 2).

18 The following analysis was designed to determine the contribution of each
19 surgical change to this overall improvement in the survivorship results. Here again the
20 end point chosen was either time to radiolucency or revision when the hip was converted
21 to THR and did not show a radiolucency. Table 7 shows the proportional hazard ratios
22 and levels of significance of the surgical changes taken one at a time. We have not
23 identified any radiolucency in any of the components in which the short metaphyseal
24 stem was cemented. An example of the value of stem cementation is shown in figure 3.

1 Finally, the stem/femoral shaft angle measured from the low antero-posterior
2 pelvis radiographs was 2.4° greater for group 2 (average 137.8°) compared to group 1
3 (average 135.4°, p=0.0002).

4 Conversions to total hip replacement

5 There were 18 revisions in 17 patients for definite femoral loosening including
6 one, which was loose and revised at a different institution but we did not receive the
7 specimen for analysis. In addition, one patient was radiologically loose and symptomatic
8 but was lost to follow-up. All but one of these femoral component loosening (hip #340)
9 happened in the first group. There were 10 male and 7 female patients. The average age was
10 43.8 years (range, 15 to 66). The average component size was 44.4mm (range, 36 to 52).
11 There were ten patients with osteoarthritis (one post-traumatic), two with osteonecrosis,
12 three with hip dysplasia, one with Legg-Calvé-Perthes disease, and one with ankylosing
13 spondylitis. The average time of the first observed radiolucency was 26.5 months (range, 12
14 to 50) and the average time to first symptoms was 32.2 months (range, 14 to 61). The degree
15 and progression of symptoms was variable but none had acute pain and none required urgent
16 or emergent surgery in contrast to earlier versions of hip resurfacing without the
17 metaphyseal stem. In fact, 4 hips, which loosened and migrated into varus tended to stabilize
18 so that the symptoms lessened prior to revision. The average time to revision was 50.8
19 months (range, 23 to 100). All but one of the femoral failures were converted to total hip
20 replacements using a unipolar ball of a size matched for the well-fixed socket and all now
21 have well-functioning replacements without complication.

22 The last hip in the series revised for femoral loosening was hip #340 (surgery date
23 6/8/00) and the last hip in the series showing a metaphyseal stem radiolucency was hip #

1 464 (surgery date 9/13/01). Table 8 summarizes the number of femoral component
2 loosening and radiolucencies for each group.

3 The activity levels were high in eleven patients (Activity rating was eight in two
4 patients and nine or ten in nine patients). Seven of the failed hips (38.8%) were resurfaced
5 in the earliest development stage of 100 hips, before the femoral suction tip was
6 developed and any fixation holes drilled into the chamfered area. Since our prior
7 report^[5], 11 hips loosened and have been converted to THR, 9 of which demonstrated
8 substantial radiolucencies prior to becoming symptomatic.

9 Using the conversion to THR as end point, we also performed a Kaplan-Maier
10 survivorship analysis on the hips that had no femoral cysts or cysts smaller than 1 cm at
11 surgery to evaluate what the overall performance of the device could be with a strict
12 patient screening for bone quality. At 3 years, the survivorship was 99.3% (95%CI: 97.3
13 to 99.8).

14

15 DISCUSSION

16 The most important result from the present study is the greater resistance to the
17 development of metaphyseal stem radiolucencies and femoral loosening of the hips from
18 the second generation femoral fixation technique, compared to the first generation. With
19 similar patient demographics, risk factors, and the same post-operative protocol, the only
20 possible explanation for this result is an improvement of the surgical technique. The main
21 limitation of this study relies in the fact that all of the changes in technique were not
22 made at the same time but represent an evolution as we evaluated more failed cases and
23 were able to relate the intra-operative photographs of the femoral head to the histological

1 retrieval analysis. However this does not offset the substantial improvement in results and
2 the demonstrated efficacy of the surgical changes made. Fortunately, most of these
3 changes were made prior to initiation of the multi-center IDE trial and our instructions to
4 the participating surgeons. From the present study which has been greatly aided by a
5 careful review of the intra-operative photographs of the femoral heads prior to cementation,
6 we can infer that adequate initial fixation (ensured by meticulous cleaning of the bone cysts
7 with curettes and sebatome (high-speed burr), proper drying of the head before cementation
8 and maximization of the interface area between bone and cement) are the main factors
9 leading to a reduction of early femoral component loosening. It is not possible to measure
10 the very qualitative improvement in removal of cystic material but the difference that the
11 high speed burr made in preparation was quite evident when all of the intra-operative
12 photographs were serially reviewed as illustrated in figure 1. The need for an increased
13 number and an expanded location (chamfered area) of fixation holes was suggested by
14 comparing the intra-op photos of several patients who loosened to the retrieved femoral
15 component with the retained acrylic, as illustrated in Figure 4. The sectioned head
16 showed a qualitative difference in the depth of penetration and distribution of acrylic
17 fixation of the various areas of the head. The superior surface of the head was sclerotic
18 and dense which is typical in osteoarthritis and there was no or minimal penetration of
19 acrylic into the bone superiorly compared to the more inferior surface which was
20 cancellous and contained acrylic projections into the trabeculae to a depth of 2-3 mm.

21 *Cementation of the Metaphyseal Stem*

22 There were no loosening or radiolucencies in the 161 hips where the stem was
23 cemented in despite large cystic defects and this observation suggested that this adjunct

1 to fixation might be important. Even though we have demonstrated that efforts to
2 improve fixation by bone preparation techniques alone are very effective in eliminating
3 problematic hips we recommend cementing in the femoral stem in the higher risk group
4 (cysts >one cm, small component size <46mm, etc.) in addition to using additional drill
5 holes in the prepared femoral head to increase fixation area. To this date there does not
6 appear to be any adverse stress shielding on the femoral neck due to the cementation as
7 previously observed in a canine model when the stem was porous coated^[18]. However, our
8 concern is the possibility that a cemented stem combined with repetitive impact cycles
9 might introduce a small degree of micromotion between materials of a different elastic
10 modulus (acrylic, bone and metallic stem), leading to loosening. This is the rationale behind
11 our current recommendation for patients with risk factors and cemented stems to avoid
12 impact activities, at least until we have long term data.

13 The early failure of several femoral components implanted among the first 100
14 hips with a stem shaft angle inferior to 130° triggered our decision to place the femoral
15 component in more valgus. Later on, Beaulé et al. highlighted the theoretical advantage
16 of valgus over varus positioning which has been shown to be detrimental to the longevity
17 of the prosthesis^[12] as it generates stresses of a greater magnitude in the femoral neck.
18 The average difference of 2.4° in femoral stem-shaft angle between the 2 groups certainly
19 does not justify by itself the observed difference in occurrence of a radiolucency but
20 shows a deliberate intention to avoid a varus placement. In the present study, the effect of
21 a varus angle on the appearance of a radiolucency could not be demonstrated even though
22 47% of the hips revised for femoral loosening in this series had an angle of less than
23 130°. The detrimental effect of varus placement might in fact be limited to the hips

1 already showing signs of micro-motion at the bone-cement interface, by accelerating the
2 loosening process.

3 Femoral loosening has not been reported to any degree in three recent literature
4 reports in which the patients operated upon had essentially a diagnosis of primary
5 osteoarthritis with good bone quality^[19-21]. These data are comparable with our results in
6 patients with good bone quality. Etiologic groups other than primary osteoarthritis often
7 include younger patients, of smaller body size with frequently larger femoral head cysts.
8 These cases are the most challenging and if the surgeon plans a resurfacing, the surgical
9 technique needs to be optimized.

10 Loosening can be due to inadequate initial fixation or failure of fixation from
11 other causes. It is probable that many who are still functioning have deficiencies in
12 fixation but the area and distribution of fixation have been sufficient and commensurate
13 with the activity level of the patient.

14 Additional data on high activity levels, especially high impact and durability are needed,
15 However since the mechanism of wear debris-induced osteolysis and loosening has not
16 been observed in the present study unlike with the earlier metal on polyethylene
17 resurfacing, low-impact activities such as unlimited cycling may apparently be safely
18 performed.

19 SUMMARY

20 Initial fixation technique is critical to minimize the membrane formation in order
21 to prevent micro-motion, which can lead to loosening. Younger patients with several risk
22 factors for femoral radiolucency and loosening remain a challenge: they need to have the
23 very best bone preparation and circumferential fixation including stem cementation and

1 they should avoid impact activities. Older patients with compromised bone and small
2 fixation surface area have the option of a total hip replacement, which, with modern
3 designs, bearing materials and techniques, should have very good durability.

4 The institution of the described changes in technique has dramatically reduced the
5 incidence of radiolucencies in the short term and it is conceivable that mid-term and long-
6 term loosening failures can be eliminated. For surgeons who may consider performing
7 the surface arthroplasty, it is important to study the technique and to start with patients
8 who have sufficient area for fixation (i.e. large component size), and good bone quality to
9 facilitate adequate and durable fixation.

Table 1. Patient demographics by group.

	Groupe 1	Group 2	p
Age at surgery (years)	48.5 (15 - 71)	49.3 (15 - 78)	0.3451
Weight (Kg)	84.9 (45 - 164)	81.8 (42 - 135)	0.0274
Height (cm)	174.9 (152 - 198)	175.6 (140 - 198)	0.3483
BMI	27.6 (18 - 46)	26.3 (17 - 41)	0.0004
Femoral Component size	46.8	46.5	0.438
SARI	2.7	2.5	0.289
Male Patients	76%	74%	
Female Patients	24%	26%	
Charnley class A	45%	57%	
Charnley class B	47%	39%	
Charnley class C	8%	5%	

Etiologies	Group 1	Group 2
Osteoarthritis	67.6%	65.7%
Osteonecrosis	8.7%	7.3%
Developmental dysplasia	10.7%	11.3%
Post-traumatic arthritis	6.7%	8.0%
Legg Calve Perthes	1.7%	3.3%
Slipped capital femoral epiphysis	1.7%	2.0%
Ankylosing spondylitis	1.0%	0.3%
Juvenile rheumatoid arthritis	0.7%	0.3%
Rheumatoid arthritis	1.0%	1.3%
Melorheostosis	0.3%	0.0%
Pigmented Villonodular Synovitis	0.0%	0.3%

Previous surgeries	Group1	Group 2
Previous osteotomy	6	5
Previous coring	9	3
Previous hemisurface arthroplasty	2	0
Previous pinning	6	7
Previous Judet graft	1	0
Previous acetabular reconstruction	1	1
Previous ORIF	0	3

Table 2. Summary of the technical changes pertaining to the 2 generations of femoral fixation.

	First Generation	Second Generation
Suction	No suction (1st 100 hips)	Dome suction
Drilled holes	A few dome holes (0 if good bone quality) - None in the chamfered area	Increased number – Chamfer holes added
Stem cementation	Stem not cemented (only in rare cases with bad bone quality)	Stem cemented in 152 regardless of cyst size
Target stem-shaft angle	Anatomic (1st 100 hips)	140 degrees
Removal of cystic debris	Incomplete - Curette only	Complete – High-speed burr

Table 3. Contact area between bone and cement

Head Size	Resected bone/cement contact area (mm ²)	With 13 drilled holes (mm ²)
36	2204.6	3130.6
38	2574.3	3500.3
40	3178.3	4104.2
42	3531.2	4457.2
44	3885.4	4811.4
46	4267.4	5193.3
48	4654.5	5580.5
50	5160.3	6086.3
52	5485.5	6411.5
54	5485.5	6411.5

Table 4. Average number (range) of drill holes made in the dome and the chamfered area of the reamed femoral head before cementation. Comparison between groups and breakdown by series of 100 hips.

	Dome	Chamfer	Total
Group 1	6.6 (0-15)	2.7 (0-13)	9.2 (0-23)
Group 2	7.0 (0-15)	5.8 (0-17)	12.8 (3-28)
p	0.0666	0.0001	0.0001

1st100	6	1	7
2nd100	7	3	9
3rd100	7	4	11
4th100	8	5	13
5th100	7	6	13
6th100	6	7	13

Table 5. Evolution of femoral component orientation in the frontal plane, measured by the stem shaft angle (SSA).

	Average (range)	p	% hips with SSA > 140
1st100	131.1 (110 to 150)	<0.0001	78%
2nd100	137.6 (111 to 163)	NS	59%
3rd100	137.7 (124 to 155)	NS	53%
4th100	138.1 (127 to 156)	NS	59%
5th100	137.8 (125 to 160)	NS	62%
6th100	137.6 (122 to 159)	NS	60%

Note: in the first 300 hips 63% had a SSA less than 140° and in the second 300 hips 60% had a SSA inferior to 140°

Table 6. Summary of the clinical results from UCLA hip scores, SF-12, and Harris hip scores (HHS) for both groups.

		Group 1 Pre-op	Group 2 Pre-op	p	Group 1 Post-op	Group 2 Post-op	p
UCLA	Pain	3.6	3.3	0.0019	9.4	9.5	0.0693
	Walking	6.0	6.2	0.1038	9.6	9.7	0.0756
	Function	5.8	5.6	0.0722	9.3	9.6	0.0150
	Activity	4.7	4.5	0.1520	7.5	7.6	0.2442
SF-12	Physical	31.4	32.2	0.2051	50.1	51.0	0.2600
	Mental	47.0	47.9	0.4174	52.0	53.5	0.0707
HHS		N/A	N/A	N/A	91.5	93.8	0.0036

Table 7: Cox proportional hazard ratios and levels of significance of the various surgical changes instituted throughout the series.

	Cox proportional hazard ratio	p
Cementation of the stem	0.1683208	0.014
* Number of drilled holes (Increment of 5 holes)	0.6693800	0.048
* Stem shaft angle (increment of 3 degrees)	0.9573400	0.455
* First 100 vs. rest	0.5253303	0.052
* 1st vs. 2nd generation	0.3281483	0.036

* Analysis performed for non-cemented metaphyseal stems after adjustment for SARI

Table 8: summary of the number of femoral component loosening and radiolucencies for each group (n=300 in each group).

	Femoral Loosening	Femoral Radiolucencies	Total	Average Follow-up (months)
Group 1	17 (5.7%)	11(3.7%)	28	82
Group 2	1 (0.3%)	2 (0.7%)	3	54

FIGURES

- Figure 1A Intra-operative photograph of the femoral head after preparation in a 43 year-old female with developmental dysplasia of the hip (hip number 174 in the series). Note the absence of drilled holes in the sclerotic bone of the chamfered area and the incomplete removal of cystic material in the defects (arrows). The femoral component loosened and the hip was converted to a THR 39 months after resurfacing.
- Figure 1B Intra-operative photograph of the femoral head after preparation in a 54 year-old male with primary osteoarthritis (hip number 546 in the series). The drilled holes cover the entire dome and chamfered areas and there is no residual cystic material visible in the defect.
- Figure 2 Kaplan-Maier survivorship curves of group 1 (the first 300 hips) vs. group 2 (the next 300 hips) using the time of appearance of a femoral radiolucency as end point. The hips with a cemented metaphyseal stem were removed from this comparison to assess the effects of the other surgical changes implemented throughout the series.
- Figure 3A Preoperative AP view of a 31 year-old female (hips number 306 and 307 in the series) with severe systemic lupus erythematosus, osteonecrosis and with several risk factors for loosening: small component size and severe cystic degeneration (multiple cysts 1 to 2 cm on both sides).

Figure 3B The stem was cemented on the right side and remains well fixed while the left, with the uncemented stem, although still asymptomatic, is radiographically loose. Note the bone formation around the stem tip, which presumably represents an attempt from the bone to stabilize the component.

Figure 4A Preoperative AP view of a 39 year-old male with inflammatory type osteoarthritis. Insert shows the femoral head after preparation. Note the absence of fixation holes into the sclerotic bone inferiorly (the superior surface of the head from this posterior approach)

Figure 4B 39 months after surgery, the femoral component loosened as shown by the wide radiolucency around the metaphyseal stem. The insert shows the retrieved component and the smooth acrylic surface adjacent to the femoral head sclerotic bone, which did not have sufficient bone-cement bonding.

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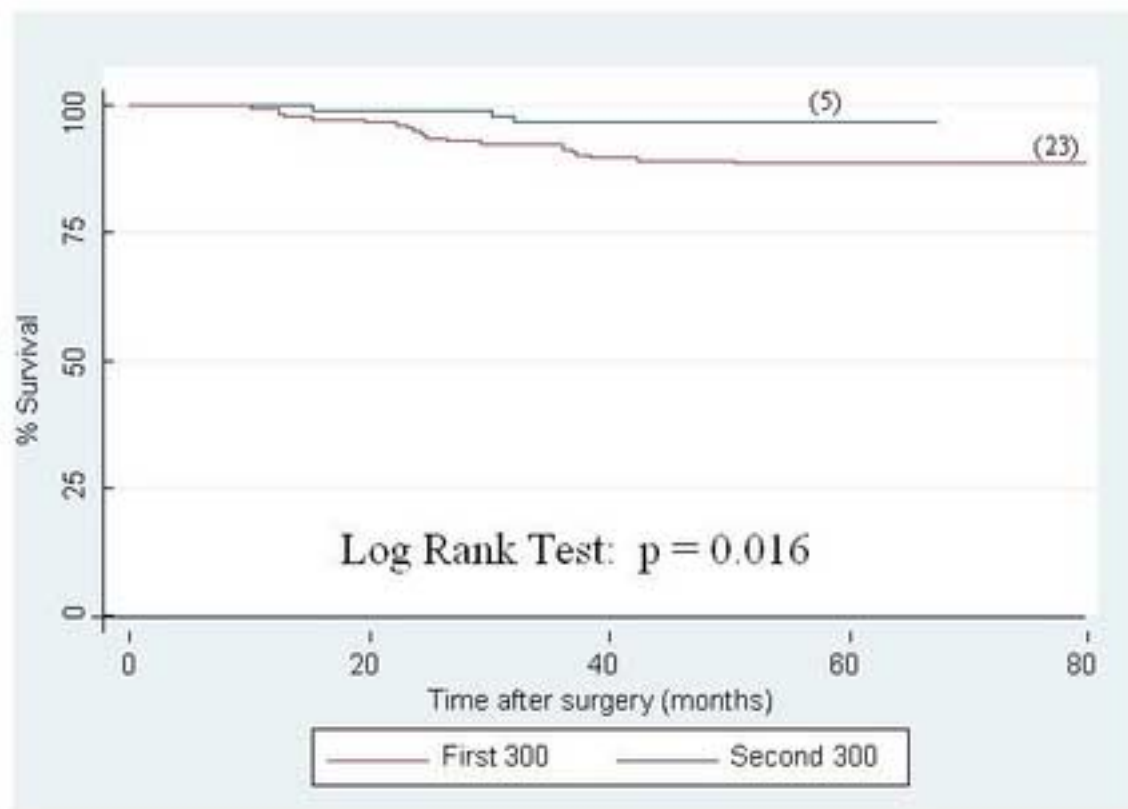


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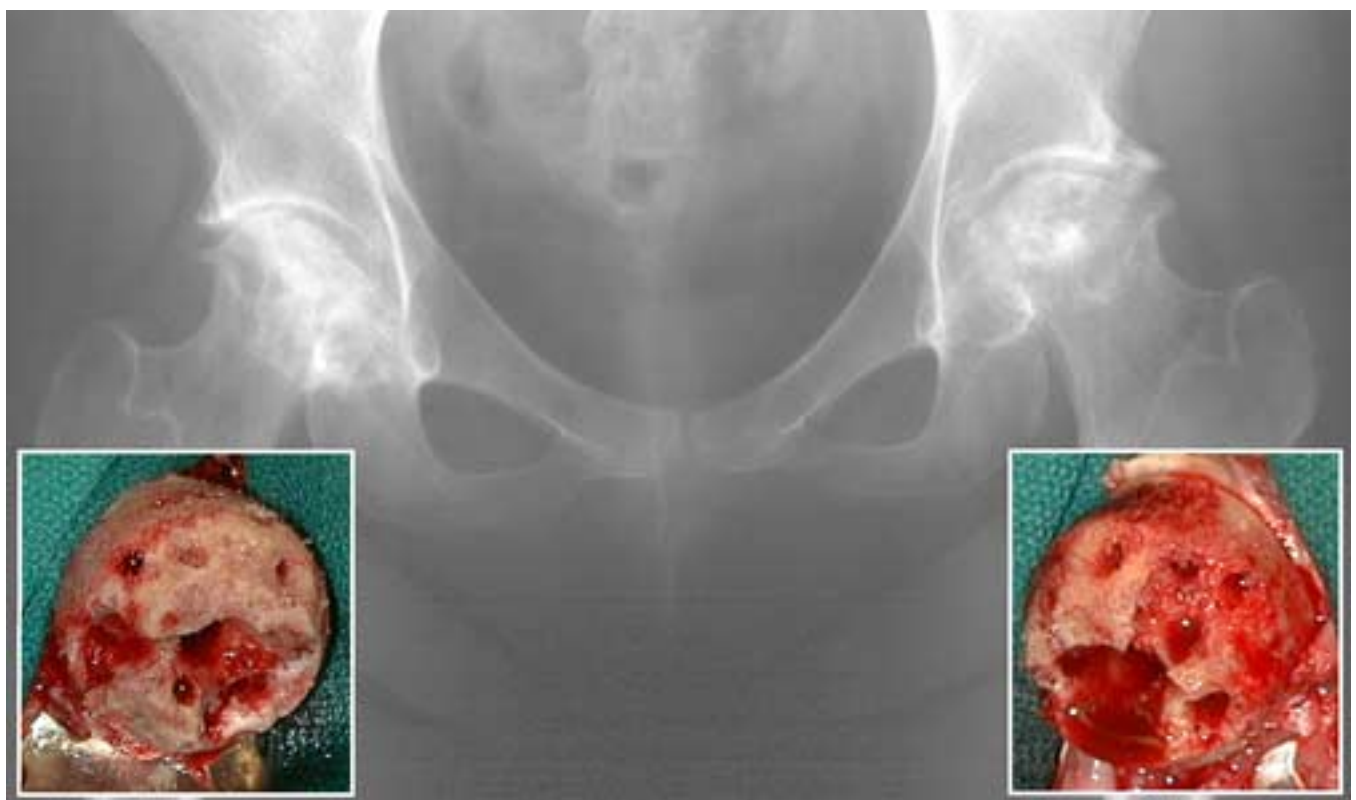


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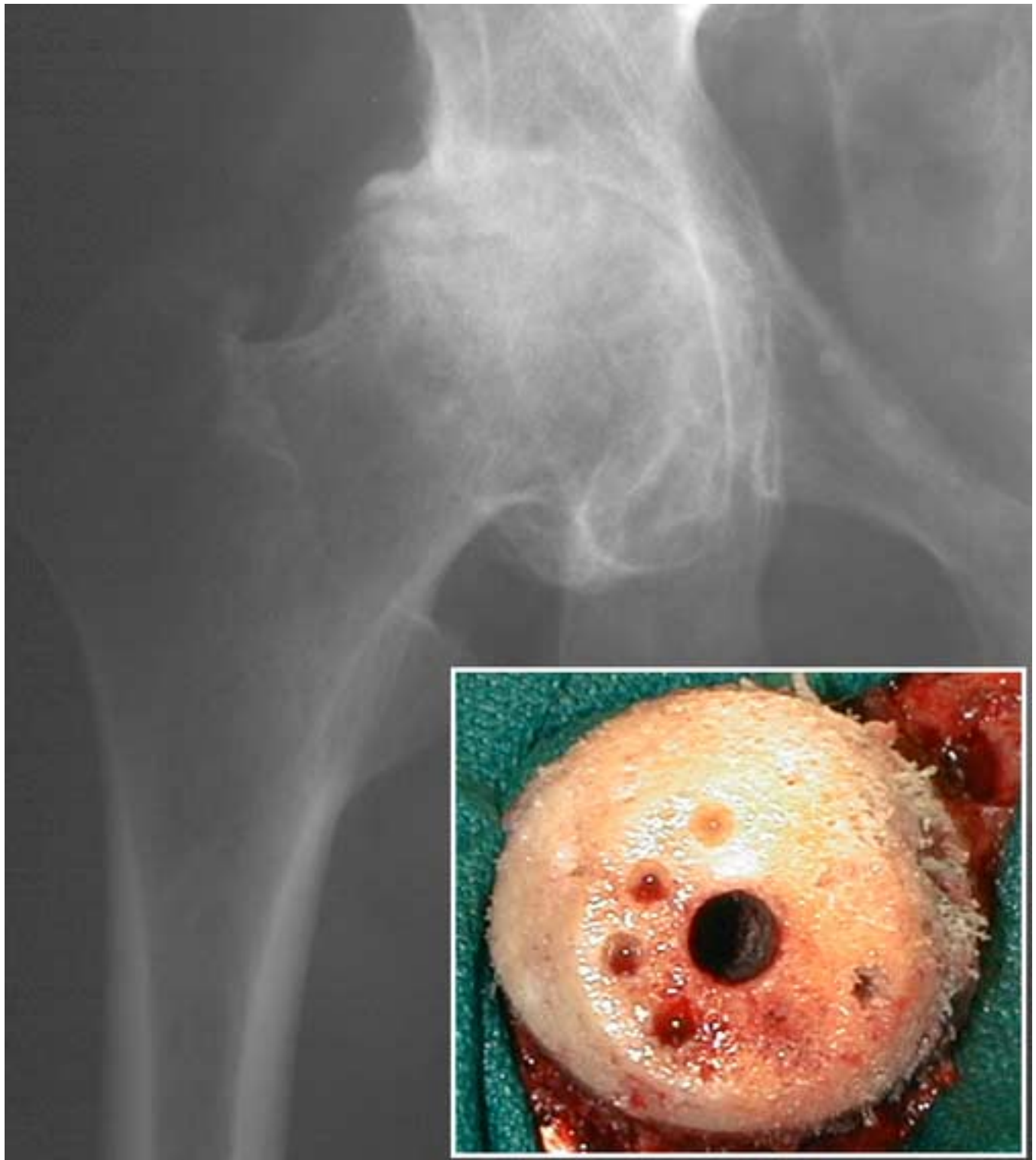


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