



Endo medullary extractability of cementless full HA coated femoral stem : Results from 19 cases

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The Aura cementless full HA coated stem is an anatomical femoral component with a different surface treatment in the metaphyseal and diaphyseal areas. We have studied the feasibility of isolated endo-medullary extraction of the stem.

19 patients (6 infections, 6 neck fractures, 3 stems with risk of fracture, 3 head fractures, and 1 recurrent dislocation) were subjected to the removal of a stable and bone integrated implant at a mean of 4.5 years after surgery. The 19 cases represent the entire population of Aura cementless integrated stem requiring revision during the period of 2003 through 2011, excluding periprosthetic bone fracture cases.

The technique consisted of a careful release of the metaphyseal part of the implant with thin osteotomes, followed by the use of a highly efficient extractor.

The re-implanted procedure always utilised standard stems : 17 cementless stems full HA coated (13 had the same size as the removed implant, 4 cases had larger sizes) and two received cemented stems.

The 19 stems were extracted by simple endo-medullary approach, without the need for additional action. Several complications were encountered, 1 intra-operative diaphyseal fracture, requiring a wiring, 1 fracture of the lesser trochanter at 15 days post-surgery, requiring a revision and 2 postoperative dislocations.

Except for the early revision due to fracture, no other stem was revised. There was no recurrence of infection and the functional results were satisfactory (PMA 15-18).

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This study was carried out in Hôpital Renée Sabran and Centre Hospitalier Général of Annecy.*

3 patients showed metaphyseal lucent lines on X-Ray leading us to advise the use of a standard stem with larger size after distal reaming, combined with preventive circulate of the calcar.

The use of dedicated instrumentation allows successful extraction of full HA coated short stem by endo-medullary approach.

Keywords : extraction ; full HA coated stem ; endo-medullary approach.

INTRODUCTION

Fully hydroxyapatite (HA) coated cementless femoral stems have provided proven long-term high quality clinical results and demonstrated excellent osteointegration (9,10,11).

The downside to their use can be the difficulty to remove a perfectly bone integrated implant when needed. The routine method is to perform a longitudinal osteotomy and particularly a femoral flap (1,2).

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However, these extraction techniques have some disadvantages : increased surgery time, increased blood loss, increased risk of perioperative or postoperative bone fracture, use of long stems frequently required and uncomfortable postoperative restrictions for the patient (3).

Publications dealing with the removal of cementless HA implants strongly attached to bone are sparse.

In the 2000s, prosthetic neck fractures due to mal positioning of laser etching occurred both on Corail (Depuy) and Aura (Biomet) femoral stems leading to an increase number of implants requiring extraction. Implant removal techniques were improved with the design of specific instruments as reported in the first series (7,12).

Aura II full HA coated stem (Biomet) is the evolution of the Aura stem (Biomet) launched in 1988 with a good 10-year survivorship published in 2006 (6). Between 2003 and 2011, we had to extract 19 cases of Aura II full HA coated stems (17 at Renée Sabran Hospital and 2 at Annecy Hospital).

The purpose of this retrospective review was to determine whether the AURA II full HA coated stem strongly attached to the bone could be extracted without femoral osteotomy in clinical practice. The secondary objective was to evaluate if the choice of the revision stem was appropriate.

MATERIALS AND METHODS

Femoral Stem

Aura II femoral stem developed by the ORA design surgeons was first implanted in 1998.

The AURA II is an anatomical stem with a CCD angle of 138° , a shoulder in the axis of the femoral neck, and a diaphyseal antero posterior radius of 1500 mm, an anteversion of the neck of 6° , a strong anterior metaphyseal filling and a constant offset.

The AURA II stem is available in cemented or cementless HA coated version.

To allow potential extraction of the implant when needed, the design group chose the option of a full HA coated implant, but with different surface treatment in diaphysis and metaphysis. Approximately three-fifths of the proximal shaft was rougher than the lower diaphyseal area allowing only a good adhesion of apatite on titanium

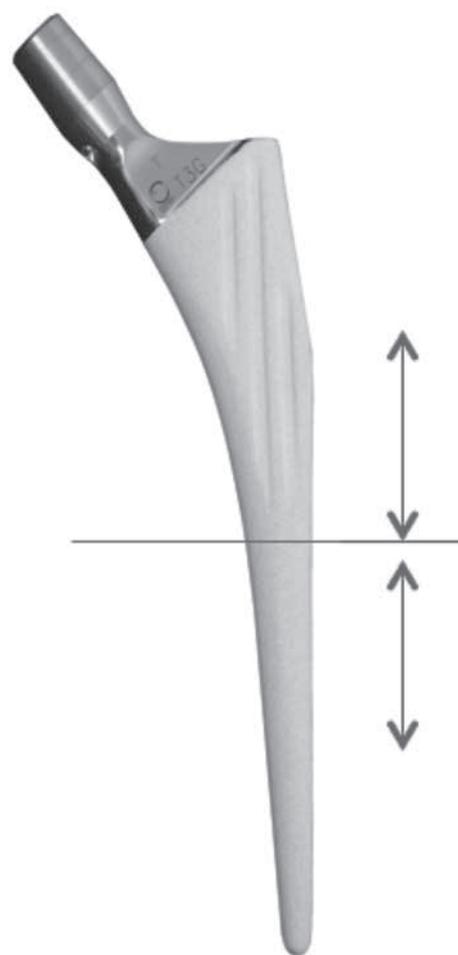


Fig. 1. — AURA II full HA coated stem. Different surface treatment in 3/5 proximal with high Roughness Average (RA) and in 2/5 distal (low RA).

(Fig. 1). The aim was to avoid significant distal bone integration and distal fibrous interposition.

Patients

Between 2003 and 2011 we had to remove 19 full HA coated stems which had evidence of strongly bone integration.

The indication of implant removal remained rare : 17 revisions were recorded out of 3012 AURA stems implanted from 2003 to 2011 at Renée Sabran Hospital. The 2 other removals were performed in Annecy Hospital.

The reasons for removals were :

- 6 infections treated using two-stage removal/re-implantation in 4 cases, and one-stage in 2 cases (Fig. 2).



Fig. 2. — Two-stage removal and reimplantation of infected THA. Revision with an identical cementless HA coated stem.

- 6 cases of prosthetic neck fractures attributed to excessively deep laser etching (Fig. 3)
- 3 cases of preventive change of stems to avoid risk of fracture due to too deep laser etching
- 3 cases of broken head (1 ceramic and 2 zirconia heads).
- 1 case of recurrent dislocation with significant leg length discrepancy

Removal of the implant was performed at an average of 4.5 years after implantation (ranged 2 months for infection to 10 years for fracture of zirconia head).

All stems were fully integrated as shown on standard X-Ray (4) and this was confirmed intraoperatively.

The technique used was always the same. For the implant removal, dedicated instrumentation designed by Depuy to remove Corail stem, or by Biomet were used.

The first step consisted of a thorough metaphyseal preparation using thin and slightly flexible osteotomes of different widths and lengths pushed down gradually between the implant and the bone on the 4 sides of the stem, in its metaphyseal portion to 2/3 of the implant approximately. The access to the medial and the internal surface of the implant was most difficult, as osteointegration was often more intense in these areas. With patience and meticulous approach the access to the medial surface was possible without fracture during extraction.

After this endo-medullary preparation, all the stems were removed with the aid of a stem puller, but without any other measure.

Ideally a dedicated extractor screwed into a hole on the implant shoulder should allow perfect extraction

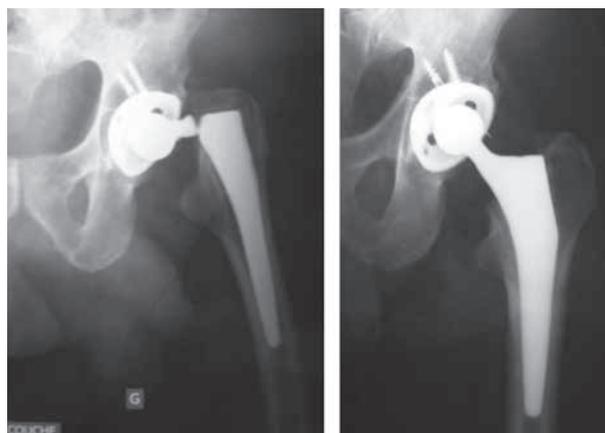


Fig. 3. — Prosthetic neck fracture due to laser etching. Removal and reimplantation of the same full HA coated stem.

close to the axis of the implant. The AURA implant had no extraction hole at the beginning of its production requiring the use of the DEPUY Arthro group universal extractor when the stem to remove is intact.

For the implants with neck fractures, the manufacturer (Biomet) provided a dedicated instrument, requiring the drilling of the titanium stem at the base of the neck with a metal drill (Fig. 4). The orifice allowed the insertion of a pin connected to a supporting bracket of a sliding hammer extractor.

The fact that the stem was anatomical did not cause any particular difficulties for the introduction of osteotomes and the release of the metaphyseal.

The AURA stem had no flange and therefore it was easier to release the medial zone and the inner face. Preferably slightly curved osteotomes should facilitate this release.

For the 19 cases the extraction was performed by endo-medullary approach without flap, window, or longitudinal osteotomy.

No diaphysis or trochanter fracture was reported during the ablation. There was no bone damage and the underlying bone has always shown excellent quality, allowing reimplantation without cement.

The duration of the stem extraction after exposure was not always specified in operative reports, but it was easy in 16 cases, requiring approximately 10 to 15 minutes of release and additional time for metaphyseal drilling in case of neck fracture.

In three cases, however, the surgeon encountered a long and difficult extraction, and a 40 minutes release time was recorded in 2 of those cases.

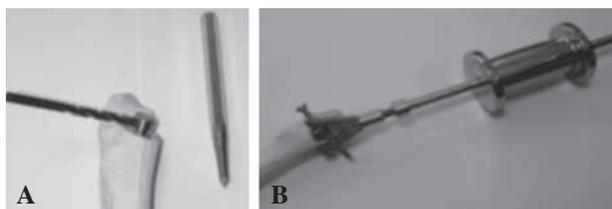


Fig. 4. — Extracting stem after femoral neck fracture :
 – Metaphyseal drilling (A)
 – Extraction with caliper and sliding mass (B).

Paradoxically two of these cases were ablations consecutive to infection and one of the stems was removed very early (56 days after implantation) in a young man with good bone quality.

In ten cases, surgery reports confirmed the difference in bone integration between the metaphyseal portion and the distal portion of the removed implant : presence of cancellous bone fragments in metaphyseal area, and smooth aspect without bone in distal part.

Reimplantation

A variety of stems were used.

– In 2 cases standard AURA cemented stems were implanted.

– In 13 patients, the revision implant was the same as the removed implant i.e. a standard AURA full HA coated stem of the same size. In all these cases the primary stability of the rasp and the implant was excellent, but a small gap between the implant and the metaphyseal bone corresponding to the thickness of the osteotomes was reported.

– In 4 cases, the femoral stem used for revision was of a larger size than the removed stem.

For two of them, a distal reaming was necessary. In one patient the surgeon required the effect of a longer femoral neck, achieved by using an overhang stem, for a case of recurrent dislocation with insufficient muscle tension. In the latter case, a larger size stem was implanted without reaming : this patient had a complication during surgery.

None of the revision surgery required the use of a long stem.

It should be noted that the reimplantation was early (6 weeks on average) in case of two-stage infection treatment.

The follow-up was simple and identical to conventional primary surgery in 17 cases. Patients were allowed immediate weight bearing with the aid of two canes initially and later with the aid of a single cane.

One heavy patient (108 kg) suffered a restriction of support gradually resumed with the help of two canes imposed for 6 weeks.

For one patient with a diaphyseal fracture of the femur repaired by cable osteosynthesis, the support was banned for two months.

RESULTS

During follow-up, the patients were assessed using the Postel Merle d'Aubigné (PMA) functional score and X-Rays were taken using standard AP and Lateral views (4).

Early complications

Intraoperatively, one patient had a spiral fracture of the femoral diaphysis at the time of reduction with the stem in place. This fracture was fixed with 4 cables ; the stem was left in place. No load bearing was allowed on the operated lower limb for the first two months. One patient had a unique dislocation 2 months postoperatively which was not reproduced. One man re-operated for fractured ceramic head replaced by another ceramic on ceramic bearing presented three dislocations during the first 18 months postoperatively. At 4.5 years follow-up, he had an excellent hip score with PMA of 18 and had no recurrent dislocation or revision, but was still anxious. One patient who received in 2011 one stage surgery two months after early infection presented 12 days after revision, a fracture of lesser trochanter with subsidence of the stem and dislocation. He was treated by placing two metal wires and by replacing the stem by a longer cementless stem. This was the only long stem of the series implanted consecutive to a fracture. His follow-up was only four months, but the clinical, radiological and biological results were excellent at this stage. One patient, who underwent a bipolar change in 2006, presented with a loosening of the acetabular component in 2011 and was waiting for revision. His stem was stable with good osteointegration.

Except for the patient planned to be reoperated, 3 patients had less than one year follow-up. One of them was reoperated for a prosthetic fracture 12 days postoperatively. He received a long stem.

The 2 other patients had no clinical or radiological problem at this short-term follow-up, and intra-operative femoral fracture has consolidated.

The other 15 patients had satisfactory results.

At a mean follow-up of 3.2 years (1 to 6 years), 11 hips were rated 17 or 18 using Postel Merle D'Aubigné score (PMA), 3 hips were rated 16. An elderly patient, operated for infection was rated 15. None of those 15 patients was reoperated, and there was no recurrence of infection for the revision cases due to infection.

On radiographs at follow-up, no subsidence was reported in 18 of the revised stems, and the long stem implanted after periprosthetic fracture was also stable.

In terms of radiological integration two cemented stems were used for revision. There were no radiolucent lines. The 17 other revision stems were cementless full HA coated, 13 of which had excellent osteointegration as shown on standard X-rays, without radiolucencies.

One stem had a lucent line on the stem shoulder in zone 14 (8).

However 3 stems had more worrying appearance at the metaphysis with marked AP and lateral lucent lines in zones 1-7-8-14 (Fig. 5). Although these three patients had good clinical outcome (PMA score of 18) this abnormal appearance revealed insufficient osteointegration and probably a fibrous interface in the metaphysis, filling the gap left by the osteotome.

DISCUSSION

Cementless titanium HA coated stems demonstrated the quality and reliability of their results and good radiological evolution at short, mid and long term.

Among them, the stems with total surface treatment and full HA coating, widely used, had the same good quality clinical outcomes and long-term survival as the best series of cemented stems (9,10-11).

Full HA coating seemed a good option that guarantees the absence of thigh pain. The radiographic appearance was very satisfactory, radiological distal images confirming a total osteointegration (5) and providing additional reassurance. There was no

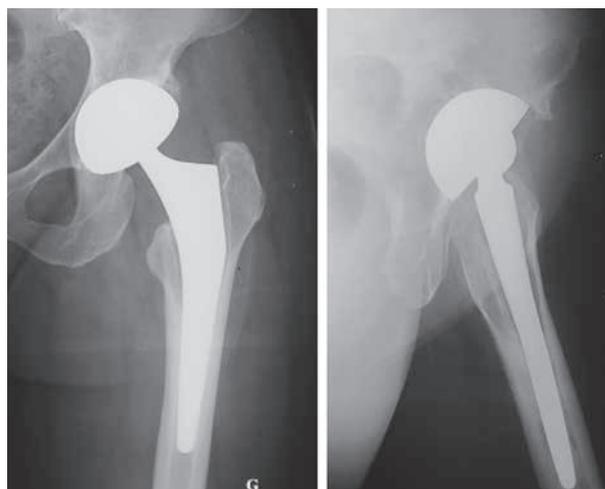


Fig. 5. — Change of THA with stem fracture risk. Installation of the same full HA coated stem.

At one year postoperative metaphyseal lucencies on AP and lateral views (zones 1-7-8-14).

radiolucent image on the distal third, unlike partial surface treated and coated stems.

However the reverse of this situation was the difficulty of extracting these highly osteointegrated stems when necessary.

Published studies in literature reporting the extraction of implants (7,12), ablation techniques, difficulties and complications, and the results of revisions in the particular case of stable and fully osteointegrated stem are very sparse.

Many studies analyzed very different situations, particularly revision due to loosening or failure. These were often non-homogeneous series, with removal of cemented or cementless short or long implants, using various ablation techniques. These series reported significant number of intraoperative or postoperative complications and showed the morbidity and complications of different forms of extraction techniques (trochanterotomy, window, femoral flap) (2,3).

The situation was different in our short but homogenous series of strongly integrated stems.

Due to the relative scarcity of these cases, surgeons and industry have paid little attention to the problem.

Longitudinal osteotomy was sometime used if required, or rather a femoral flap (1,13). These procedures were difficult to execute due to the adhesion

of bone to outer surface of the femoral stem. Surgery could be complicated, operation time increased with more blood loss leading to intraoperative or postoperative complications.

More often these procedures involved the use of a longer stem, together with a postoperative period without support leading to discomfort for patients.

In recent years, metallurgical problems, associated with prosthetic neck fractures in particular, led to the design and improvement of dedicated instrumentation to remove ingrown implants.

The Arthro group's experience in the extraction of Corail stem was reported by Vidalain on 17 cases in 2006 (12), then by Fessy during a roundtable at SOFCOT in 2007 on 34 cases (7). These authors recommended the use of specific instruments, Moreland type thin and flexible osteotomes, of increasing length, Kirschner pins to cut diaphyseal bridges and finally extractor screwed into the neck with a sliding mass hammer.

This technique allowed endo-medullary extraction in 6 out of 10 cases of Vidalain series (12), but 4 patients required the creation of a window. This short series reported significantly more favorable postoperative complication rate and clinical results than a short comparative series of extraction via femoral flap.

In the more recent and most important series by Fessy (7), only two failures of endo medullary extraction out of 34 attempts were reported. For those 32 extractions, surgeons have re-implanted 28 times a standard stem (14 stems of the same size, 14 of larger size), but there were 4 cases of long cementless HA coated stems.

The problem could persist due to the distal diaphyseal integration especially in small femurs with very intimate cortical implant contact at the diaphysis (7).

The main innovation in the AURA design was the use of 2 different surface treatments between the metaphysis and the diaphysis with a lower roughness in the distal 2/5 of the stem, allowing a good integration of the Apatite to the Titanium.

This option for the AURA implant, allowed us in our short series, the endo medullary extraction of the stem in all cases. We also used thin and flexible

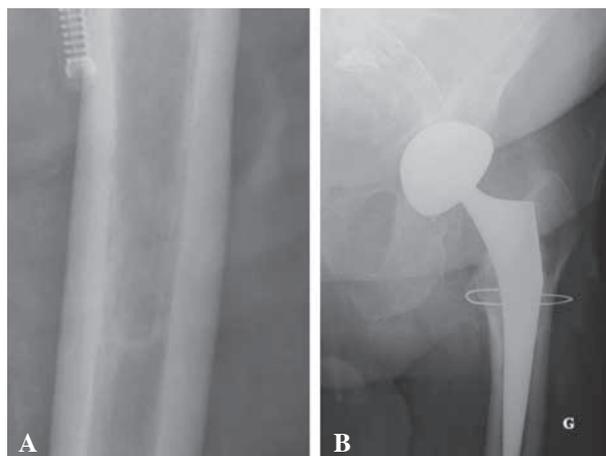


Fig. 6. — Two-stage removal reimplantation further to infection.

- X-Ray after removal : visible distal cortical bone mold (A).
- Reimplantation of full HA coated stem of identical size. Good integration 2 years postoperatively (B).

osteotomes, but it was not necessary to push down to diaphysis or to use pins to release the distal bridges.

Also the removed implants showed no bone fragments attached to the third distal unlike in metaphysis.

This option seemed therefore a reasonable choice, facilitating extraction of the osteointegrated stems. However the analysis of the two complications that occurred in 2011 and the radiological analysis of the implants used for revision led us to the conclusion that the choice of revision stems was not the better choice in this series although the clinical results were still satisfactory.

In fact a cortical bone reactive area was left in the distal one-third of the stem during extraction (Fig. 6). This mold could block the distal third of the rasp and the revision implant, if the size of the implant is the same, giving perfect stability in distal but leaving in metaphyseal a thin real space between the stem and metaphyseal bone.

This small space, always present, represented the thickness of the osteotomes used for the release of bony bridges.

We did not take this into account and in 13 cases of our series an implant of the same size was placed

without intimate bone-implant contact in the metaphysis.

To avoid this pitfall, it seemed better to ream the distal 1/3 to avoid locking in the distal bone casting and to allow implantation of a cemented stem or to insert a non-cemented stem of larger size, with a good metaphyseal contact. This option was used only 3 times in this series.

The implantation of a stem of the same size did not cause any trouble for the first 12 cases.

However, 2 fractures observed in 2011 were probably due to this choice.

Finally and most importantly the radiological findings in 3 patients revised with the same size of cementless stem, with a persistent metaphyseal lucent lines over a year (1 year 6 months to 5 years) in zones 1-7-8-14, was worrying although the clinical outcome was excellent (Fig. 5). This certainly showed poor metaphyseal bone integration and the presence of a fibrous interface.

It therefore seemed logical to implant a stem of larger size after distal reaming, allowing a good metaphyseal bone implant contact.

Preventive metal wiring of lesser trochanter should also be systematic in the future if bone release weakened the metaphysis, especially on the medial surface where osseointegration is often extremely intense.

CONCLUSION

Cementless full HA coated stems showed good reliable results and exhibit good radiological integration in the short, medium and long term.

The difficulties of extraction in case of problems were a concern for surgeons. The design of dedicated instruments and technical improvements seemed to resolve the problem in most cases. And it was possible to extract a fully HA coated stem by endo medullary approach without bone damage, using an adequate material for revision.

In this series the removal of the stem was always possible without femorotomy.

The option of a full HA coating on a Titanium surface treated stem of different roughness in metaphysis and diaphysis is an interesting compro-

mise, allowing the same quality of fixation, with an easier extraction.

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