Hip painful prosthesis: surgical view

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Summary

Painful hip prosthesis is the most feared immediate and remote complication of a primary implant and usually represents the failure of one or more therapeutic moments. In cases of aseptic implant failure, the causes invoked may be represented by an incorrect indication, the quality of materials, local and general condition of the patient and especially from a bad joint biomechanics. In cases of septic loosening, however, the cause of failure is found in the location of pathogens within the implant. In planning a revision is necessary to respect many important steps. They are represented by the exact identification of the causes of failure, the correct preoperative planning, by respecting the skin incisions, the proper choice of the prosthesis, planning the surgical technique, and finally by an appropriate rehabilitation program.

In the evaluation of hip failure the first diagnostic step is to recognize exactly those aseptic and septic forms anyway to exclude the diagnosis of infection.

KEY WORDS: THA; loosening; infection; bone-loss.

Introduction

The long-term success after total hip arthroplasty depends on maintaining a good fixation of prosthetic components. The periprosthetic osteolysis is the most common complication after primary arthroplasty, and the consequent easing pain are the main causes of prosthetic revision. The loss of acetabular component fixation occurs in approximately 2-8% of hip replacement, femoral component loosening occurs in percentages between 6% and 18% of cases (1, 2). Bone loss is predominantly due to wear-mediated inflammation. However, bone resorption may be multifactorial, and micromotion and altered mechanical loading may also play a role. Periprosthetic osteolysis (Figure 1) is progressive and may be complicated by joint failure or periprosthetic fracture with the subsequent need for surgical revision (3, 4). Therefore, diagnostic imaging may be helpful in accurately evaluating the extent and distribution of osteolysis, in anticipation of further surgical management (5, 6).

Hip revision surgery is rapidly increasing because of the increasing number of arthroplasties implanted in recent years.

Discussion

A painful hip must be considered infected until the contrary. It is therefore important to assess the type and sequence of pain, general and local conditions of the patient, evaluate laboratory tests, the X-ray and in doubt do other imaging examinations. It is most important to distinguish aseptic periprosthetic osteolysis from loosening caused by infection. Infection complicates approximately 2% to 3% of hip arthroplasties (7). The diagnosis of infection depends on a combination of clinical features (erythema, warmth,
joint swelling, effusions), laboratory tests (elevated white blood cell count, erythrocyte sedimentation rate, C-reactive protein), and diagnostic imaging. While both aseptic periprosthetic osteolysis and infection may demonstrate similar imaging characteristics, infection is more likely to be associated with endosteal scalloping, acute multisite periosteal reaction, and periprosthetic bone resorption (8, 9).

The pre-operative planning is critical to the success of a prosthetic revision surgery. The objectives to be met are:

- identify the causes of failure
- assess the patient’s general condition
- assess acetabular and femoral bone-loss
- evaluate the biomechanical changes

The assessment of these points yields the following results:

- choose the most appropriate therapeutic strategies
- anticipate and be ready to treat any intraoperative complications
- make a stable and pain-free system
- preserve or increase bone stock
- restore joint biomechanics

The mobilization of the hip is defined as the loss of stability of a prosthesis or a failure or stabilization of a prosthesis that requires a secondary integration to complete the initial primary stability.

The mobilization is a gradual process that recognizes biological and mechanical causes.

The mechanics have had more to design and prosthetic materials, bone quality, the technique of implanting (positioning, cemented or cementless), the quality of the bone-prosthesis or bone-cement-prosthesis interface.

The biological one consists of a gradual wear of materials (polyethylene, metal, etc.) that involves the release of debris in joint bringing inflammation reaction that result in the prosthesis mobilization (10–12).

Another cause of implant loosening may be the periprosthetic fracture that can occur following an efficient trauma, or more frequently in the presence of osteolytic areas as a result of insufficient trauma.

In fact, the mechanical and biological causes are not always separable, the prosthesis change the distribution of mechanical forces on the bone that involves biological reactions of physiological adaptation and on the other hand, the production of debris is related to mechanical factor that accelerates material’s wear (13).

Currently, the problem of the longevity of the system is essentially linked to osteolysis; osteolysis is the initial findings reported in induced-hardened and not mobilized. Osteolysis is the biological response to wear debris originating materials by mechanical or chemical action. The greatest source of debris is the acetabular articular surface between the liner and head prosthesis (14, 15). Wear particles from the bearing surfaces play a major role in initiating periprosthetic osteolysis, which is also potentiated by mechanical factors such as increased synovial fluid pressure. The precise mechanisms by which wear particles induce periprosthetic osteolysis have not been fully elucidated and remain an active subject of research.

Particle characteristics such as composition, size, shape, and number (especially for particles in the most biologically active, sub-micrometer-size range) are recognized to significantly affect the overall cell and tissue response. The polyethylene particles that are smaller than 1 micron cause greater tissue reaction. Those produced by the friction of metal collar at the junction of the prosthesis head, and screw cup of modular components are larger than the particles of polyethylene. Their action may be indirect, acting as a third body in poly-wear or live as free metal ions can trigger the cellular response. Debris stimulate an inflammatory respon-
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of the phenomenon that inevitably leads to the mobilization of the implant. For this reason, the periprosthetic bone loss is the main problem in aseptic loosening, it is the expression of the pheno-
mena of aggression by the reactive granulation tissue debris pe-
netrating to the bone-cement or bone-prosthesis interface. The cor-
rect evaluation of the extension, repeatable and extent of loss of
substance is a key parameter for the choice of the technique of
revision. There are in literature different classifications of bone loss
in acetabular and femoral bone (18-23). Currently the most widely
used is that of Paprosky, which allows the classification of bone
defects with plain radiographs of the pelvis and hip than evaluat-
ing the migration and/or medialization of the acetabular com-
ponent, osteolysis ischial and radiographic drop.

- Type I: Minimal loss of metaphyseal cancellous bone. Intact
diaphysis. Consider cemented vs cementless fixation.
- Type II: Extensive loss of metaphyseal cancellous bone. In-
tact diaphysis. Loss of cancellous bone makes cemented fixa-
tion more suspect, consider uncemented fixation (24-26) (Fi-

gure 3).
- Type III-A: The metaphysis is not supportive. There remains
greater than 4 cm of bone in the diaphysis to allow for a scratch
fit. Consider uncemented fixation with a fully porous-coa-
ted stem.
- Type III-B: The metaphysis is not supportive. There remains
less than 4 cm of bone in the diaphysis to allow for a scratch
fit. Due to short segment of cylindrical bone to support a fully-porous coated stem, the failure rate is high with such a de-
vice. Consider a modular tapered stem.
- Type IV: Wide open canal without any appreciable isthmus to
support an uncremented stem. Consider impaction grafting if
the proximal tube is intact +/- an intact calcar. Other alternatives
would include a modular tumor megaprosthesi.

Similar to his femoral defect classification, this system attempts
to stratify the degree of host bone loss in order to estimate the abi-

ty to achieve stable cementless fixation for any given bone loss pattern.

Four landmarks require evaluation:
- Femoral head center as measured from Hilgenreiner’s line (ho-

rizontal line connecting the inferior aspects of the teardrops
or the superior margins of the obturator foramina). Note any
superior displacement greater than 3 cm if the displace-
tment tends to go medial or lateral.
- Ischial osteolysis- as measured from Hilgenreiner’s line infe-

riorly to the edge of the osteolytic lesion in the ischium. Gre-
ter than 1.5 cm of bone loss represents 20-25% loss of the ace-
tabular bone stock.
- Tear Drop- Loss of the radiographic tear drop indicates damage
to the medial wall as well as the inferior portions of the columns,
  ~ 10-15% host bone loss.
- Kohler’s line- breakthrough medial to this line (the iliioschial
line) represents medial wall destruction and likely damage to the
midportion of the columns.
  - Migration relative to this line can be graded as follows:
    - Grade 1- the socket remains lateral to the line
    - Grade 2- the socket has migrated to, not through, the line
    - Grade 3- the socket has migrated medially into the pel-

vis

Type 1- there is an intact rim with little or no migration superior
or medial. The teardrop and ischium are intact.
- Type 2A- minimal increase in bone destruction, but any superior
migration is less than 3 cm (i.e. superomedial bone loss with an
intact rim).
  - Treat with an uncemented hemisphere (with screws) and pos-
sibly cancellous bone grafting to small defects.
- Type 2B- greater distortion of the superior rim (small superolateral
  segmental rim defect of less than 1/3 rim circumference) but less
  than 3 cm superior migration. The dome remains supportive and
  lysis in the teardrop/ischium is minimal. Medial migration to the
  medial wall, but not violated.
  - Treat with an uncemented hemisphere (with screws) and can-
cellous bone grafting to any contained defects. There may be
a role in some cases for a small structural bone graft super-
olateral to the segmental defect. However, as a rule this graft
would be to restore bone stock because it would be a Type
3 if the bone graft was required for implant stability.
- Type 2C similar to 2B with migration medial to Kohler’s line and
  moderate to severe teardrop osteolysis. Minimal ischial osteoly-
sis. The dome remains supportive. This is the case with an in-
  tact rim but no medial wall.
  - Treat with an uncemented hemisphere (with screws) and can-
cellous bone grafting to defects. Consider the use of a “me-
dial wafer” structural bone graft.
- Type IIIA- significant superior dome destruction with greater than
  3 cm superolateral migration. Kohler’s line is intact, but there is
moderate ischial and teardrop lysis (Figure 4). There is usually ade-
quate host bone for ingrowth, but the cup requires some form of
augmentation to achieve implant stability.
  - Treat with an uncemented cup with screws and:
    - A structural bone graft- femoral head
    - A modular prosthetic graft- e.g. wedges
    - Place the cup into the high hip center
- Type IIIB- significant superior dome destruction with greater than

Figure 3 - Revision with Wagner stem using Wagner osteotomy.
The use of bone grafts is intended to restore an adequate bone stock and/or to make a mechanical support for the revision prosthesis. The choice of graft is made according to the classification of bone defects presented above.

Acetabular bone grafts showed massive structured long-term high percentage of failures. In cases of segmental defects using grafts stru-turate support stabilized with screws or cemented cups for 8-10 years showed 54% of failures (28). So nowadays it is preferable to use the grafts in the form of morcellizzato and then place the acetabular component in neocotile or metal rings reinforced cups or jumbo-cup.

A femoral treatment of bone defects can be performed with cancellous grafts or grafts morcellizzati structured. The use of massive segmental transplantation is indicated in cases where there are proximal circumferential bone defects with greater length to 5 cm.

References

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