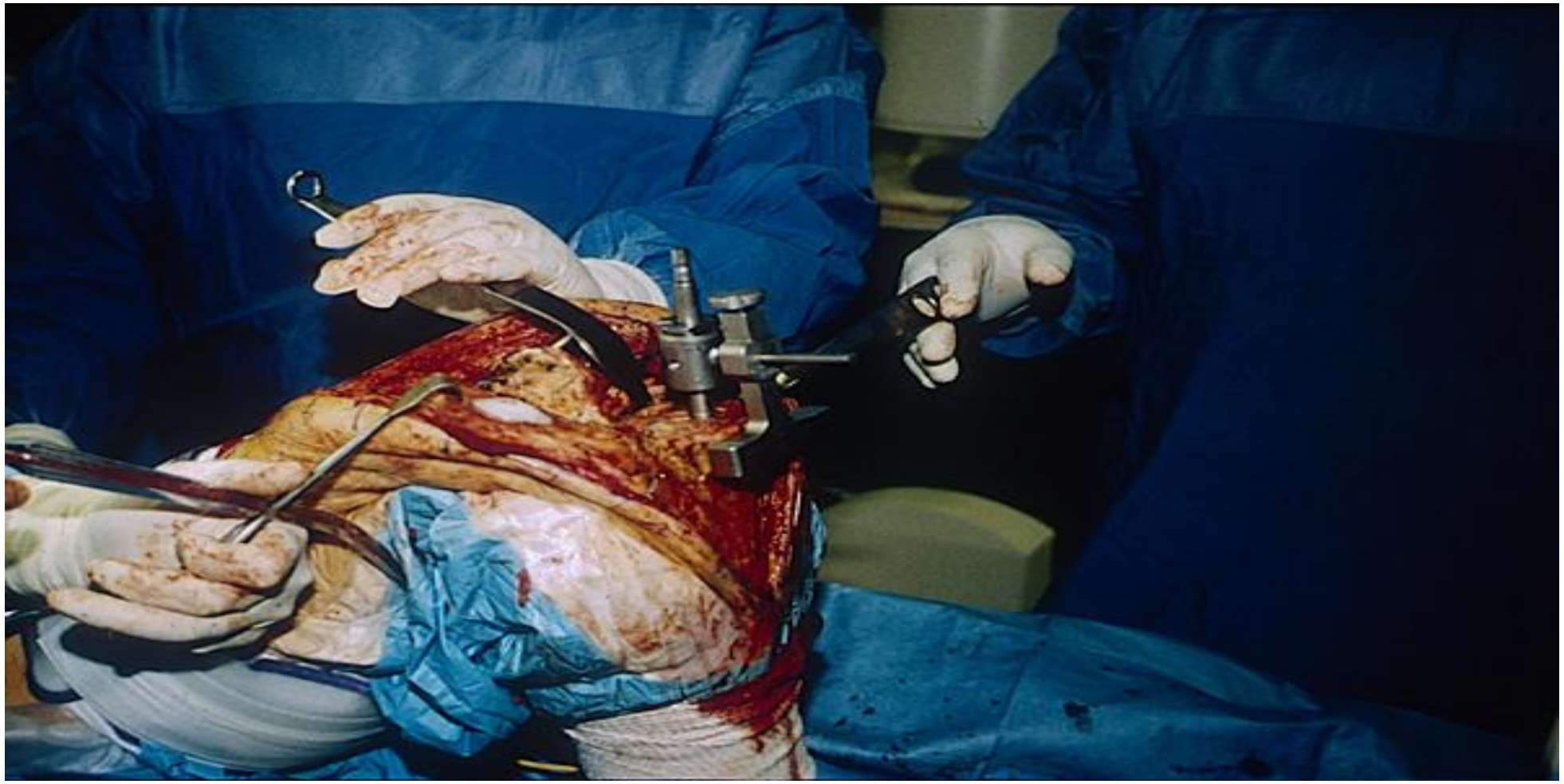
PLEASE CLICK ON THE FOLLLOWING LINK TO WATCH THE LECTURE ONLINE:-

https://www.youtube.com/watch?v=0KumgVbeLLE&list=PLuBRb5B7fa_dtajIUw2Eo1E-8Uv8vVNmR&index=2

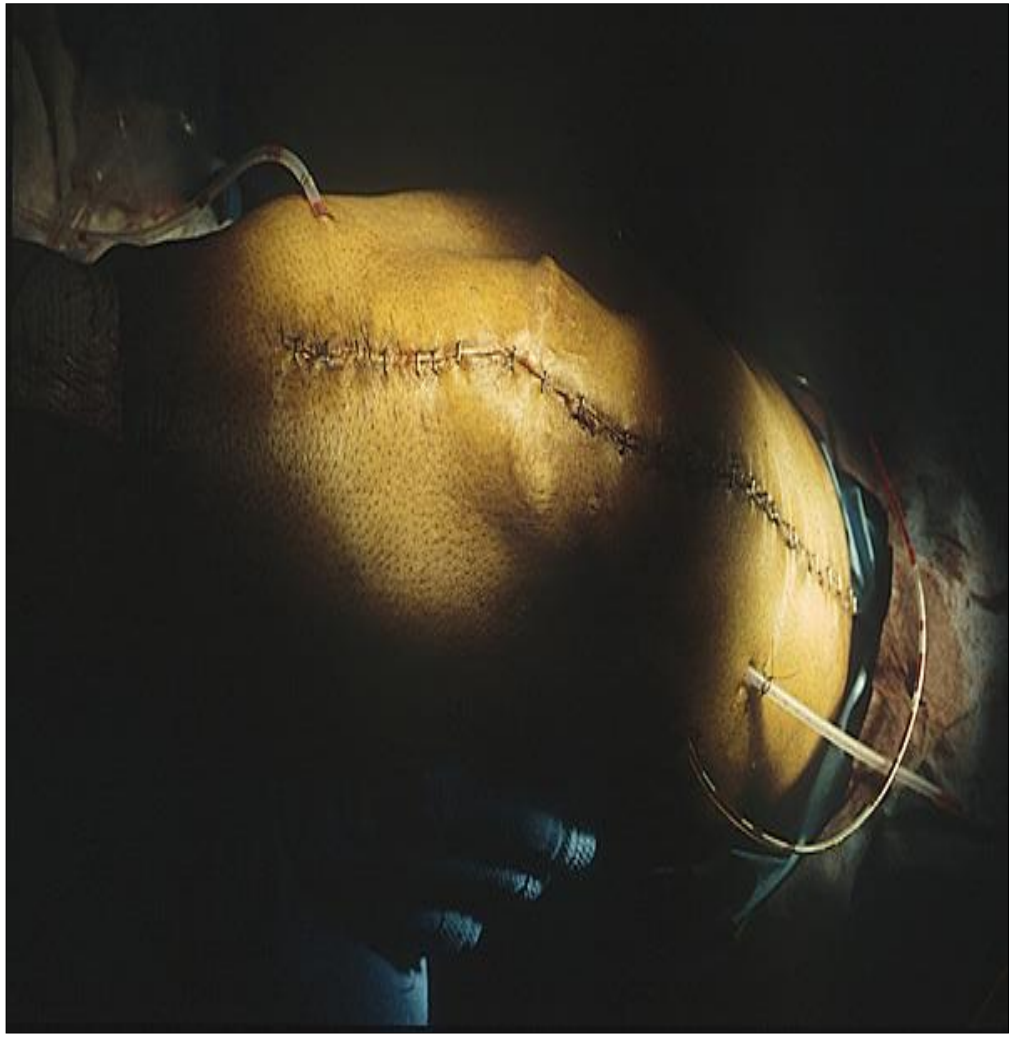
Infection in Total Knee Replacement



Dr. Raed Al-Zaben MD

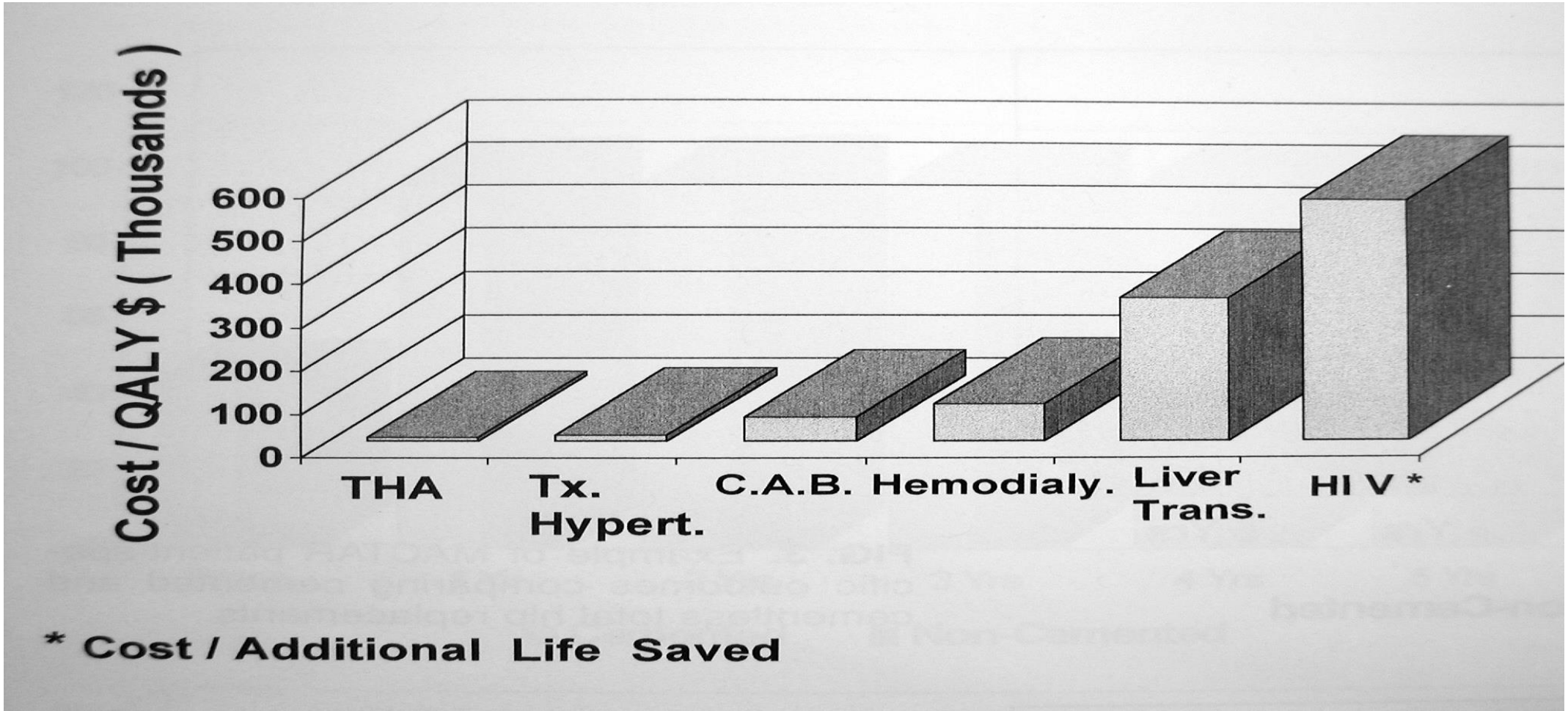
Objectives:

1. Back ground and prevalence.
2. Diagnosis and Classification.
3. Management.
4. Prevention.



Background

- Total joint replacement (TJR) is one of the most cost-effective procedures in all of medicine.



Background

- Total joint replacement is one of the most commonly performed and successful operations in orthopedics as defined by *clinical outcomes* and *implant survivorship**

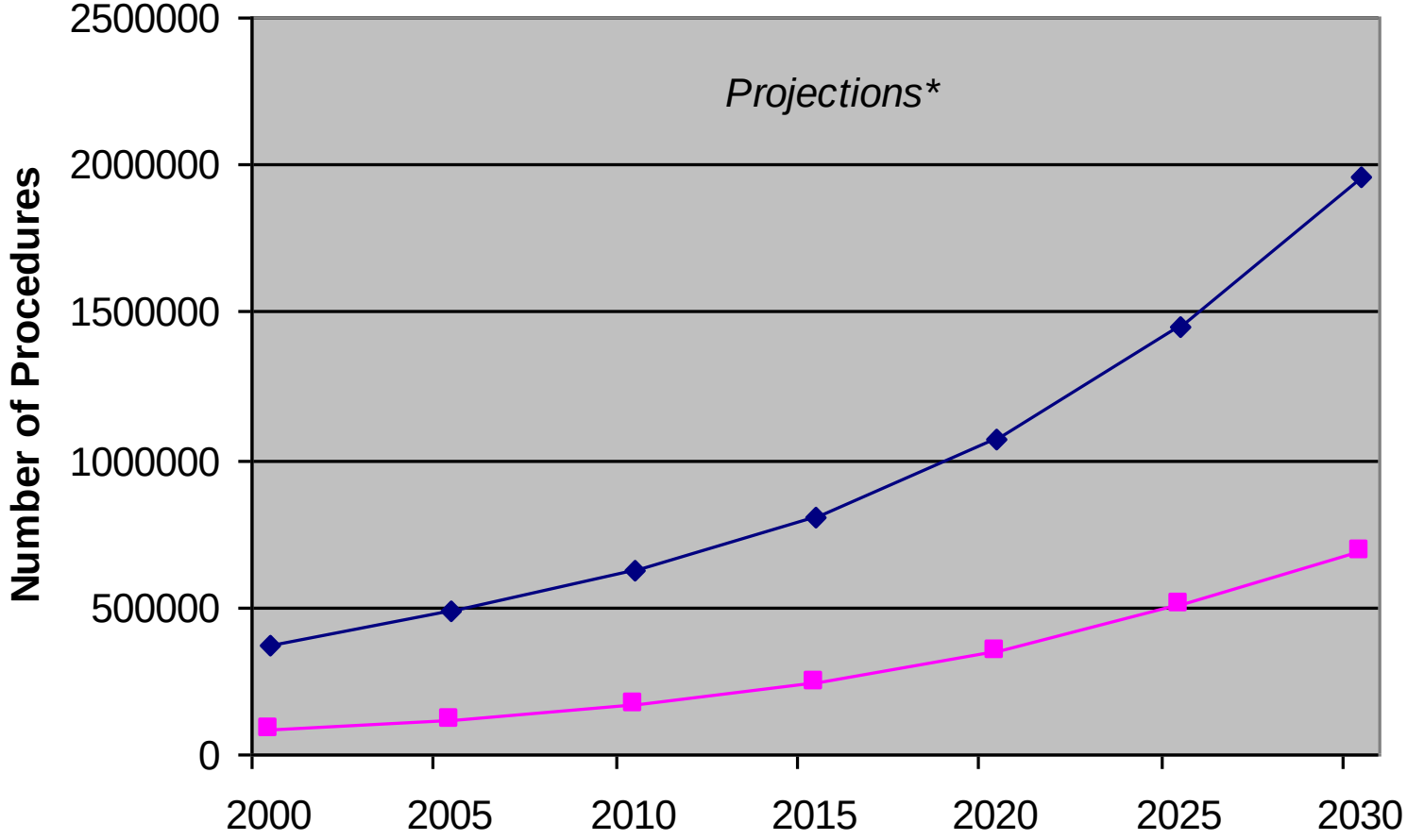
Twenty-five-Year Survivorship of Two Thousand Consecutive Primary Charnley Total Hip Replacements

Factors Affecting Survivorship of Acetabular and Femoral Components

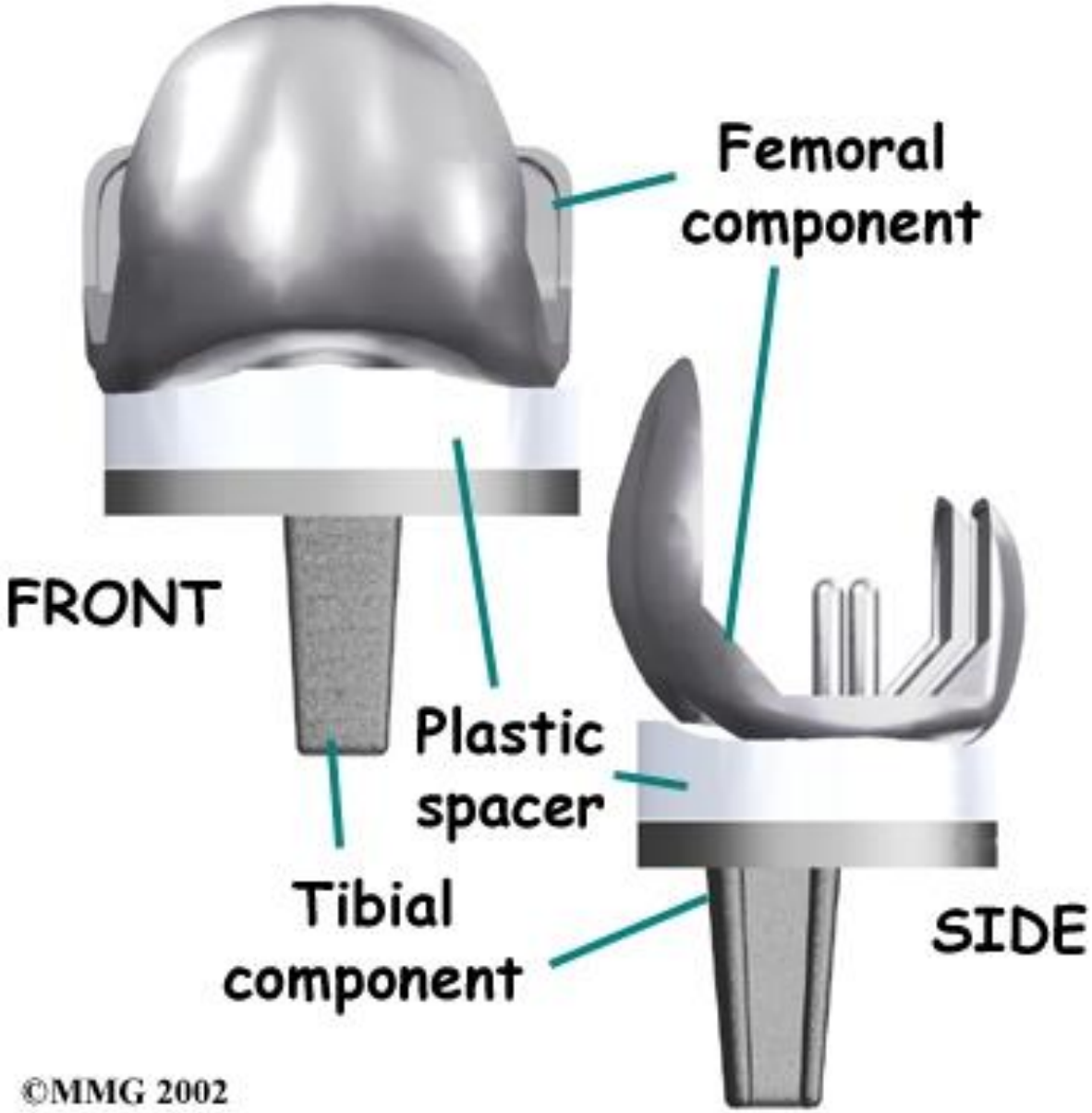
By Daniel J. Berry, MD, W. Scott Harmsen, MS, Miguel E. Cabanela, MD, and Bernard F. Morrey, MD

Investigation performed at the Department of Orthopedic Surgery, Mayo Clinic, Rochester, Minnesota

TJA Volume Estimates

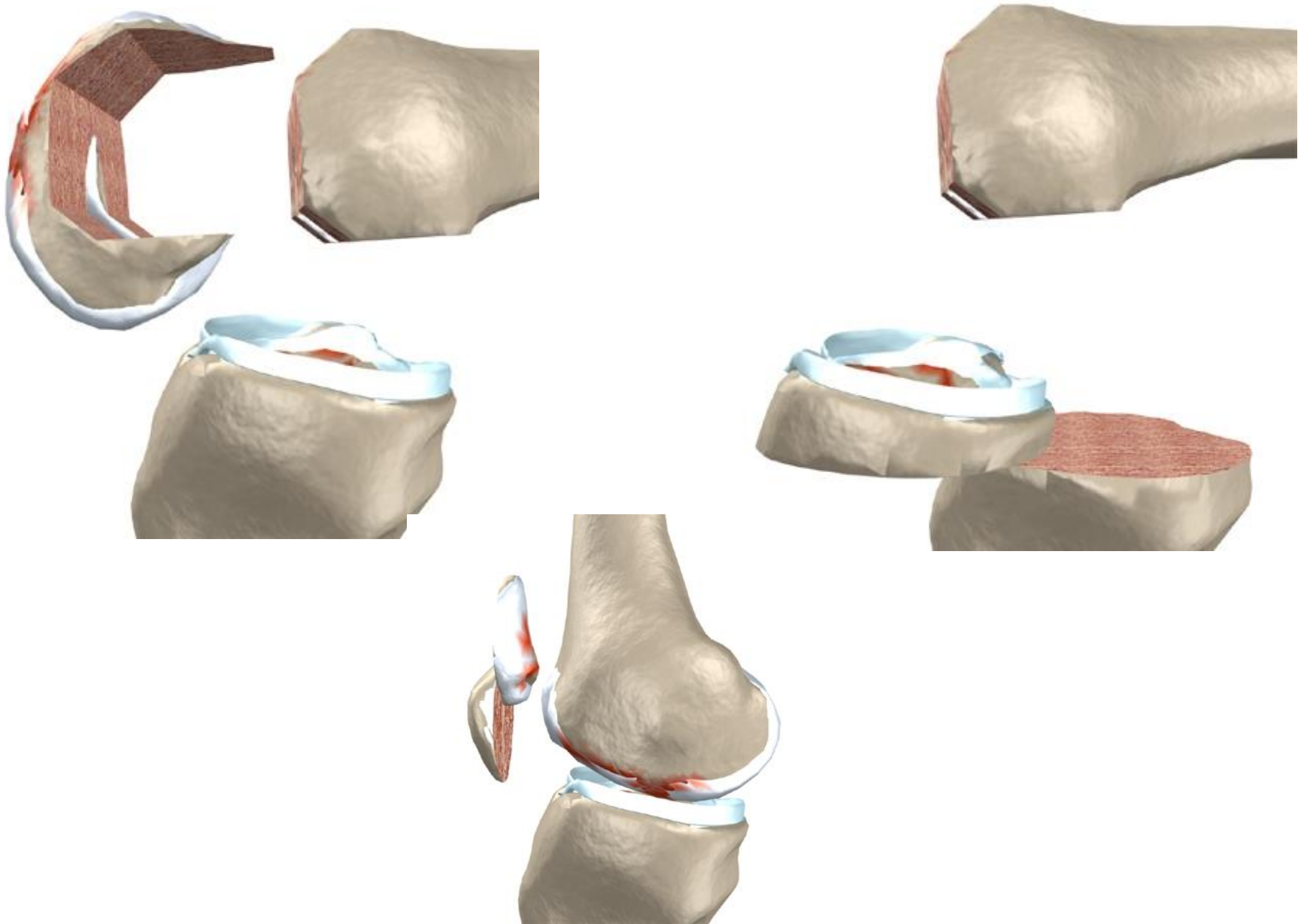


Knee Replacement—Implants

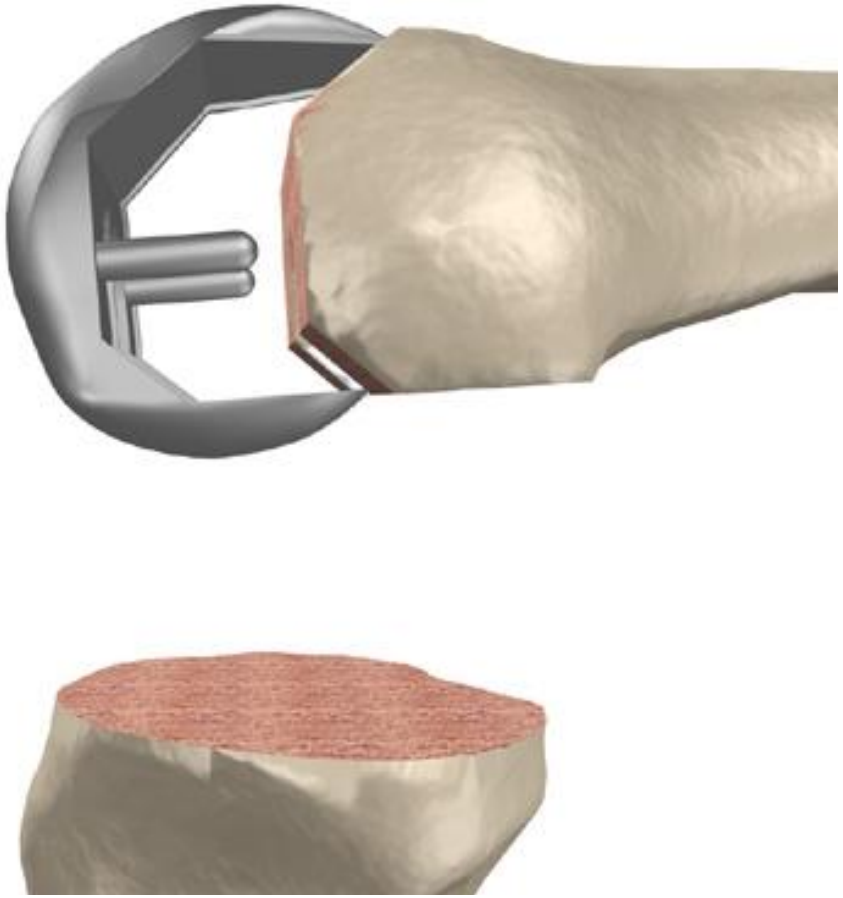


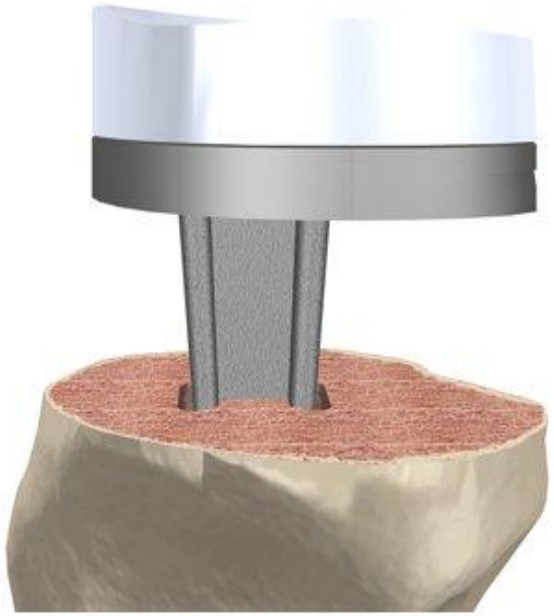
Patellar component

Knee Replacement—Bone Cuts

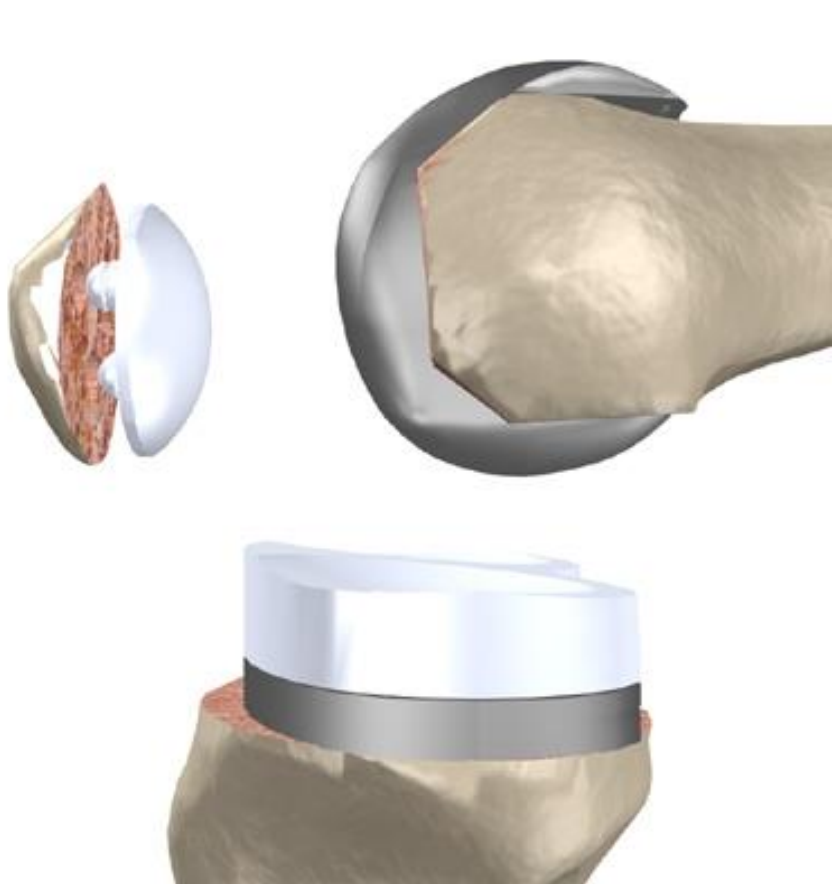


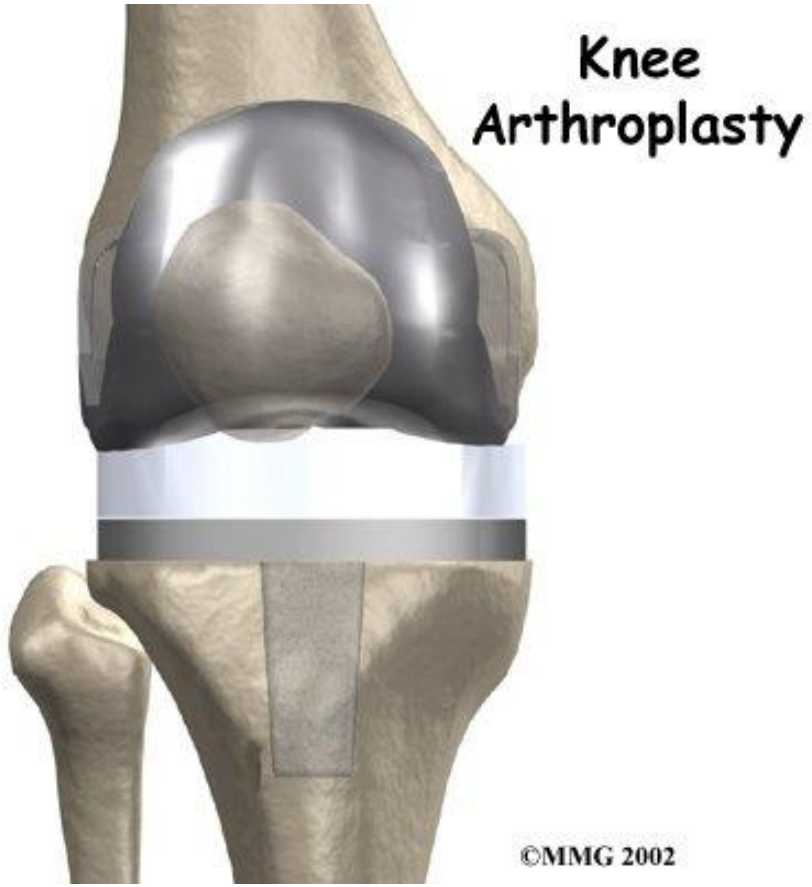
Knee Replacement—Implants





Knee Replacement—Implants





Failure

Despite this success, there are some failures.

Dislocation, per prosthetic fractures, aseptic lessening, septic lessening.

Causes of TJR Failure

1. Wear of articular bearing surface.
2. Aseptic/mechanical loosening.
3. Osteolysis.
4. Infection.
5. Instability
6. Peri-prosthetic fracture.
7. Implant Failure.

Infection is actually, rare but serious problem in joints arthroplastic surgery

Autori	Anno	Interventi	Infezioni
Charnley	1969	190	9%
Eftekar	1976	800	1%
Preston	1978	49	4%
Andrews	1981	1746	3.8%
Hanssen	1998	30680	1.7%
Mendenhall	1995	128000	1.1%

Epidemiology

INFECTION RATE AFTER TOTAL KNEE ARTHROPLASTY

0,5 - 5%

- Grogan J. Bone Joint Surg. Am.1986; 68:226-34
  Wilson J.Bone Joint. Surg. Am. 1990; 72:878-83
  Bengston Acta Orthop Scand. 1991; 62(4):301-11
  Rand JA. Orthop Clin North Am. 1994.

Epidemiology

Infection after total knee arthroplasty

A. W. Blom, J. Brown, A. H. Taylor, G. Pattison, S. Whitehouse, G. C. Bannister

2004

"**Our** known infection rates of 1% after primary and 5.8% after revision TKA are comparable with published reports."

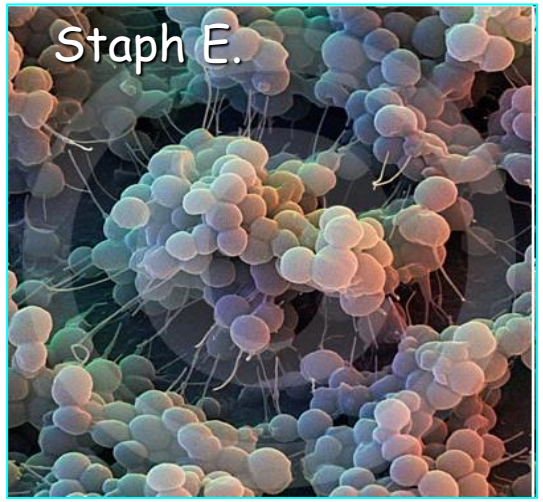
Our Study about infection

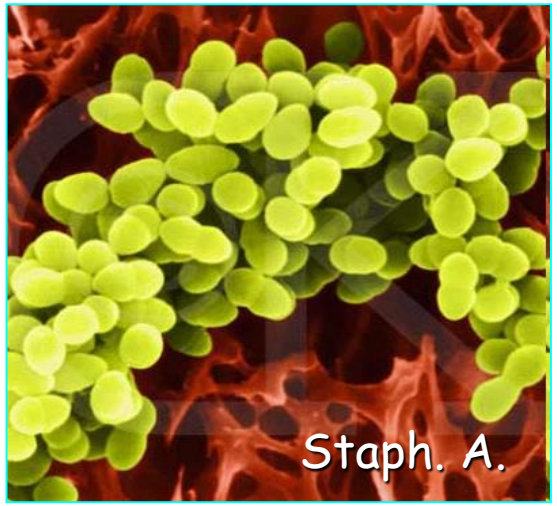
- Prospectively; 465 patients have been followed for 24-36 months after primary joint arthroplasty procedures (knees and hips) that have been done in orthopedic department of the Prince Hashem Hospital from the January 2014 to January 2015.
- During the follow up period; 11 patients have died and 42 have lost the follow up, so these patients had been excluded from our study. The remaining 412 patients (282 females, 130 males) have been examined many times in our clinic for possible infection, and have been investigated if the infection was suspected.
- We have found that; 6 patients have got per prosthetic infection (1.3%), 3 cases had Staph epidermis, 2 cases had Staph Aureus, and one case had E.coli. Three cases have had early superficial infections, one case has had early deep infection and 2 cases have had late infections. So the cases that had needed revision were 3 (0,6%).

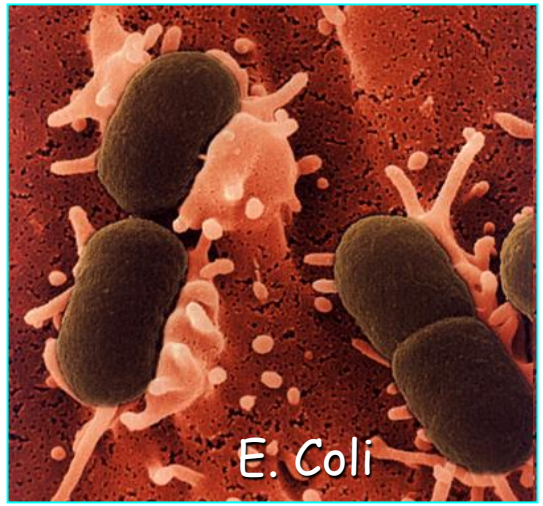
Etiology

Pre and intra-operative pathogen

ISOLATION







Etiology

Table 1. Organisms Involved in 22 Consecutive TKA Infections

Organism	N	Percent
Staph epidermidis (Coagulase −)	9	41.0
Staph aureus (Coagulase +)	4	18.5
Pseudomonas aeruginosa	1	4.5
E. coli	1	4.5
Enterobacter aggiomerans	1	4.5
Group G *Streptococcus*	1	4.5
morganella morgani	1	4.5
Pseudomonas aeruginosa, Staph epi	1	4.5
Proteus mirabillis, Staph epi	1	4.5
Shigella-sonnei, Staph epi	1	4.5
Candida albicans, Streptococcus	1	4.5
Total	22	100

The Journal of Arthroplasty Vol. 19 No. 4 Suppl. 1 2004

diagnosis

- A combination –clinical
  -radiological
  -pathological

clinical

- Pain
- Loss of ROM
- Swelling
- Local warmth
- Signs-sinus, effusion, wound erythema

investigations

- X rays-periosteal reaction,subchondral bone resorption.
- ESR and CRP.
- Aspiration.
- Bone scan.
- Culture.
- Intraoperative frozen Section.
- Synovial biopsy-last resort.
- PCR.

Labs

- CBC
  - Rarely positive
- ESR
  - Very sensitive but not specific
  - Usually > 35
  - Takes 1 year to return to normal after surgery.
- C-reactive Protein
  - Peaks 48 hrs post-op and declines to normal 2-3 weeks later
  - Used to monitor treatment
  - Can be elevated with CAD. Not sensitive.

Aspiration

- False positive in 0-15%
- False negative when organisms have poor vitality
- Should be selective and use with labs.
- Get cell count with it

Cell Count in aspiration

With the following parameters shown to be very good test.

- Cut-off value shown to be 1,100 to 3,000 WBC.
- Lower glucose than blood glucose.
- Differential with 60-80% Neutrophils.
- Higher value for recently operated on knee.

Intra-op Frozen Section

- Intra-op Gram stain
  - Poor sensitivity and poor predictive value
    - Morgan JBJS 2009.
    - Can get false positives from debris.

- Using 5 PMN's/HPF

  84% sensitive and 96% specific

  Lonner suggests 10 PMN's/PHPF

- Should always use when replanting after infection or when highly suspicious

Bone scan

- Positive with aseptic loosening and infection.

- Need tagged WBC scan to be more specific
  - May not be reliable (biofilm shields the bacteria)

Intra-operative Cultures

- Gold standard for our setup.
- Send 5 samples (2/5 for positive).
- 6-13% false positive.

Clinical-temporal classification

Immediate: before 4 weeks

Early: between 4 weeks to 2 years.

Delayed: over 2 years.

Occasional: positive culture in replacement.

Segawa et al. JBJS, 1999

Classification

Coventry's state

Stage Zero = Operating contamination (positivity of at least 2 of 3 buffers intra-op

Stage I = Acute infection post-operative (within 3 months after)

Stage II = delayed deep infection (3 to 24 months after)

Stage III = late hematogenous infection (a distance of years)

Coventry MB. Orthop Clin North Am. 1975 Oct;6(4):991-1003.

Classification

TABLE II Classification of Infection on the Basis of Clinical Presentation

I. Positive intraoperative culture

II. Early postoperative infection
   A. Superficial
   B. Deep

III. Acute hematogenous

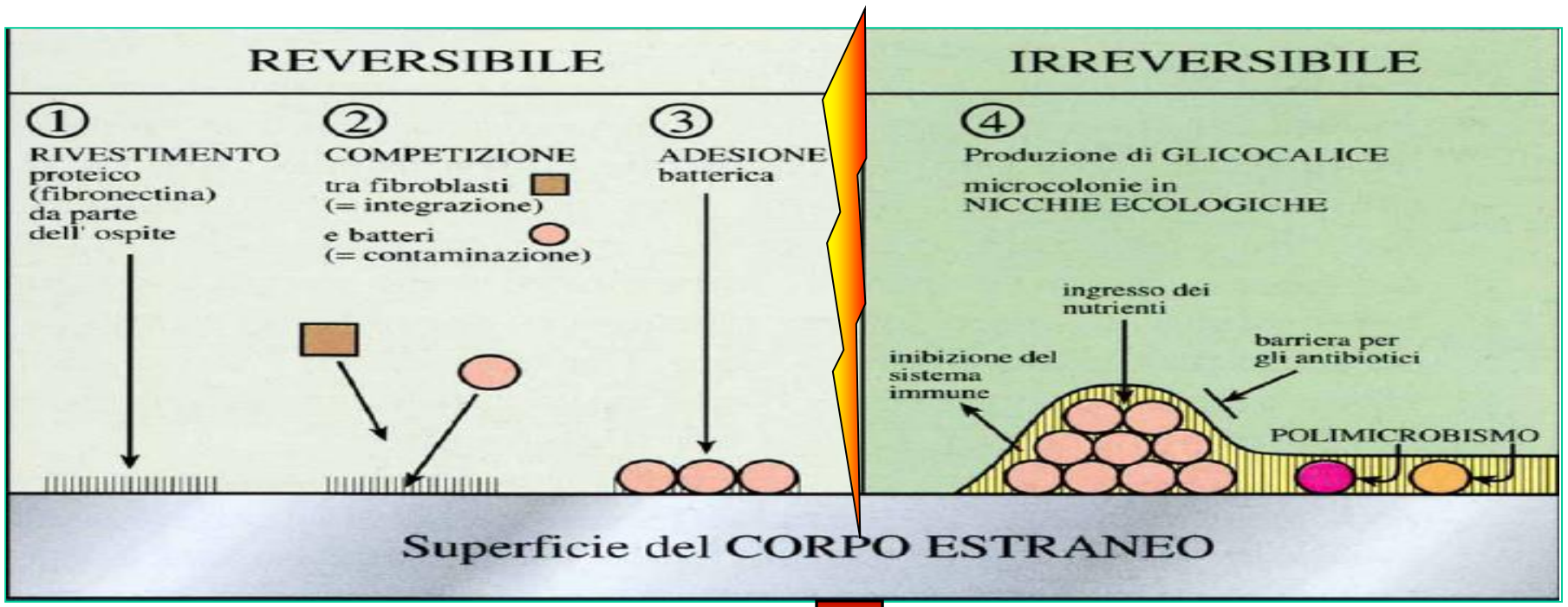
IV. Late chronic

J Bone Joint Surg Am. 85-A · SUPPLEMENT 1 · 2003

1: Orthop Clin North Am. 1984 Jul;15(3):517-35.

Bacterial adherence and the glycocalyx and their role in musculoskeletal infection.

Gristina AG, Costerton JW.

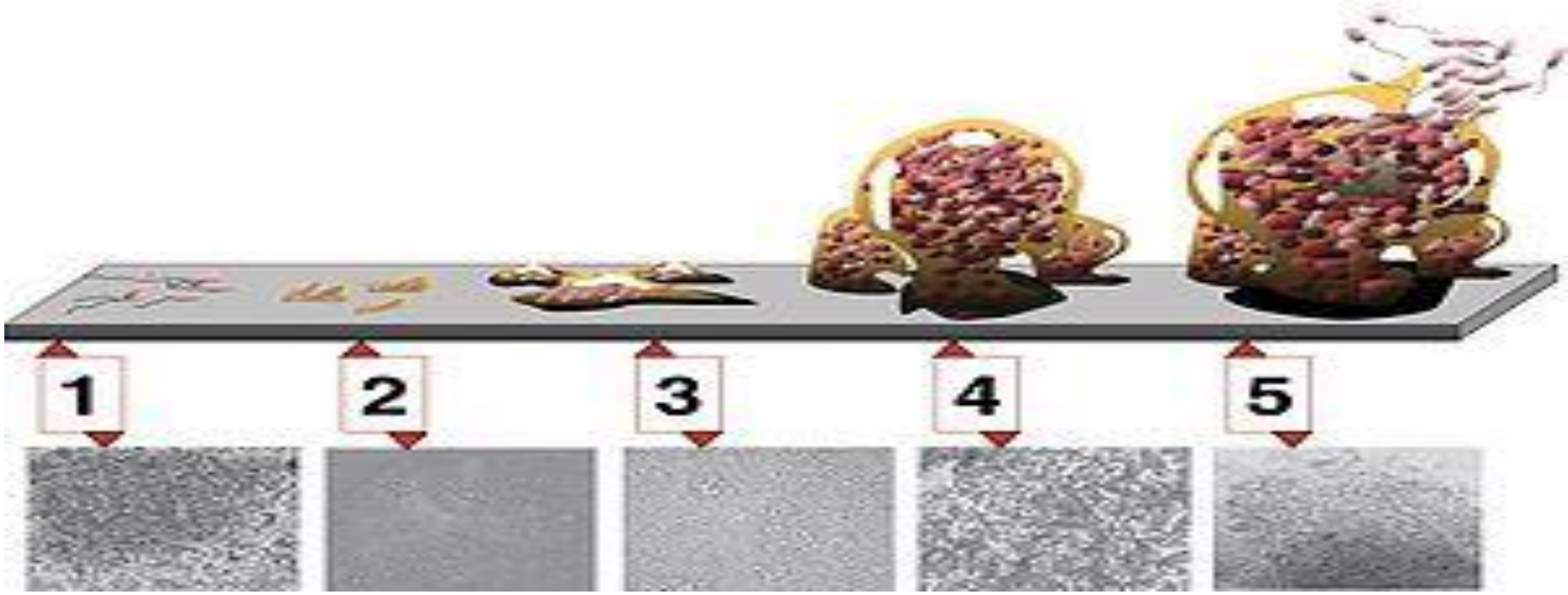


TIMING

BIOFILM

- There are five stages of biofilm development

1. *Initial attachment* (reversible)
2. *Irreversible attachment*-cell adhesion structures.
3. *Maturation I*.
4. *Maturation II*.
5. *Dispersion*.



Biofilm

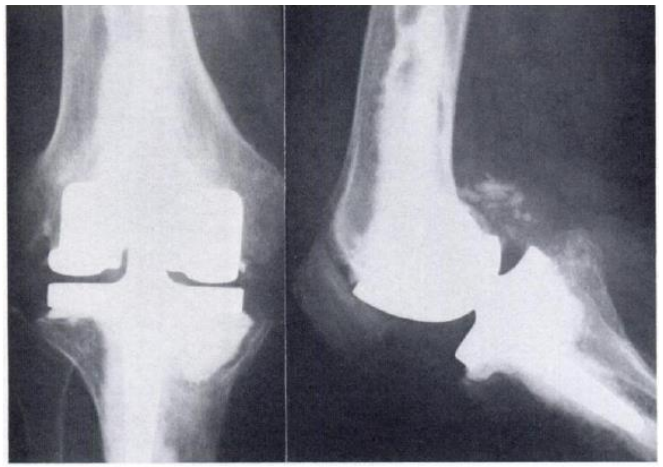
- Matrix offers a diffusion barrier (mechanical) ,and makes it harder for antibiotic, white blood cells, and Ig to penetrate,
- This can reduce sensitivity to antibiotics by a factor of $10^{(3)}$.
- Neutrophilic granulocytes penetrate the biofilm poorly and in the process lose their ability to phagocytose.
- Apoptosis occurs with excessive complement activation and release of radicals and proteases, resulting in a local immune deficiency.
- After non radical Tx has ended, return --->active mode, show resistance to the originally administered AB.
- Safest Tx= surgical removal of sequestrum bearing biofilm.

Treatment of prosthetic infection

- Long-term antibiotic suppression.
- Surgical debridement with retention of the prosthesis.
- Two-stage re-implantation procedures.
- One-stage re-implantation procedure.
- Resection arthroplasty
- Arthrodesis
- Amputation

Long-term antibiotic suppression.

- ❑ Indicated in:
  - med compromised patients that prosthesis removal is not feasible.
  - The prosthesis is not loose
  - Low virulence micro-organism



- ❑ Duration: life long

Algorithm Infections About TKR

- TKA
- Clinical Sepsis

< 3 wks

Debridement with Polyethylene exchange, Antibiotics (6 wks)

Success

No Success

2-Stage Replant

> 3 wks

2-Stage Replant

Success

No Success

Arthrodesis

Resection Arthroplasty

Two-stage Revision of Infected Total Knee Arthroplasty Using an Antibiotic-impregnated Static Cement-spacer

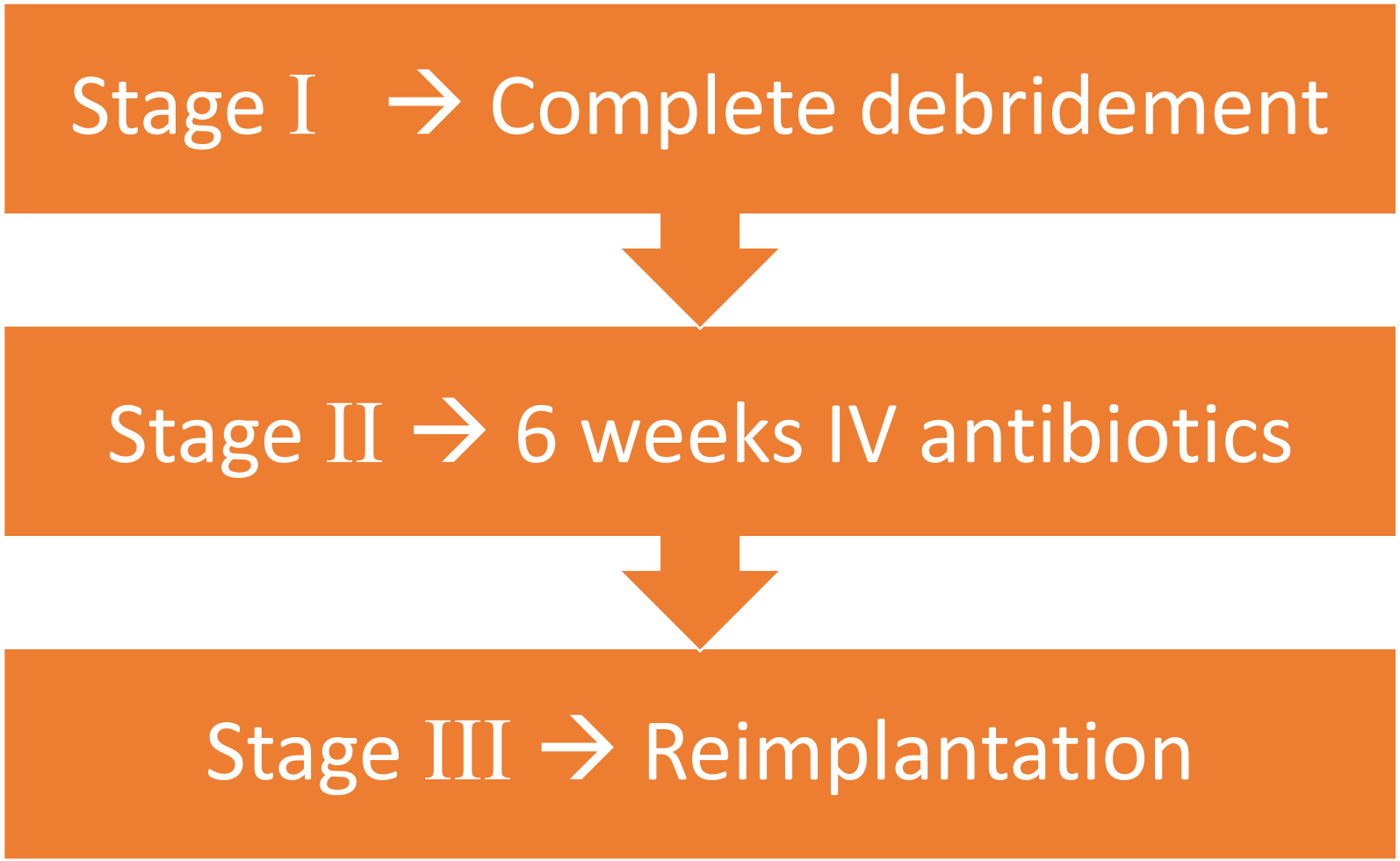
Chi-Shiung Hsu, MD; Chia-Chen Hsu[1], MD; Jun-Wen Wang, MD; Po-Chun Lin, MD

Two-stage reimplantation remains the most effective and common treatment for eradication of infection in a chronically infected TKA. The success rate of infection eradication after the two-stage procedure is between 85% and 95%.

Chang Gung Med J Vol. 31 No. 6
November-December 2008

Two-stage reimplantation of an infected total knee arthroplasty using a static antibiotic-cement spacer achieved an infection control rate of 86% and improvement in the clinical results.

Two-Stage Re-implantation

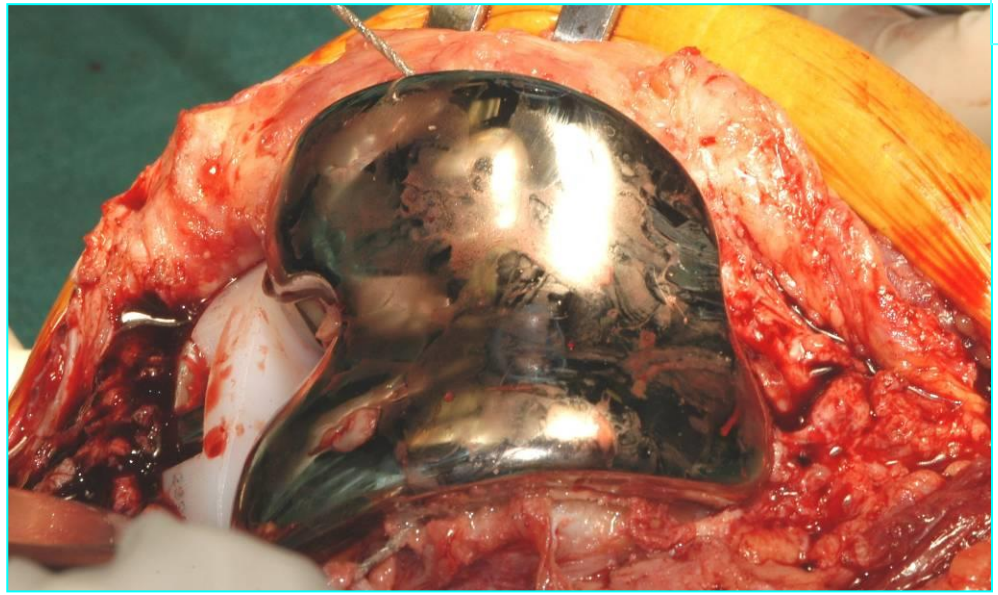


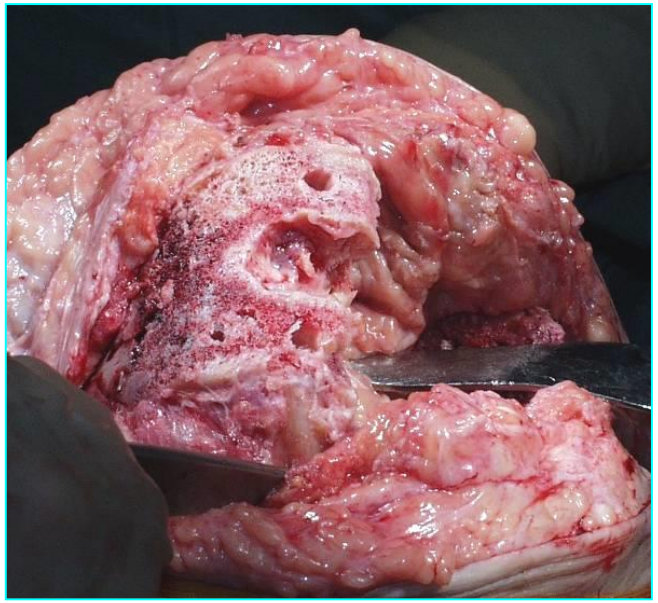
Two-Stage Reimplantation

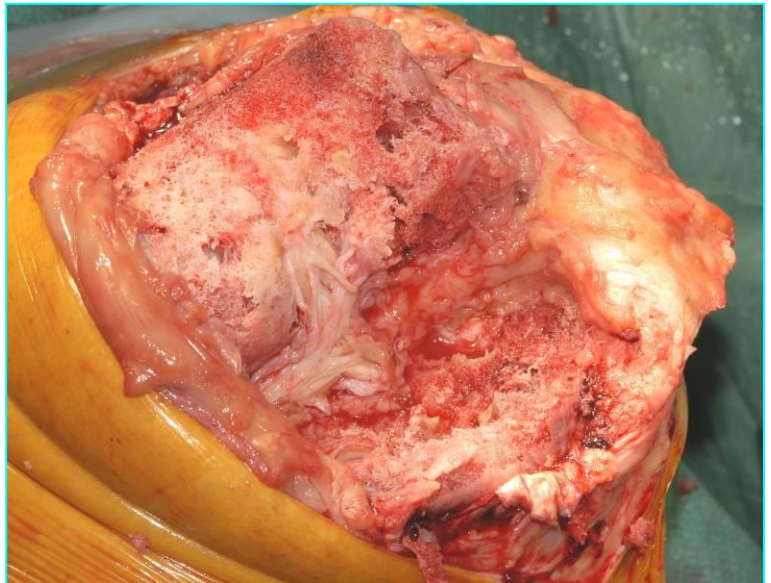
Stage I

- remove prosthesis / cement
- thorough debridement

1. Removal and debridement.







Two-Stage Reimplantation

Stage I

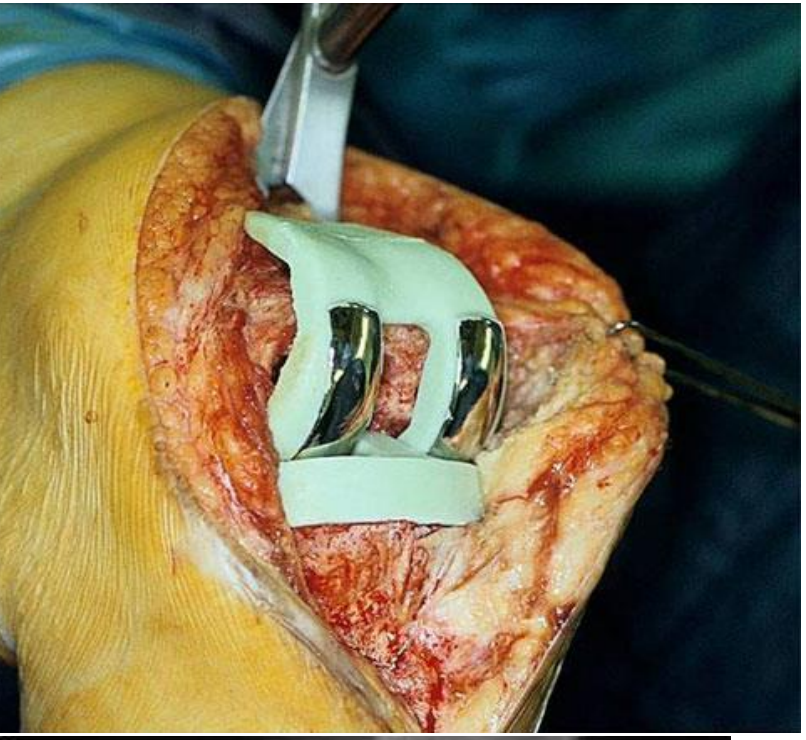
create antibiotic spacer impregnated with antibiotics.

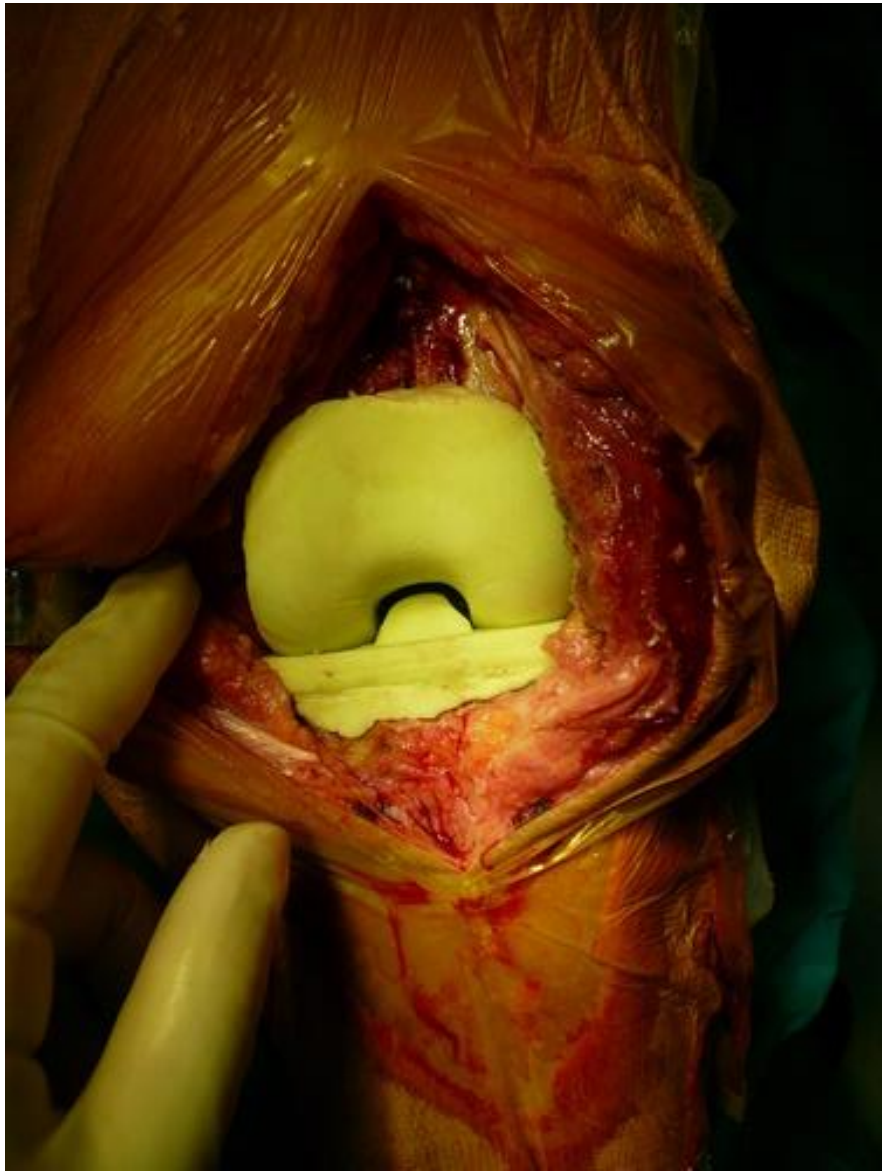
- Microbial Sensitivity.
- Bactericidal.
- Heat stable.
- Powder form.

Spacer to preserve tissue tension.

Facilitates space for re-implantation and wound exposure.

instertion of spacer





Stage II – Antibiotic Treatment

- I.V antibiotic.
- MIC 1:8 / 6 wks
- Patient should use knee brace.
- In mobile articulating spacers patient is allowed up to 50% PWB and is encouraged ROM.

3. Antimicrobial therapy

- Starts as soon as microbiological cultures are ready.
- Lasts for a mean 6-8 weeks.
- When there is no sign of infection and the markers drop, the patient is ready for the next stage.

Stage III – Reimplantation

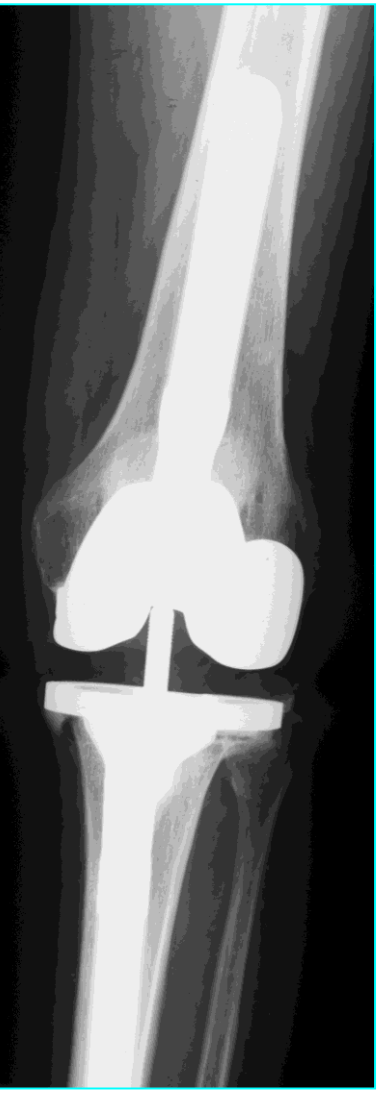
- Serial aspirations
- Bone scan / Sed rate
- Pre-op planning

- Intra-operative Frozen Section

  - < 5 PMN's per HPF – no infection
  - > 10 PMN's per HPF – infection




4. Reimplantation



Why not one-stage re-implantation strategy?
The contraindications and limitations

1. The presence of soft tissue compromise.
2. Unclear infective microorganism.
3. Highly resistant and virulent infective microorganism.
4. Patients with concurrent sepsis/ systemic infection.
5. Patients who can not with stand long surgery.
6. Failure of previous revision surgery attempts.
7. Infection involving the neurovascular bundles, that precluding radical debridement.
8. Intraoperatively, it has strict rules. Also it is preferable not to use allograft bone.

Our study about 2 stage strategy.

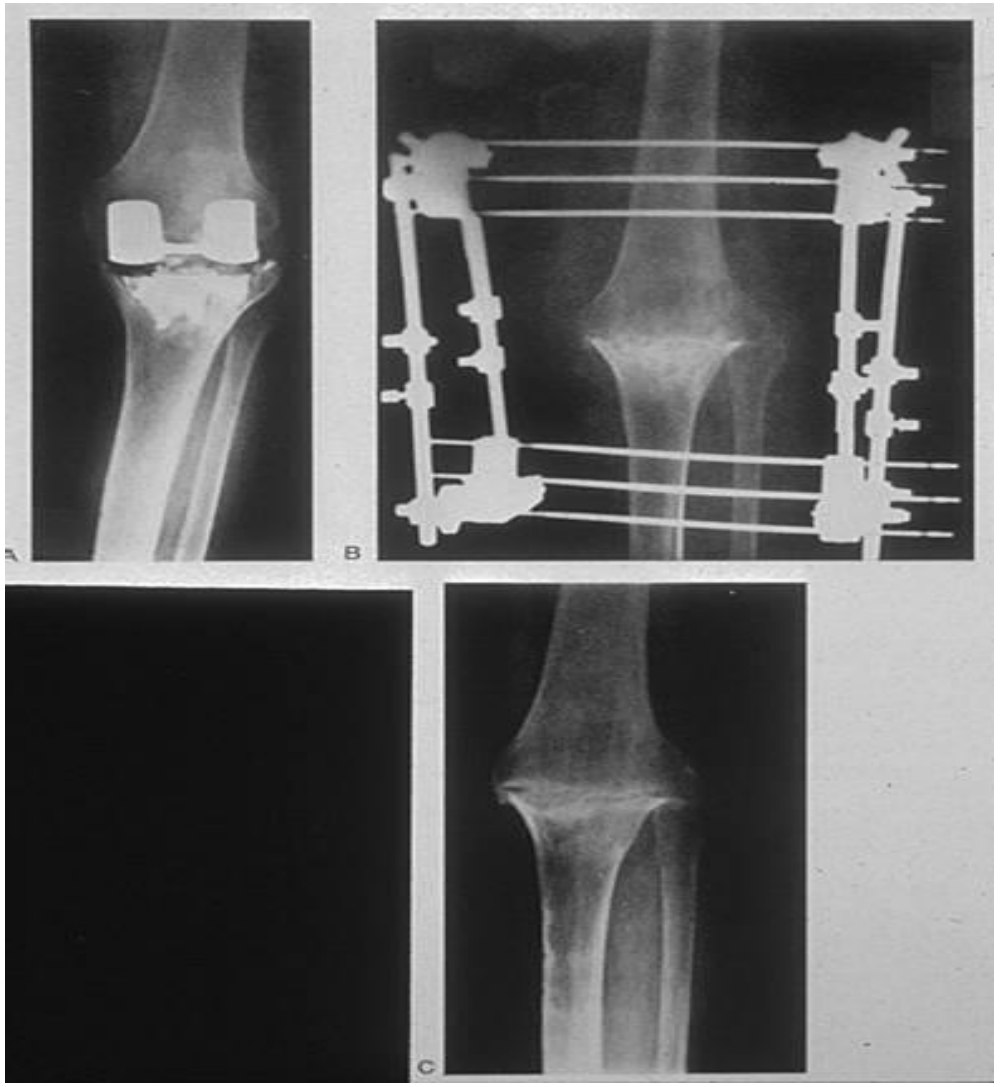
- Retrospectively; 28 patients with infected total knee arthroplasty have been treated in our orthopedic department in the period between 2010-2017.
- 26 females, and 2 males.
- All patients have been operated by 2 stages Revision Total Knee replacements.
- The minimum follow up period was 24 months (mean 40 months; 24-83 months).
- Recurrent or persistent infection was diagnosed in 4 patients.
- The infection was eradicated in 86% of cases.
- the average Knee Society Score was 73 points (range 24-100). And the average functional score was 49 points (range 20-90).

Resection Arthroplasty

- Removal all components
- Remove all cement
- Effective in medically compromised patient

Indications of Arthrodesis

- Extensor mechanism disruption
- Resistant bacteria
- Inadequate bone stock
- Inadequate soft tissues
- Young patient



Prevention

Three Major Sources of Infection

- Patient
- Surgical Team
- Hospital Environment

Etiology

- ½ infections introduced at the time of surgery or immediately post-op.
- 1/3 are hematogenous
- Remainder not sure.

Optimizing Patient

- Lose weight
  - obese patients have 6.7% higher risk of infection
  - Obesity with increased infection rate due to longer surgical time, greater surgical dissection, and high calorie poor nutrition diet.
- Control perioperative blood sugar in diabetics.
- Stop TNF Alpha Antagonists one dosing cycle prior to surgery.

Optimizing Patient

- Pre-operative staph screening
  - Molecular DNA studies have shown majority of infecting strains are part of resident's nasal flora.
  - PCR test for staph aureus and MRSA
  - Nasal Bactroban if nares positive for MSSA or MRSA
    - Rao in 2008 showed reduced infections from 2.6% to 1.5%
  - Vancomycin and isolation precautions for MRSA

Antibiotic Prophylaxis

- **The Most Important Factor in Lowering Infections**
  - Charnley lowered infection rate from 7% to 0.5%
- Want highest blood concentration of antibiotic at time of incision
- Should be completed within 20 to 60 minutes prior to incision
- Should be repeated if surgery lasts more than 2 hours or when patient loses more that 30% of blood volume (1.5L)
- Should be continued for 24 hours post-op
- No evidence of efficacy beyond 24 hours. Avoid Overuse of Antibiotics because it Can mask deep infection where antibiotics are not helpful and change classification from acute to chronic infection.

cephazoline

- Considered by many to be best.
- Bactericidal.
- Excellent and rapid tissue penetration (within minutes) and good bioavailability.
- Broad spectrum (active against all skin flora including gram negatives)
- Disadvantage: does not cover MRSA or MRSE
- Patients weighing greater than 80 kg should get 2 gram.

Antibiotic Impregnated Cement

- Advantages:
  - Lower incidence of infection
    - Norwegian Arthroplasty Registry (10,611 THR's) and Swedish Joint Registry (92,675 THR's)

- Disadvantages
  - Higher incidence resistant organisms (Swedish Registry, Kendall JArthrop '96)
  - Structural support (can use up to 2g per 40g bag of cement)
  - Cost

Operating Room

- All studies have shown that number of bacteria cultured at surgical site and on surgical table directly proportional to number of people in operating room.

- Number of times door opens directly proportional to number of bacteria present

Laminar Flow and Ventilated Suits

Swedish registry > 150,000 TJR's

- No decrease risk for infection with ventilated suits or laminar flow as long as prophylactic antibiotics used

- New Zealand Registry showed higher incidence of infection with both laminar flow and space suits

Persistent Wound Drainage

- Established Knee Infections
  - 17-50% have persistent wound drainage beyond 3-4 days.

- Krakow ’93 J Arthroplasty
  - 8/597 (1.3%) – Persistent Drainage
  - All taken back to OR
  - Average 12.5 days post-op
  - Two (25%) had positive deep cultures
  - None developed clinical infection
  - Conclusions:
    - Persistent drainage = impending infection
    - Aggressive operative treatment recommended

Conclusions

- Prevention.
- Adequate surgical debridement
- Staged revision.
- Adequate &Susceptibility antibiotic