CORAIL®
HIP SYSTEM

Femoral Revision Algorithm

A practical guide for the use of the CORAIL Hip System in femoral revision surgery

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Introduction

The principles that govern the mode of prosthetic fixation, implant stability and grafting should be highlighted both pre and intra-operatively.

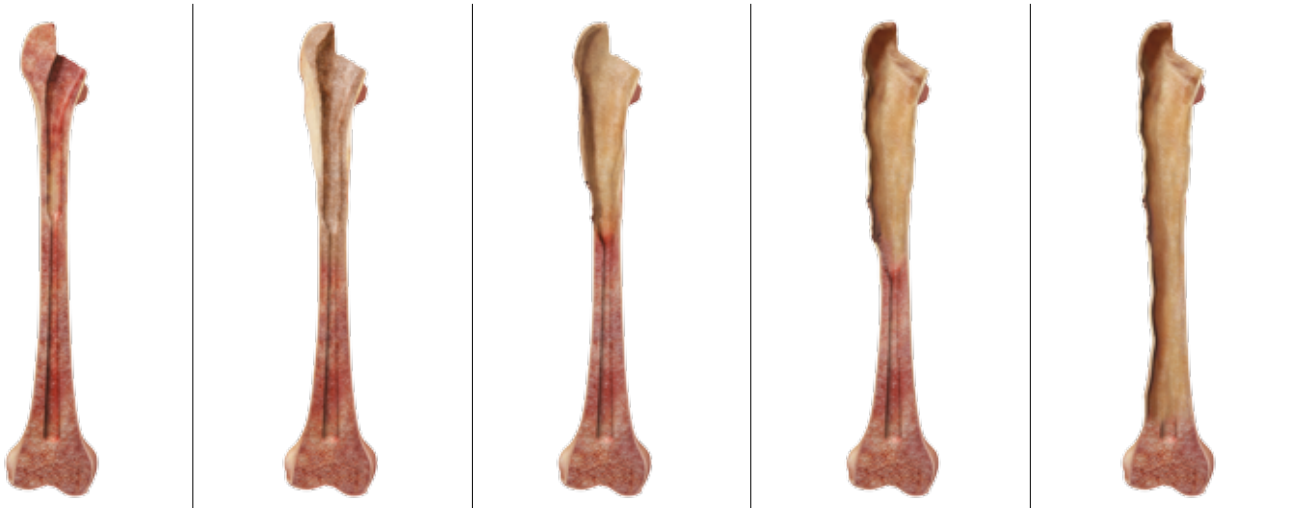
An important consideration in primary surgery is the need for complete integration of the stem to the host bone and this is even more important in revision surgery where there may be a reduction in bone quality and quantity, thus reinforcing the use of a cementless fully HA-coated stem in this surgical indication. The use of a cementless stem fully coated with hydroxyapatite (HA) has proven to be extremely successful in revision surgery.[1] Data in the literature confirms the excellent results achieved in femoral revision surgery with HA-coated cementless prostheses.[1]

Indications

There are two situations in which the CORAIL Revision Stem is used in primary surgery: First, when dealing with very large cylindrical femurs with thin cortical walls in which the CORAIL Primary stem may not achieve optimum stability – in such cases the CORAIL Revision Stem would be selected as it is longer and enables excellent primary stability. Second, in very old patients with osteoporotic bone, the CORAIL Revision Stem makes it possible to achieve excellent primary stability. These are rare indications.

For revision total hip replacement, a defect classification system, such as that of Paprosky, can be used to specify the indications and the surgical strategy. The likely defect classification can be determined through pre-operative radiological assessment and confirmed during the procedure after removal of the failed implant (Figure 1).

Paprosky's Classification[2]



Type I	Type II	Type IIIA	Type IIIB	Type IV
There is minimal loss of metaphyseal cancellous bone and an intact diaphysis.	There is extensive loss of metaphyseal cancellous bone and an intact diaphysis.	The metaphysis is severely damaged and nonsupportive, with >4 cm of intact diaphyseal bone available for distal fixation.	The metaphysis is severely damaged and nonsupportive, with <4 cm of diaphyseal bone available for distal fixation.	There is extensive metaphyseal and diaphyseal damage in conjunction with a widened femoral canal. The isthmus is non-supportive.

Figure 1. Paprosky's Classification[2]

Indications

Type I Defects
For Type I defects, the standard CORAIL Primary stem can be used (Figures 2a, 2b, 2c), except in the case of insufficient primary stability, in which case the CORAIL Revision Stem should be used (Figures 3a, 3b, 3c).[3] In a revision setting, the option of the collared stem should be considered.

Pre-operative x-ray
Figure 2a

Post-operative x-ray
Figure 2b

CORAIL Prosthesis
Figure 2c

Type II and IIIA Defects
Paprosky defects Type II and IIIA are good indications for the CORAIL Revision Stem if primary stability of the stem can be achieved before bone grafting.

Pre-operative x-ray
Figure 3a

Post-operative x-ray
Figure 3b

CORAIL Revision Stem Prosthesis
Figure 3c

Type IIIB and IV Defects
In the case of defects Type IIIB and IV, it is often impossible to achieve primary stability with a CORAIL Primary or a CORAIL Revision Stem, and therefore a longer, distally locked REEF™ prosthesis must be used (Figures 4a, 4b, 4c).

Pre-operative x-ray
Figure 4a

Post-operative x-ray
Figure 4b

REEF™ Prosthesis
Figure 4c

Type IIIB and IV Defects
In the case of defects Type IIIB and IV, the metaphysis is severely damaged and non-supportive. The distally Loading RECLAIM Revision hip system addresses defects of moderate, Type II to severe, type IV deformity in which in which the metaphysis is not intact and fixation at or below the femoral diaphysis is required.

Pre-operative x-ray
Figure 5a

Post-operative x-ray
Figure 5b

RECLAIM™ Prosthesis
Figure 5c

Surgical Technique

We shall now comment on some features of the surgical techniques.

Proximal Implantation without ETO
In those instances where the primary stem can be removed through a standard proximal approach to the femur, it is not necessary to use an extended osteotomy to gain improved access. Here, the CORAIL Primary or CORAIL Revision Stem can be implanted as per the prescribed standard surgical technique. In the event that a REEF™ stem is indicated, an extended osteotomy is recommended.

Transfemoral Approach
The use of a transfemoral approach can be used during the implantation of a CORAIL Revision Stem. Generally, the femoral tube is closed by cerclage to reconstruct the femoral shaft, and then the femoral preparation is carried out as it would be for a closed femur procedure. The primary stability of the stem inside the host bone is the limiting factor. In the case of a highly enlarged metaphysis, the gap should not be filled by bone graft but perform a tightening femoroplasty around the CORAIL Revision Stem (using cerclages wires). The use of wires is also indicated if the integrity of the calcar is compromised.

Figure 6a
Pre-operative x-ray

Figure 6b
Post-operative x-ray

Figure 7a
Pre-operative x-ray

Figure 7b
Post-operative x-ray

Extended Trochanteric Osteotomy (ETO)
In the event that there is residual space around the stem, this can be filled with compacted cancellous bone. The primary stability of the stem inside the host bone is the limiting factor. Hydroxyapatite promotes osteoconduction without any formation of fibrous tissue around the stem for defects, assuming that the stem is stable. In the case of a highly damaged metaphysis, it is better to perform a tightening femoroplasty around the CORAIL Revision Stem (using cerclage wires), then fill the gap with an allograft.

Filling Bone Defects

The stability of the stem must be achieved prior to inserting bone graft. The bone graft serves only to fill in defects and not to ensure the stability of the stem. A wedge bone graft would fail to achieve sufficient stability and therefore would potentially lead to failure of stem osteointegration. If insufficient primary stability is observed, a longer, distally locked stem (REEF prosthesis) should be used to achieve primary stability.

Bone graft integration is slow but effective, and proper distal fixation of the stem on the host bone is required until the proximal graft has been osteointegrated. A calcar defect is frequently observed in femoral revision cases. In such instances, the use of a "horseshoe" shaped allograft onto which the CORAIL Revision Stem collar will load is indicated (Figure 8). The integration of this type of graft is excellent due to the loading pattern and use of hydroxyapatite coating under the collar. Moreover, this graft makes it possible to wedge the stem vertically, in order to prevent it from subsiding during the first post-operative weeks.

Figure 8
"Horseshoe" allograft

It should be noted that often at the end of the procedure, some hydroxyapatite coating is slightly visible which is not fully covered by the host bone or the filling graft. In those cases, surgeons may prefer to cover the coating with host bone or bone graft, although this is not mandatory.

Figure 9a
Pre-operative x-ray

Figure 9b
Post-operative x-ray

Fixation on Sclerotic Host Bone

This situation is far from ideal for prosthetic fixation (Figure 9a), yet experience has demonstrated the reliability of the long term fixation of the CORAIL Revision Stem.[3] Whilst the objective is to seek non-compromised healthy bone distal to the proximal sclerotic host bone for implantation, fully HA-coated stems have proven to be a solution even in sclerotic bone, with bone reconstruction visible on X-rays and the total absence of peri-prosthetic lysis which is frequent in femoral revision procedures.

Additional points

To increase the potential for a successful outcome, the surgeon should consider the following points:

- Ensure that all cement is removed prior to implantation to achieve optimal osteointegration
- When reaming of the femoral canal is indicated, consider the use of flexible reamers prior to the use of straight reamers
- Where visual access is available, it can be useful to check that the "minimal embedding level" is reached using the dedicated witness groove on the trial stem.

Conclusion

The standard CORAIL stem can be used for revision cases where the metaphyseal zone remains mechanically and biologically healthy (Paprosky Type I).[1]

The CORAIL Revision Stem is indicated in the case of more severe damage that jeopardises the stability of the metaphysis. The CORAIL Revision Stem can bridge aggressive granulomas and cortical defects ensuring both metaphyseal and diaphyseal anchorage for maximum stability. This means this implant is suitable for revisions of Paprosky Type I, II and IIIA.[4]

The CORAIL Revision Stem may be unable to achieve stability in cases of extreme implant loosening or those with associated fractures (Paprosky Type IIIB and IV) and in such cases, stems with a distal locking option should be considered.

References

1. Reikerås O, Gunderson RB. Excellent results with femoral revision surgery using an extensively hydroxyapatite-coated stem: 59 patients followed for 10-16 years. Acta Orthop. 2006;77:98-103.

2. Della Valle CJ, Paprosky WG. Paprosky Femoral Classification. J. Bone Joint Surg. Am. 2003;85:1-6.

3. Ait-Siselmi T, Pinaroli A, Lavoie F, Cartillier JC. Conservative Femoral Stem Revision: Avoiding Therapeutic Escalation. J. Arthroplasty. 2009:24; 365-373.

4. Balaÿ B, Cartillier JC, Charlet C, Machenaud A, Semay JM, Setiey L et al. Approche stratégique dans les reprises de prothèse totale de hanche descellée. Rev Chir Orthop 1993;79:503-507.

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