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ORIGINAL PAPERS: CLINICAL OR BASIC RESEARCH

# Therapeutic strategy in revision of infected total hip and knee arthroplasty

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*ABSTRACT*

***Objectives:*** *The aim of this paper is to review the literature for the current attitude in the prevention and treatment options/tendencies/clinical management in septic revision of hip and knee arthroplasties (THR and TKR, respectively) and illustrate it with our experience.*

***Methods:*** *Along with the literature data, we present the surgical procedures performed in department our clinic for primary infected THR. The revision surgical procedures were performed between 5 days and 7 years after primary THR or TKR. Between 30.03.1990 – 30.03.2004, 117 patients were operated on at our department, of which 105 with infected THR (67 women and 48 men), and 12 with TKR (8 women, 4 men), with a total of 255 surgical procedures. The risk factors for infection in our series were identified in 49% of the cases.*

*Of the 105 cases of infected THR, 21 were early infections and treated by soft tissue debridement and lavage only. Of the 84 late infections, 10 underwent a one stage debridement and revision procedure, while in the other 74 cases the two stage procedure was selected and begun. The two stage treatment comprises a first intervention of thorough bone and soft tissue debridement with prosthesis removal and implantation of a cement spacer, and is followed at 2-3 months by the revision arthroplasty. Only 20 cases of these two stage procedure were completed until now with the second revision arthroplasty.*

*In the knee series, 6 patients 50% underwent a soft tissue debridement for early infection, while the late infections were all treated by the two stage procedure.*

***Results:*** *In septic revision of THR, both the 20%, which represented early infection, as well as the late infections treated by one stage procedure, had a good outcome. In the 20 cases that completed the two stage surgical protocol we had 90% of good and fair results, with a 10% recurrence of infection. In the knee series, the early debridement group had a good outcome. In the late infections, there was one death after the first debridement procedure and the rest of 5 cases had fair and good outcomes after treatment completion.*

***Conclusion:*** *Primary hip arthroplasty is a spectacular surgical intervention. However, it must be performed in circumstances of great security against infections. Once the infection appears, it must be managed as early as possible in order to achieve – according to possibilities – preservation of both the patient's life, bone stock and the prosthesis or its replacement. We consider that cement spacers provide satisfactory functional results and that the patients might not need a later prosthetic replacement.*

**Key words:** infected prosthesis, spacers, total hip replacement, total knee replacement, antibiotic, septic revision

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## INTRODUCTION

In this paper we revise the therapeutic guidelines in the prevention and treatment of the infected total hip and total knee arthroplasties. We also illustrate the existing data with the cases that underwent surgery at our department.

We studied the already existing literature data regarding the treatment of infected knee and hip arthroplasties. In the revised literature, the incidence of the infected total arthroplasty is 1% in total hip arthroplasty, 3% in primary total knee arthroplasty, 3-4% following total hip revisions. In the USA alone there are 6000 new cases each year, reaching a cost of 600 million USD per year for the 600.000 total hip prostheses with 1% septic revisions. ❑

## METHOD

We present our experience with 117 consecutive infected cases of primary THR (105) and TKR (12) that were admitted at the Hospital of Orthopaedics, Trauma and Osteoarticular TB "Foisor" between 30.03.1990-30.03.2004. The primary intervention has been performed in different clinical centers. The revision surgical procedures were performed between 5 days and 7 years after primary THR or TKR, comprising a total of 255 reinterventions in our department. The sex ratio was 7:5 (67 women and 48 men) in THR and 2:1 (8 women, 4 men) in TKR, reflecting the sex ratio of the primary arthroplasty group.

Multiple surgical procedures were carried out for each case, varying from 1 to 8, with an average of 2 per patient.

Of the 105 cases of infected THR, 21 were early infections and treated by soft tissue debridement and lavage only. Of the 84 late infections, 10 mild cases underwent a one stage procedure, when a safe debridement was obtained. In the other 74 cases considered more serious infections by both preoperative and intraoperative assessment, the two stage procedure was selected and begun. The two stage treatment comprises a first intervention of thorough bone and soft tissue debridement with prosthesis removal and a cement spacer implantation, followed by a revision arthroplasty after 2-3 months. Only 20 cases of these two stage procedure were completed until now, with the second revision arthroplasty.

In the knee series, 6 patients underwent a soft tissue debridement for early infection, while the late infections were all treated by the two stage procedure.

We were able to collect data on the therapeutic management of patients both at the primary procedures (in 62% of cases operated in our clinic) and at the reintervention ones, due to retrospective study of medical records. Records of follow-up visits were also available in 90% of the patients. We compared the results to the existing literature data.

### Surgical Technique

There are two different ways of managing the infected prosthesis revision. The one stage prosthesis exchange technique includes, in the same surgical procedure, both the prosthetic removal and prosthetic replacement after debridement. The two-stage exchange technique needs two surgical interventions; the first one is the debridement stage, removing all of the implanted material and debridement, followed by a cement spacer insertion. The spacer is manufactured either of antibiotic loaded acrylic cement alone, or metallically armed if needed (in order to satisfy certain mechanical properties requirements). The second intervention can be performed after at least 8 weeks period of i.v. antibiotics, when a usually uncemented arthroplasty replacement is performed.

In all of our cases, we tried to preserve as much bone stock as possible. However, chosing an oncological surgical technique is critical for the success of the treatment and should be performed by all means.

The treatment is conducted by the orthopedic surgeon under the guidance of an experienced infectious diseases specialist. The treatment is expensive, painful, and often inefficient, yet instructive for the surgeon who performed the primary procedure.

**Two stage prosthetic replacements** is the technique frequently adopted in knee septic revision1 . Two stage replacements are efficient in 81-100% cases (2).

The principles are the same for both knee and hip. In the first stage, one performs drainage, detailed debridement, removal of prosthetic components and of the cement residues, necrectomy and fixation of an antibiotic acrylic cement spacer. In the second stage, after 6-12 weeks of antibiotherapy (with an average of 8 weeks) (3), when inflammatory tests return to

normal values, a second surgical procedure follows. The spacer is removed and, after an abundant lavage, the revision arthroplasty is performed. Despite all the efforts, the recurrence of infection still occurs in 4-9% cases; moreover, there are studies showing up to 30% recurrence rate at 10 years (4).

## Cement spacers

The spacer contains thermostable antibiotic like Gentamycin, Tobramicin 1,2 g/dose of cement, Vancomycin 1 g/dose of cement. Gentamycin release from the cement takes place at a maximal rate during the first day, and goes on gradually within the first month (300-400 mg), with constant release after more than 7 months (5).

Bone fixation of the spacer must only prevent rotation and movements at the cement-bone interface. The spacer removal during revision should be possible at the time of the second procedure without any destruction or bone loss. A metallic scaffold of the spacer ensures an increased mechanical resistance.

The advantages of the preformed spacers are medically and mechanically obvious, at both knee and hip levels, in terms of mechanical resistance, as well as decreased operating time and ease of technique (1).

Out of financial considerations, we were not able to use preformed spacers (Prostalac).

At the hip level, we manufacture intraoperatively Gentamycin loaded (Palacos) cement spacers, reinforced with metallic plates or other metallic materials; the Ender elastic nails scaffold proved to be the strongest one. Curved elastic nails offer the advantage of mechanical strength and also provide a limited distal contact inside the femoral canal. After the metallic material insertion, anteversion and length correction, we include 3-4 doses of acrylic cement. In one single case, we tried to mechanically model the cement before reducing the spacer into the acetabular socket, similar to the reduction of Moore prosthesis. It was the only case with postoperative pain. The spacer in the hip acts as a cervico-cephalic prosthesis. The antibiotics included are thermostable. In accordance with the antibiogram, we added Vancomycin to the Palacos cement for Vancomycin sensitive MRSA.

As far as the knee is concerned, the spacer can be rectangular with an intramedullary rod,

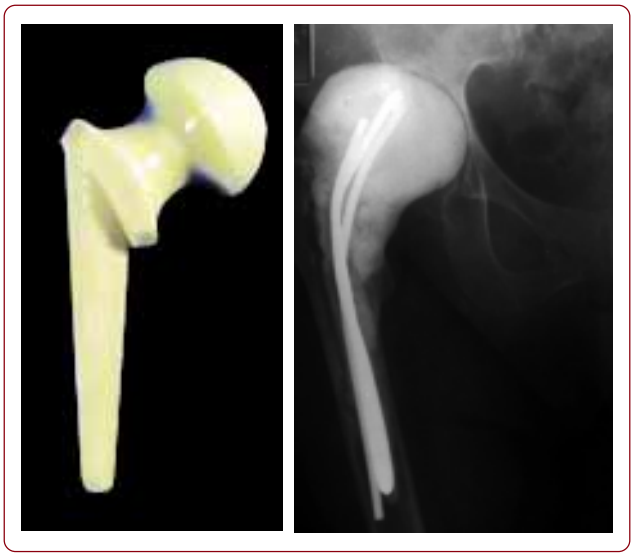

**FIGURE 1.** Preformed Prostalac antibiotic cement spacer in the form of a cervico-cephalic prosthesis versus intraoperatively custom made spacer of acrylic antibiotic cement on Ender elastic curved nails scaffold.

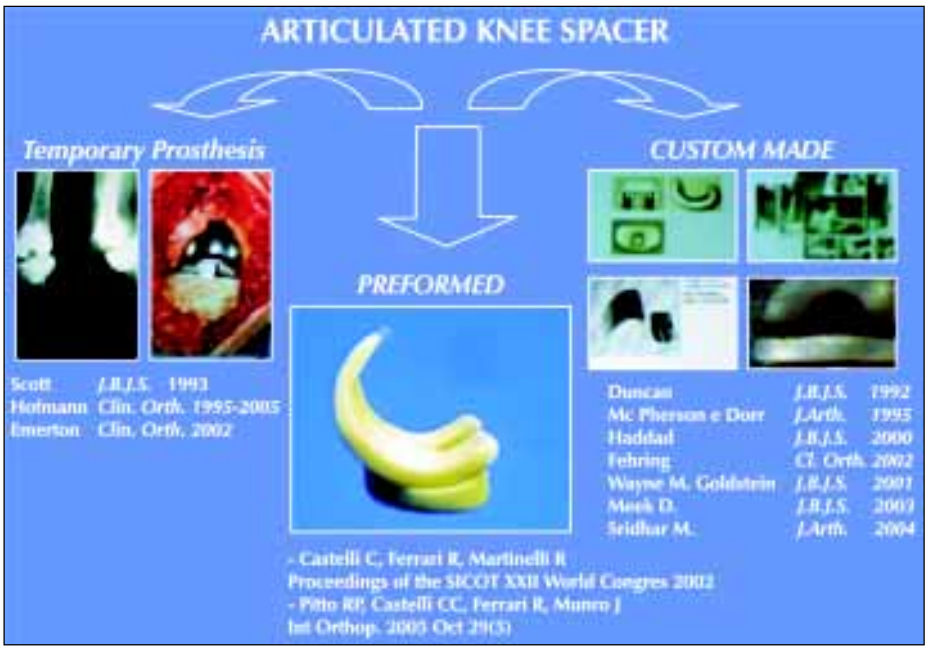


**FIGURE 2.** TKR Options for maintaining space after debridement of infected TKA: (1) Spacer, (2) the inclusion of the old prosthesis after removal and sterilization in an tibiotic cement, or (3) custom made antibiotic cement spacers either molded for the femur, with the tibial prosthetic component and for the tibia with the femoral prosthetic component or preformed components – Prostalac.

**FIGURE 3.** First stage of two stage septic revision for infected TKR, with manufactured articulated cemented spacer

or it can be articulated, resembling a total knee prosthesis. There are commercially available preformed spacers – Prostalac. The intraoperatively manufactured ones are the negative of the prosthetic parts (6).

If spacer dislocation occurs, it offers a good reason for revision of the spacer. This provides increased stability, a new amount of local antibiotic to be released and a new drainage-debridement as well.

## Antibiotherapy

Antibiotherapy must include 2 i.v. antibiotics for a minimum 6 weeks period. We currently use an association of Glycopeptides (Vancomycin, Teicoplamin), Fluoroquinolones (Ciprofloxacin) and/or Rifampicine.

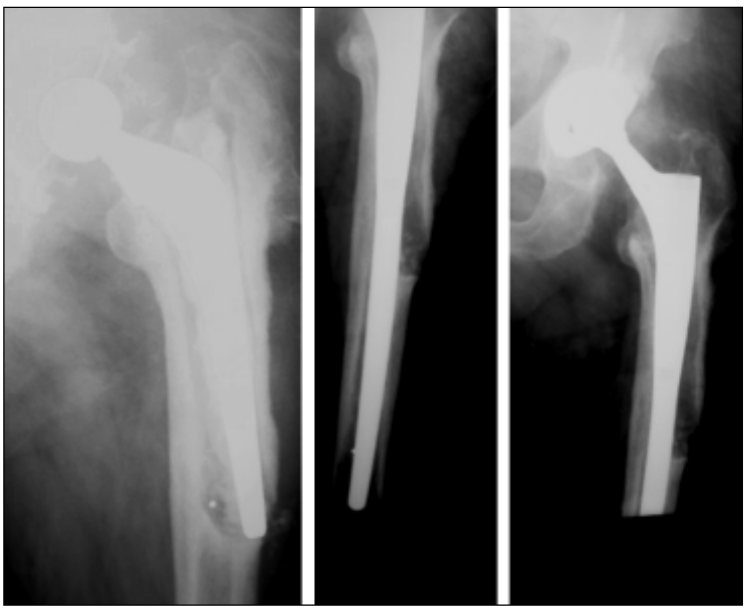

**FIGURE 4.** Single stage septic revision with modular uncemented Zimmer Prosthesis

## Prosthetic replacement

The criteria that must be met in order to proceed with revision arthroplasty are: inflammatory tests returned to normal levels (blood count, ESR, CRP), negative cultures from aspirate 2 weeks after the cessation of the antibiotic therapy and a clinically normal joint. For the knee, two-stage revision is recommended (7,8,) while one stage revision can be performed at the hip level.

It is recommended for the modular uncemented prosthetic replacement to be performed at the hip level, in order to eliminate the antibiotic resistant germs from the proteic layer (7). Modular uncemented prostheses provide the muscular tension balance, as well as a good mobility and stability. Proximal bone stock restoring can be achieved by means of morcellized bone grafts and growth factors.

Until now, we could only revise 20 patients out of 74 that begun two stage revision of infected hip arthroplasty and underwent removal of the prosthesis. The delay of debridement confirmed by clinical and laboratory findings (ESR, CRP, blood count and fibrinogen), along with financial reasons, lead to this situation.

We have to mention that the Gentamycin spacer, as well as the ilio-femoral cooptation, offer satisfactory functional results, and some patients are not willing to venture into a later prosthetic replacement.

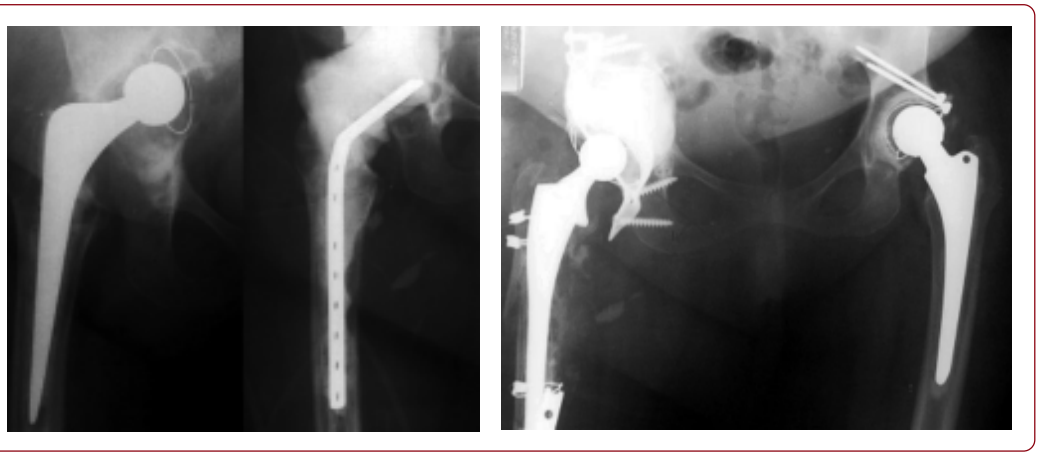

**FIGURE 5.** Two stage septic revision for THR, Cemented Spacer with blade, Septic revision with uncemented DLS Prosthesis

**Septic one stage revision** is preferred for infected total hip arthroplasty, but only if early aggressive debridement is performed. Literature data show this technique ensures a success rate of 73-83% in terms of infection control (8). Some surgeons prefer antibiotic cemented prosthesis in this case, which could unfavorably affect the hip. It is a more expensive procedure, with the risk of wasting one prosthesis. Otherwise, it seems to be a safe procedure when soft tissues and bone are healthy, or when the causative germ is isolated, its sensitivity to antibiotics is identified and the patient can tolerate oral antibiotherapy for a prolonged period of time.

Postoperatively, we administered focused antibiotherapy using a large spectrum of antibiotics in adequate doses, for at least 6 weeks. Pathogenic treatment is aimed to correct anemia, hydro-electrolytic imbalances and associated systemic illness.

Cessation of antibiotic administration must take into consideration the clinical evolution and the lab tests: ESR, CRP, blood count and fibrinogen. It will be continued if the cultures from intraoperative samples are positive and stopped if they are negative.

Early and careful debridement followed by prosthetic replacement in a single-stage procedure was used in only 10 cases; 2 years follow-up confirmed absence of inflammatory processes and a good prosthetic function. Cessation of the antibiotic treatment was decided based on the clinical evolution and laboratory values. ❑

## RESULTS

The results were assessed using clinical Harris score in the hip (test results were graded as good above 85 pt and fair between 65-85pt) and KSS score in the knee series (good results were considered to be above 75 pt). The absence of local and general septic signs, normal inflammatory tests and the absence of the ostelysis signs at the bone-prosthesis or bone-cement interface represented criteria for a successful cessation of infection.

In septic revision of THR, the 20% which represented early infection, as well as the late infections treated by one stage procedure, had a good outcome. In the 20 cases that completed the two stage surgical protocol, we had 90% of good and fair results, with a 10% recurrence of infection. We noticed a relatively good functional status in patients undergoing only the first stage procedure of the two stage treatment protocol in the hip; in addition, we consider cement spacer to provide a reasonable stability and function to older patients with a poor biological status.

In the knee series, the early debridement group had a good outcome. In the late infections there was one death after the first debridement procedure and the rest of 5 cases had fair and good outcomes after treatment completion. The death occurred after the first stage intervention because of antibiotics related renal failure and generalized sepsis. The patient had been treated with a Gentamycin 2g/day and Vancomycin 2g/day regimen. ❑

## DISCUSSIONS

### Prevention of infection at the primary intervention

The prevention of the deep infection is strictly related to the awareness of the patient's risk

factors (diabetes mellitus, rheumatoid arthritis, renal failure, urinary tract and dental infections, smoking, HIV-infection), as well as of the surgical risk factors related to the O.R., to those related to the surgical technique (prolonged operating time – more than 2,5 hours, revision surgery, reinterventions) and to the pharmacologic approach of infection. Close attention has to be paid to hematomas, prolonged drainage, old scars and skin necroses.

## Identification of risk factors

The risk factors for infection in our series were: 4% preexisting infections (urinary tract, dental – 4 cases), 6% hematomas after adductors' tenotomies, 2% defective drainage of the primary prosthesis – 2 cases, 5% metallic osteosynthesis generating in bursitis (wires for trochanteroplasty, too long nails 6 cases), 6% hip interventions prior to primary arthroplasty (osteotomies – 4 cases, fractures and operated hip dislocations – 2 cases, failed arthroplasties- 4 cases, revision arthroplasty – 2 cases), acetabulum defect with intrapelvic cement migration 4 cases (4%), bone grafts – chronic infections 4 cases (4%), hip fracture with repeated revisions 4 cases (4%) and 14% preexisting systemic diseases: diabetes mellitus, chronic hepatitis, tuberculosis, rheumatoid arthritis – 15 cases.

The risk factors could not be identified in about half of the prosthetic infections.

Our antibiotic prophylactic regimen for the primary procedure consists in i.v. first generation Cephalosporin (Cefazolin, Cefuroxim) sixty minutes prior to the procedure. We administered Vancomycin for 24h in only 2 situations: either when MRSA infections were present in the respective wards, or if the patient had a history of MRSA infection. This is the standard protocol that we found in the revised literature.

Repeating intraoperative antibiotic administration after 3 hours is recommended if there is massive blood loss or if the patient is obese. The antibiotic administration is ceased after 24 hours, even if the drain is still in place, but may continue if we suspect an infection and secretions were intraoperatively collected. In such cases, we continue the initial antibiotic administration until we have the final result of the antibiogram (1,8,9).

We cannot overemphasize the importance of asepsis and antisepsis in the operating room. Great care should be taken in handling the sterile operating equipment. It has been demonstrated that the use of vertical air flow which ensures 15 air changes per hour, the strict disinfection measures– asepsis, sterilization, a flawless surgical technique, changing the gloves every 20 minutes, the use of 2-3 pairs of gloves – all these measures lower the risk of infection only by 0,25%. However, the 0,25% decrease of the prosthetic risk infection is quite important, considering the total 1% risk of prosthetic infection (1).

The routinely use of antibiotic cement in primary arthroplasty is still controversial, because it lowers the resistance to fatigue of the

**FIGURE 6.** C.E. DDH Stage B – total hip arthroplasty with acetabuloplasty, trochanteroplasty. Infection was caused by skin and subcutaneous tissue necrosis due to wire synthesis. Debridement, spacer and revision prosthesis with Kent femoral component type.

cement by 15-20%100; yet, it is a very useful measure in cases of revision surgery that presents with a higher risk of infection. Thermostable antibiotics are used in acrylic cement: Gentamycin 1 g/dose, Tobramicin 1,2 g/dose, Cefamandol 1 g/dose of cement.

## Skin necrosis prevention

In case of previous interventions, especially in TKA, previous vertical incisions should either be included in the new one and removed, or a tissue bridge larger than 5 cm should be left between the new incision and the old one; transverse incisions should be crossed at right angles.

If skin necrosis should develop post-operatively, we suggest the following: for an area up to 3 cm of skin necroses, local treatment may be applied; on the contrary, for larger skin necroses, an aggressive treatment is necessary: debridement, necrectomy, muscle flaps, VAC (continuous aspiratory system), skin grafts or flaps.

Postoperative punctures carry the risk of infection; the soft tissues constitute a protective envelope acting as a barrier against infection. Therefore, local injections, anesthetic pump, corticosteroid injections or X-ray guided injections should be avoided, and – if necessary – carefully managed. We have to keep in mind that very rarely these punctures can and will contaminate the wound.

## Diagnosis of infected arthroplasty

Definitions. Early infection develops within the first month of the initial surgical intervention, still allowing soft parts debridement and prosthetic retention. Late infection becomes apparent later than one month. If intraoperatory cultures, hemocultures become positive, prosthetic removal of all components, including cement, if there is any, thorough debridement and i.v. antibiotherapy are compulsory (9,10). Late infection may be either chronic or acute hematogenous.

## Infection assessment

I. **Clinical exam and history.** Pain, as well as stiffness in total knee arthroplasty, are considered to be signs of infection, until proved otherwise (1,11). Local celsian signs are further leading towards the same diagnosis of infection, while the presence of fistulas leaves the matter to no debate. Regarding the medical history of the patient, we pay great attention to chronic dental, genital, urinary, ENT infections, as well as to previous surgical interventions – osteotomies, osteosynthesis for fractures, implant removal. The history of the primary arthroplasty offers important clues for correct diagnosis. Questions like: "What was the evolution of the primary arthroplasty? What was the antibiotic prophylaxis? For how long? How did the wound heal? Were there any fistulas?" need to be answered.

II. **Preoperative paraclinical tests**

1. Inflammation tests (blood cell count, ESR, CRP, fibrinogen, C procalcitonin) – if positive, further conduct to the diagnosis of sepsis.
2. Synovial fluid analysis must be obtained from preoperative puncture (fluid should be immediately sent to the lab for

**FIGURE 7.** B.V. Skin necrosis of total knee arthroplasty, that needed excision, rotated flap and plastic surgery.

bacteriological exam: smear, cultures, antibiogram) (12 ,12). Pathological exam confirms infection if more than 5 pmn are present in 5 fields (according to Mirra 1982) or more than 10 confirm it (according to *Lonner JBJS 1996).*

3. Imaging studies (X-rays, fistulographies, CT scan, Positron Emission Transmission (PET scan), Indium labeled white blood cells scan are all helpful in confirming diagnoses and planning surgery.

**III. Intraoperatively: fluids and tissue sampling (immediate transport to the lab).** Bacteriological exam: Gram stains, Cultures, Antibiogram. Pathological exam – more than 5 PMN in 5 fields – Mirra 1982, over 10 PMN confirm the infection according to Lonner JBJS 1996.

The joint aspiration is important in 3 situations:

a. before reimplanting a prosthesis in case of obvious infection, in order to identify the bacteria and properly conduct antibiotic therapy;
b. before reimplanting a prosthesis in case of sepsis suspicion – anamnestic or clinic infection suspicion, lab tests suggesting the infection, marked leukocyte bone scan – with the aim of confirming the diagnosis as well as for properly conducted antibiotic treatment;
c. before reimplanting a prosthesis in case of preexisting spacer, with the clinical or paraclinical (positive inflammation tests) suspicion of infection recurrence, or in case of a sonographically confirmed liquid collection (10). ❑

## Conclusion

Primary hip arthroplasty is a spectacular surgical procedure, which must be performed under maximum asepsis and antisepsis conditions. Once the infection occurs, it must be dealt with as soon as possible, in order to allow – according to each case – the preservation of the prosthesis or its revision, by saving both the patient's life and the bone stock.

**FIGURE 8.** G.V. THR for Open Fracture Dislocation of hip, posttraumatic colostomy, operated total hip arthroplasty with acetabuloplasty – Burch-Schneider cage causing pressure necrosis on gluteal skin graft, which needed debridement with implant removal and cement spacer insertion.

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