CENTER OF ORTHOPAEDICS AND TRAUMATOLOGY
UNIVERSITY HOSPITAL BRANDENBURG / HAVEL

EKA
EUROPEAN KNEE ASSOCIATES
A SECTION OF ESSKA

MHB
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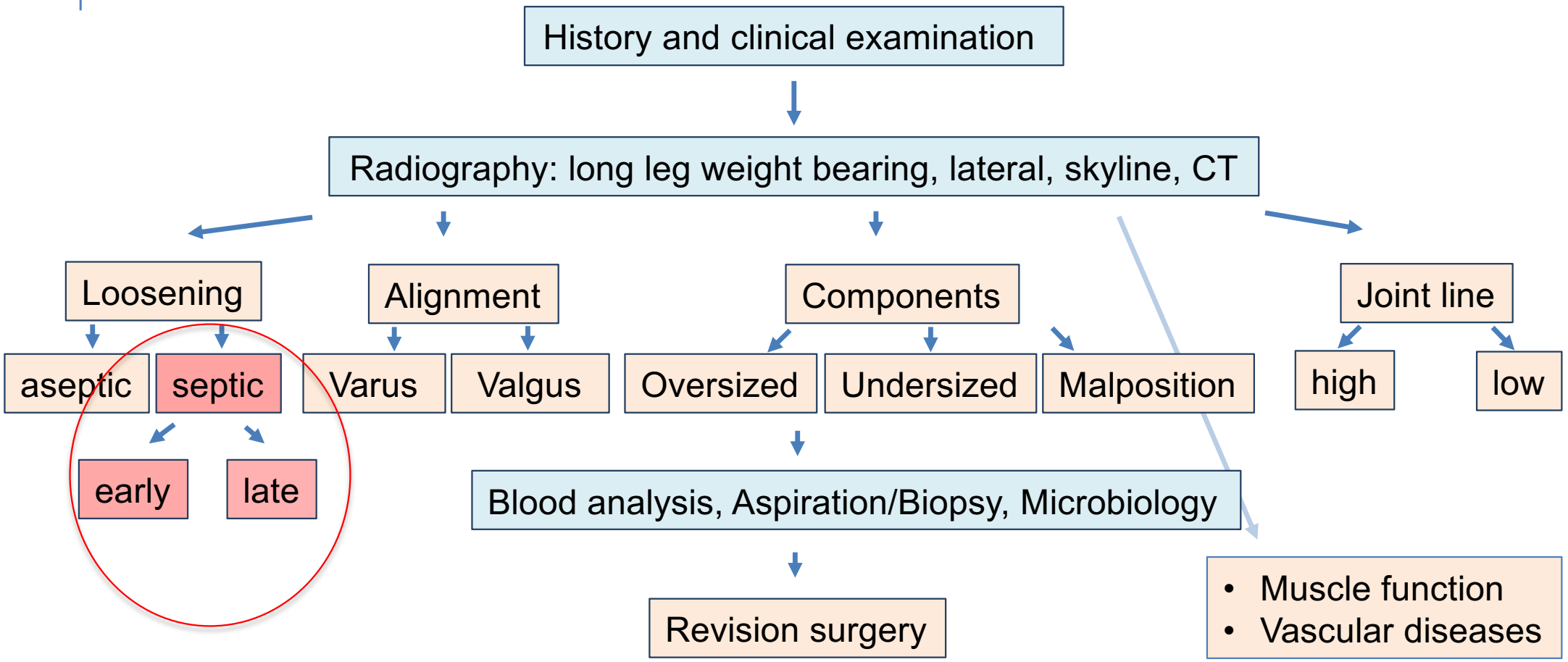
MEDICAL SCHOOL

Periprosthetic Joint Infection

Diagnosis, Biology, Imaging

ROLAND BECKER

PAINFUL TKA


History and clinical examination
Radiography: long leg weight bearing, lateral, skyline, CT
Loosening
Alignment
Components
Joint line
aseptic
septic
Varus
Valgus
Oversized
Undersized
Malposition
high
low
early
late
Blood analysis, Aspiration/Biopsy, Microbiology
Revision surgery
• Muscle function
• Vascular diseases

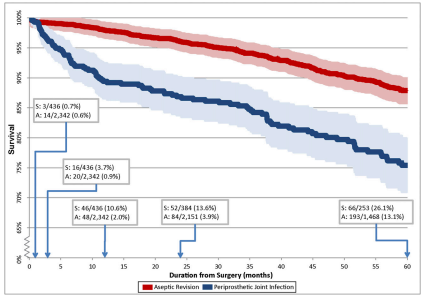
INCIDENCE = 0.6% (KNEE 1.1%)

- 65% of PJI within first year

  early=31%
  chronic late = 56%
  acute hematogenous = 13%

- Most common organism **Staph. aureus and epidermidis**
- Increase risk of infection in patients with BMI>40kg/m^2

Significant increase in mortality rate



Pulido et al. CORR 2008, Zmistowski COOR 2013,

PREDISPOSING FACTORS

Anemia (F<12g/l, M<13g/l)	
Cardiac disease	OR=4.46
Diabetes (HbA1c ≤ 8)	OR=1.61
Hyperglycaemia	
Chronic renal disease	OR=1.91
Malnutrition	
BMI > 40kg/m^2	
ASA score > 2	OR=2.06

Pulido et al. CORR 2008, Zmistowski COOR 2013,

PERIPROSTHETIC JOINT INFECTION

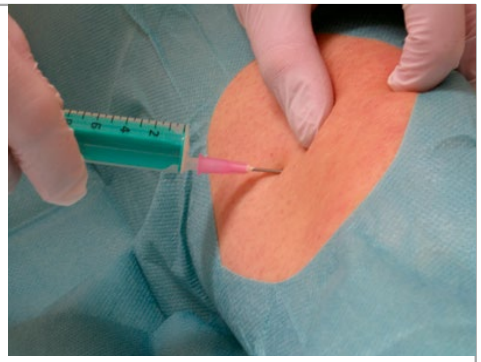
Early infection
- direct contamination
- Mature biofilm after 3 weeks
- Important for management
- DAIR

Delayed infection **Late infection**

Exchange of the TKA

Zimmerli NEJM 2004

DEFINITION PJI



1. Sinus tract communication with the prosthesis
2. Pathogen isolated by culture from 2 tissue of fluid samples
3. Four of the following criteria exist:
    a: Elevation of erythrocyte sedimentation rate (ESR) and CRP
    b: Elevation of synovial leukocyte count (>2000µL)
    c: Elevation of neutrophil percentage (>80%)
    d: Purulence in the affected joint
    e: Isolation of a microorganism in one culture of periprothetic tissue or fluid
    d: Greater than five neutrophils per high-power field in five high-power fields observed from histological analysis of periposthetic tissue x400 magnification

Parvizi CORR 2011

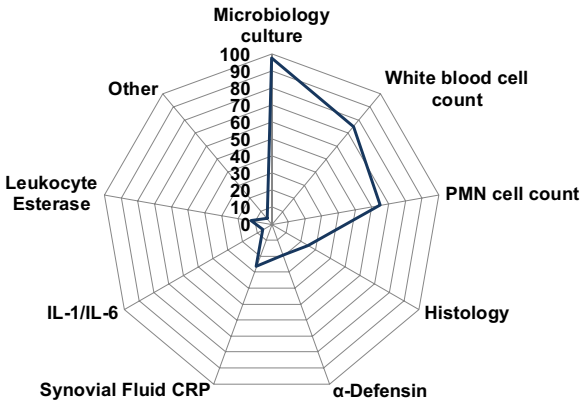
ORGANISM

Bacteria	Frequency
Staphylococcus	50 – 60 %
Gram-negativ, aerobe Stäbchen	20 %
Streptococcus	10 - 15 %
Mixed bacterial infection	10 - 15 %
Anaerobier	7 - 10 %
other	2 %

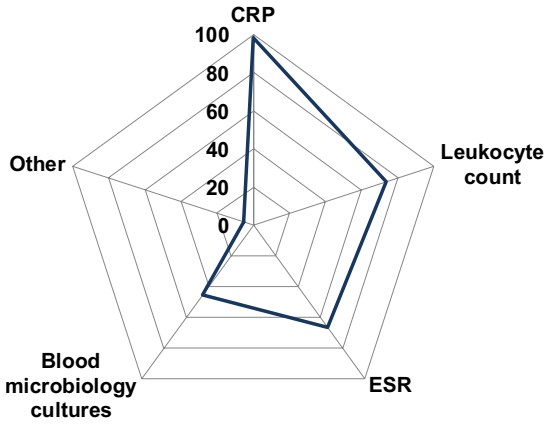
EKA– SURVEY 2016

262 responder = 31575 TKA

Most common synovial fluid test



Most common tested serum parameters



Ahmad S et al. KSSTA 2016

JOINT ASPIRATION

Joint aspiration

→ Gram staining

→ Culture for 10-14 days

JOINT ASPIRATION

Comparison of infected versus non infected knees

	Infected knees	Non infected knees
Aspiration days after surgery	20.8±7.6	15.9±10.5
ESR (mm/hr)	80±29	75±30
CrP (mg/dL)	171±127	88±75
Synovial fliud (WBC count (cells/µL)	92600±127000	4200±5700
Polymorphniclear cells (%PMN)	89.6± 20.6	76.9±21.2

Bedair CORR 2011

JOINT ASPIRATION

Comparison of infected versus non infected knees

	Sensitivity	Specificity
CRP – Threshold ≥ 166 mg/dL	16% (9-23%)	94% (90-99%)
Threshold ≥ 95 mg/dL	68% (60-70%)	66% (57-74%)
Synovial fluid (WBC) ≥ 10700 cells/µL	95% (91-98%)	91% (87-96%)
Synovial fluid (WBC) ≥ 27800 cell/µL	84% (78-90%)	99% (98-100%)
Polymorphnuclear cells (%PMN) Threshold ≥ 89%	84% (78-90%)	69% (62-77%)

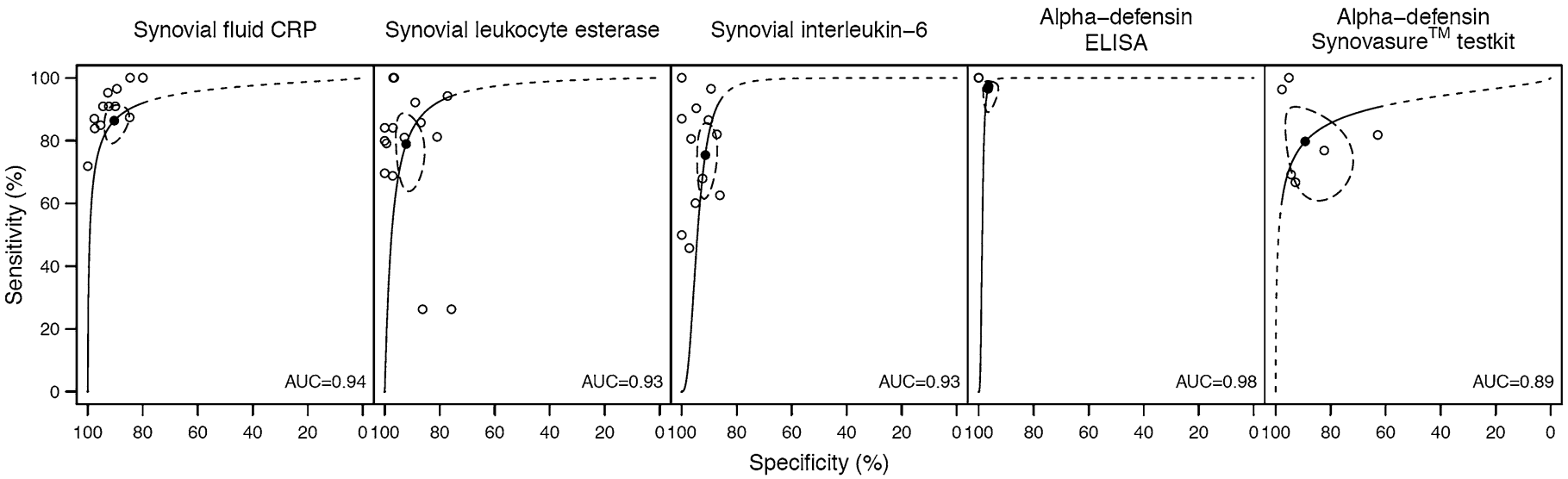
Bedair CORR 2011

SYNOVIAL BIOMARKERS

- C-reactive protein (sCRP)
- Interleukin-6 (sIL-6)
- Leukocyte esterase (sLE)
- Alpha defensin

  ELISA alpha defensin test
  Synovasure ^{TM} alpha-defensin test kit

SYNOVIAL BIOMARKERS

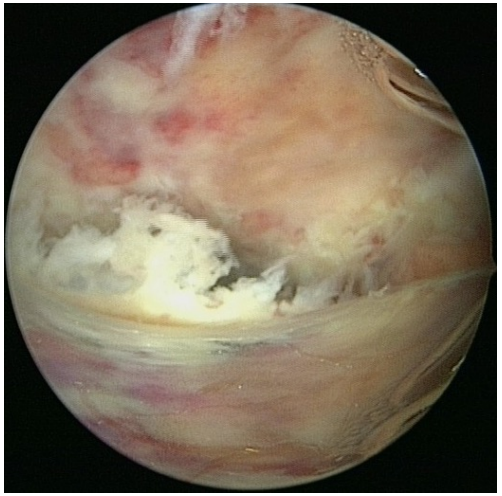


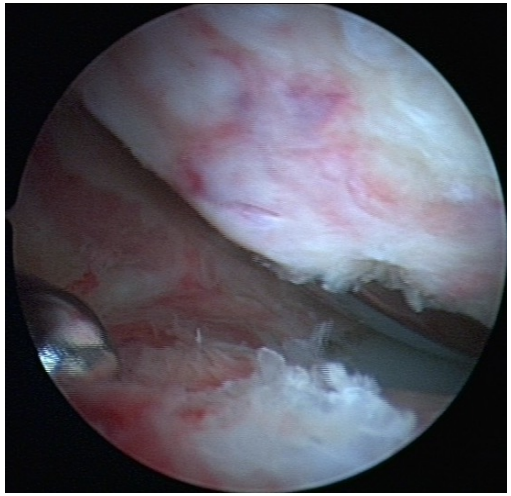
S Ahmad KSSTA 2018

BIOPSY

A) Puncture of the joint using a punch → low sensitivity (50-60%)

B) Arthroscopy: 5 samples for microbiology → sensitivity > 80%





DIAGNOSTIC TESTS

Blood test

- White blood cell count (WBC)
- Erythrocyte sedimentation rate (ESR)
- Interleukin 6
- C-reactive proteine

Nuclear diagnosis

- Positron emission tomography (PET-scans)
- Anti-granulocyte antibodies (AGS)
- Triple phase bone scan (TPB)

Synovial test

- White blood cell count (EBC)
- White blood cell differentiation

Histopathology

- General tissue
- Polymorphonuclear leukocytes

Bacteriology

PCR

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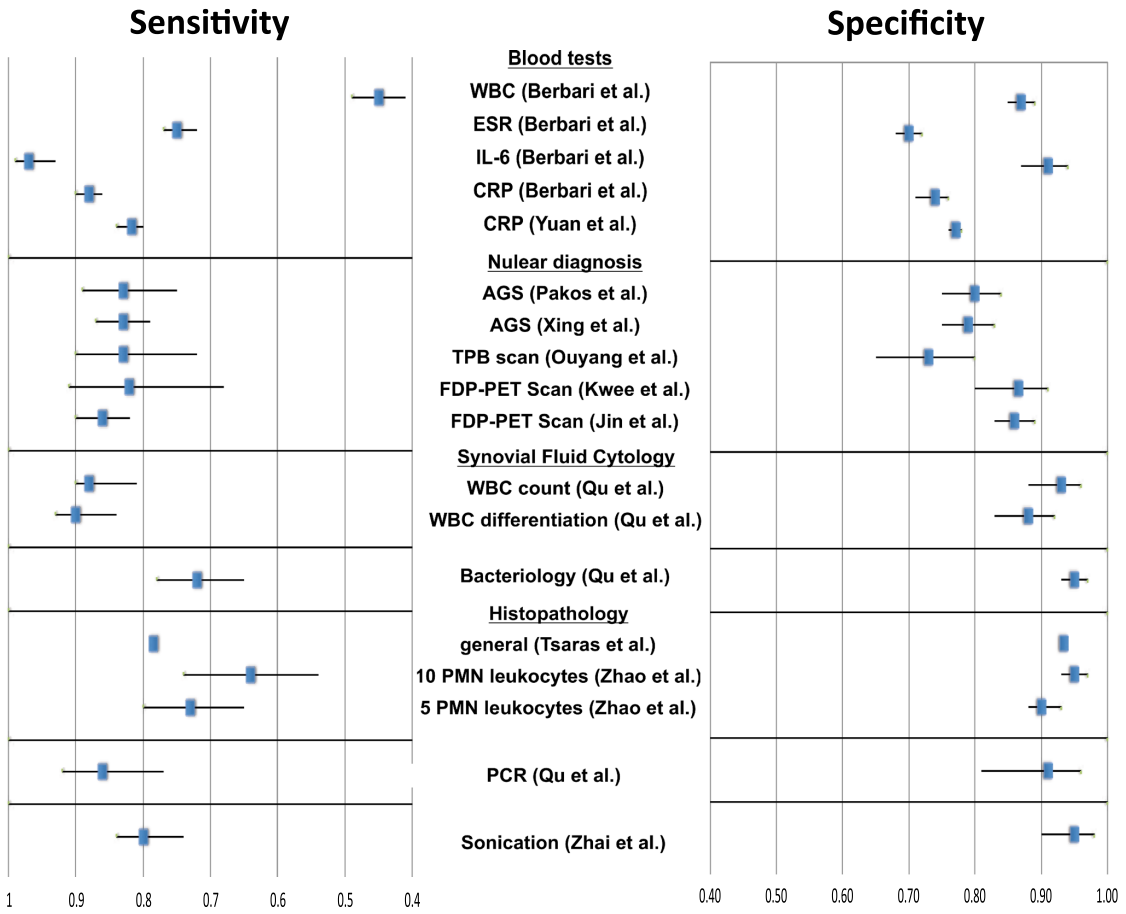
DIAGNOSTIC TESTS



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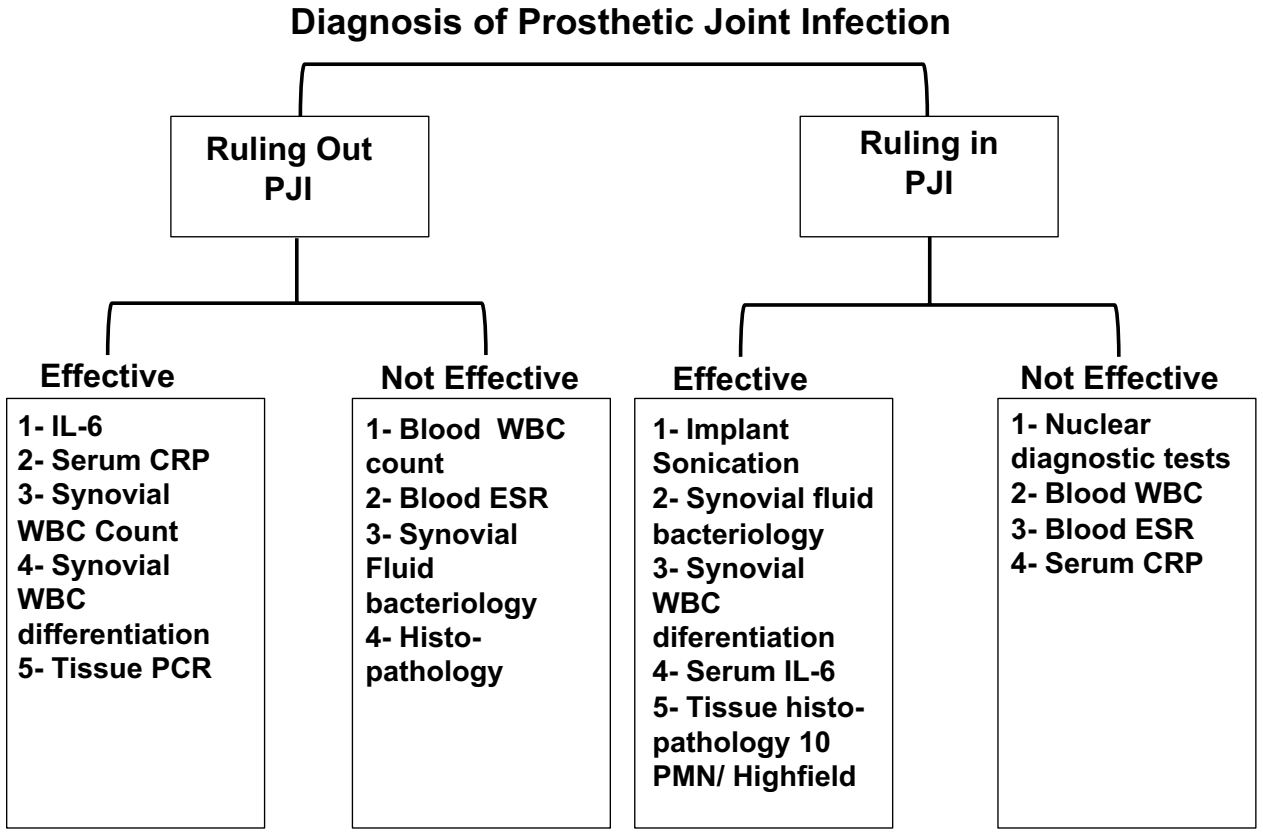
DIAGNOSTIC TESTS



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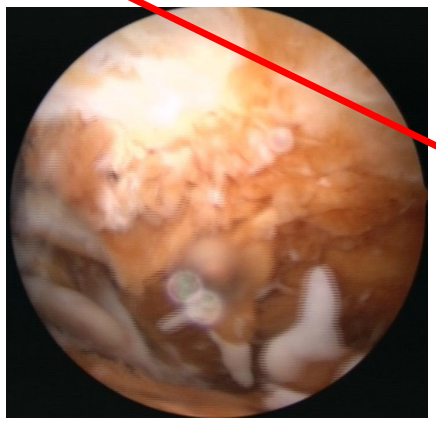
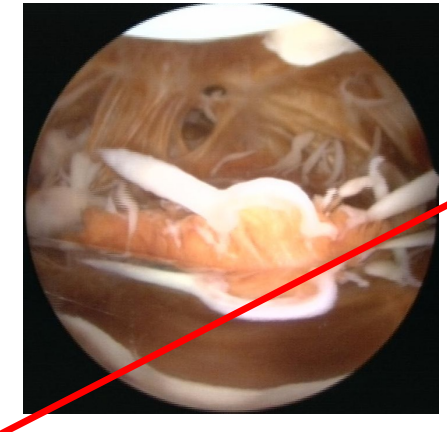
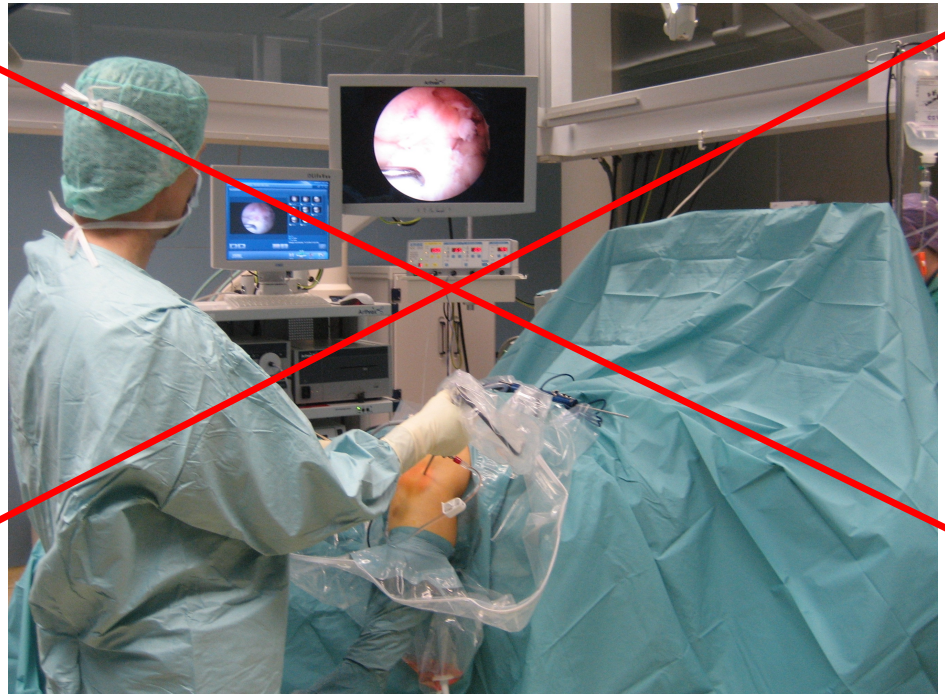
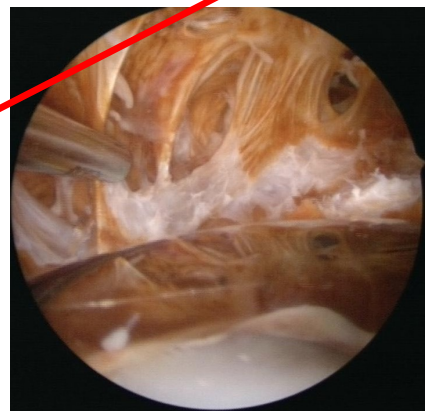
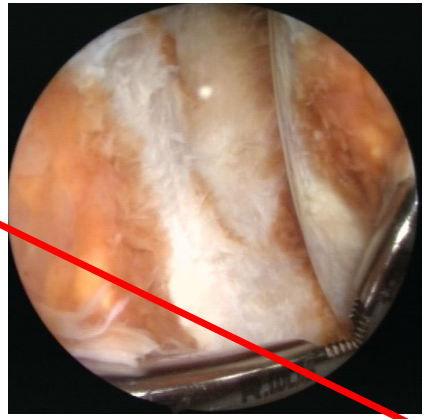
ARTHROSCOPY











DAIR – Debdridement, antibiotics, implant retention

Timing: < 4 weeks after surgery

- Success rate 65% (range 31-90%)
- Superficial infection more likely to be treated successfully
- High risk of failure in hematogenous infections when WCC >$10x10^9$/L
- Treatment as early as possible
- Failure rate higher (up to 34%) when patients were treated initially with DAIR

Becker, Operative Techniques in Orthop. 1, 2016, Jämsen JBJS-Am 2009

DAIR – Debdridement, antibiotics, implant retention

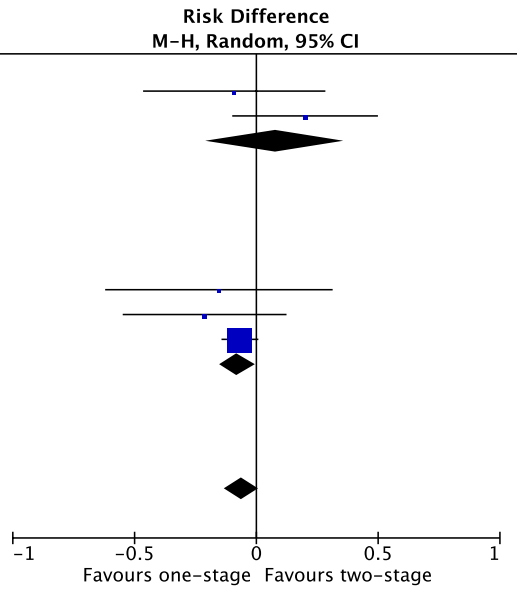
Surgical technique

1. Patients consent for exchange of the TKA
2. No torniquet
3. Use the same skin incision and approach
4. Removal of all suture material
5. Take **5 biopsies**
6. Complete synovectomy, but preserve the joint capsule
7. Use pulse lavage
8. Change gloves and instruments
9. Use intraarticular drainage routinely

EXCHANGE OF IMPLANTS

Single stage ⟷ Two stage

Study or Subgroup	One-stage Events	Total	Two-stage Events	Total	Weight	Risk Difference M-H, Random, 95% CI	Year
1.1.1 Prior to year 2000							
Borden 1987	0	3	1	11	3.5%	−0.09 [−0.47, 0.28]	1987
Scott 1993	2	10	0	7	5.4%	0.20 [−0.10, 0.50]	1993
Subtotal (95% CI)		**13**		**18**	**8.9%**	**0.08 [−0.20, 0.36]**	
Total events	2		1				
Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 1.42$, df = 1 (P = 0.23); $I^2 = 30\%$							
Test for overall effect: Z = 0.54 (P = 0.59)							
1.1.2 Year 2000 and after							
Laffer 2006	0	2	2	13	2.2%	−0.15 [−0.62, 0.31]	2006
Mortazavi 2010	0	3	17	80	4.3%	−0.21 [−0.55, 0.12]	2010
Haddad 2014	0	28	5	74	84.6%	−0.07 [−0.14, 0.01]	2014
Subtotal (95% CI)		**33**		**167**	**91.1%**	**−0.08 [−0.15, −0.00]**	
Total events	0		24				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.93$, df = 2 (P = 0.63); $I^2 = 0\%$							
Test for overall effect: Z = 2.06 (P = 0.04)							
Total (95% CI)		**46**		**185**	**100.0%**	**−0.06 [−0.13, 0.01]**	
Total events	2		25				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 3.98$, df = 4 (P = 0.41); $I^2 = 0\%$							
Test for overall effect: Z = 1.75 (P = 0.08)							
Test for subgroup differences: $Chi^2 = 1.07$, df = 1 (P = 0.30), $I^2 = 6.4\%$							



Nagra NS, KSSTA 2015

SUMMARY

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More than 1 criterium = PJI

1. Sinus tract or purulence around the implant
2. Synovial leukocyte count: > 2000/µl Leukocytes or
   > 70% granulocytes (PMN)
3. Periprostheticc tissue shows inflammation
4. Microbiology: Microb. Growth in synovial fluid
   ≥ 2 tissue samples
   Sonication fluid (>CFU/ml)

SUMMARY

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	Acute PJI (< 3-4 weeks)	Chronic PJI
Clinical signs	Acute pain Fever Redness, swelling Proolonges wound oosing	Chronic pain Sinus tract loosening
Microorganism	High-virulent: Staphylococcus aureus Gram-negative bacteria (E.coli, Klebsiella, Enterobacter, Pseudimonas aeruginosa	Low-virulent: Coagulase-negative staph. (Staph. Epidermidis, Cutibacterium (Propionibacterium))
Surgery	Debridement, exchange of mobile parts	Exchange of the protheses

A Trampuz, Pro-Implant Foundation

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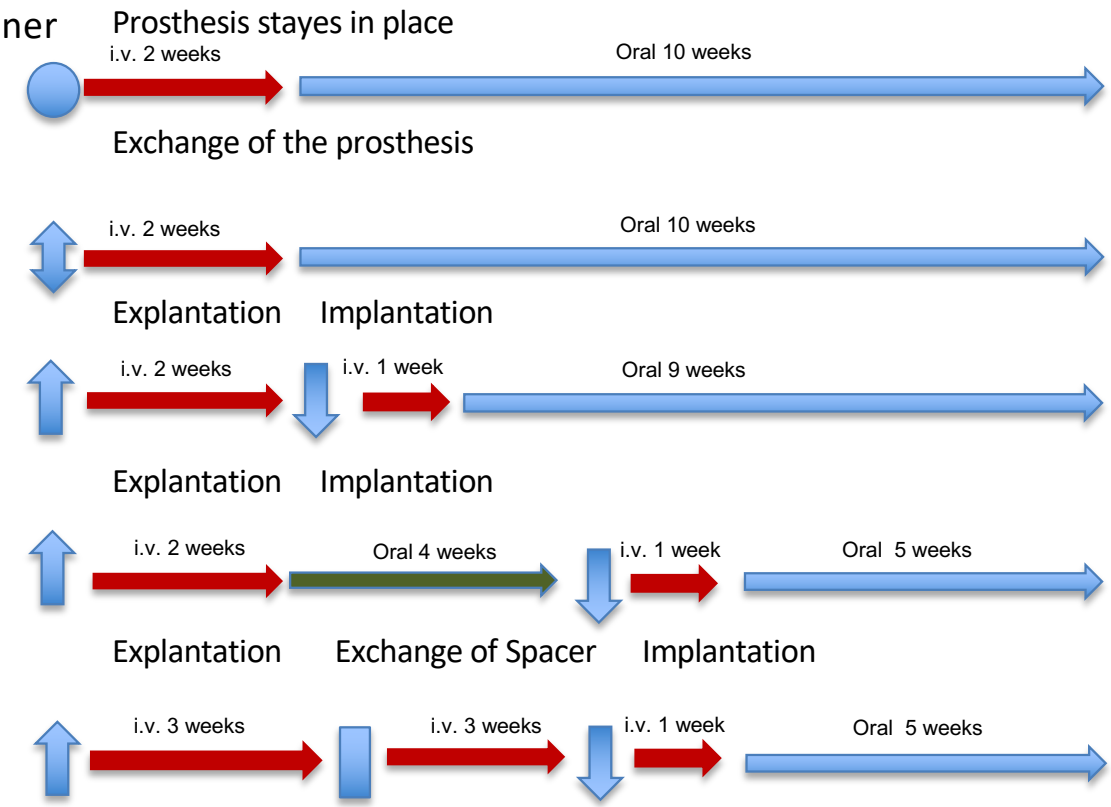
Pocket Guide to Diagnosis & Treatment of Periprosthetic Joint Infection (PJI)

PRO-IMPLANT FOUNDATION

Version 9:
October 2019

Contact our Consultation Portal for individual recommendations or Register for PRO-IMPLANT Workshops: www.pro-implant.org

SURGICAL MANAGEMENT (A. Trampuz 2017)



ANTIBIOTIC THERAPY

Micro-organism	Antibiotics*	Dosage	Route
Staphylococcus spp.	Initial therapy (2 wk)		
Methicillin-sensible	Rifampin plus	450 mg (2x/d)†	PO
	Flucloxacillin‡	2 g (4x/d)	IV
Methicillin-resistant	Rifampin plus	450 mg (2x/d)†	PO
	Vancomycin *or*	15 mg/kg (2x/d)§	IV
	Daptomycin	8-10 mg/kg (1x/d)‖	IV
Staphylococcus spp.	Followed by		
	Rifampin plus	450 mg (2x/d)†	PO
	Levofloxacin *or*	750 mg (1x/d) or 500 mg (2x/d)	PO
	Ciprofloxacin *or*	750 mg (2x/d)	PO
	Teicoplanin *or*	400 mg (1x/d)¶	IV
	Fusidic acid *or*	500 mg (3x/d)	PO
	Trimethoprim or sulfamethoxazol *or*	1 Tablet forte (3x/d)	PO
	Minocyclin‖ *or*	100 mg (2x/d)	PO
	Linezolid *or*	600 mg (2x/d)	PO
	Clindamycin#	1200-1350 mg/d in 3-4 doses	PO
Streptococcus spp.**	4 wk		
	Penicillin G‡ *or*	20-24 Mio U/d (4-6 doses)	IV
	Ceftriaxone	2 g (1x/d)	IV
	Followed by		
	Amoxicillin *or*	1000 mg (3x/d)	PO
	Clindamycin#	1200-1350 mg/d in 3-4 doses	PO
Enterococcus spp.††			
Penicillin-sensible	Penicillin G‡‡ *or*	20-24 Mio E/d in 4-6 doses	IV
	Ampicillin *or* Amoxicillin‡‡	2 g (4-6x/d)	IV
Penicillin-resistant	Vancomycin *or*	15 mg/kg/d§	IV
	Daptomycin *or*	8-10 mg/kg/d‖	IV
	Linezolid	600 mg (2x/d)	IV or PO
Enterobacteriaceae	Beta-lactam for 2 wk§§		IV
	followed by Ciprofloxacin	750 mg (2x/d)	PO
Enterobacter spp.‖‖ and Nonfermenter¶¶ (eg, *Pseudomonas aeruginosa*)	Cefepim *or*	2 g (3x/d)	IV
	Ceftazidim *or*	2 g (3x/d)	IV
	Meropenem	1 g (3x/d)##	IV
	for 2-4 wk, followed by Ciprofloxacin	750 mg (2x/d)	PO
Propionibacterium spp.	Penicillin G *or*#	20-24 Mio E/d in 4-6 doses	IV
	Clindamycin for 2-4 wk, followed by	1800-2400 mg/d in 3-4 doses	IV
	Amoxicillin *or*	750 or 1000 mg	PO
	Clindamycin#	1200 or 1350 mg/d in 3-4 doses	PO
Gram-negative anaerobes (eg, *Bacteroides* spp.)	Metronidazole	500 mg (3x/d)	IV or PO
Mixed infections without MRSA	Ampicillin or Sulbactam *or*	3 g (4x/d)	IV
	Amoxicilin or Clavulanic acid *or*	2.2 g (3x/d)	IV
	Piperacillin or Tazobactam *or*	4.5 g (3x/d)	IV
	Imipenem *or*	500 mg (4x/d)	IV
	Meropenem	1 g (3x/d)##	IV

Becker et al Operative Techniques in Orthop. 2016

Thank You


Owing to improved understanding of biomechanics and tribology and advances in implant design and treatment technique, total knee arthroplasty (TKA) is considered a very successful treatment for osteoarthritic knees. Nevertheless, a significant minority of patients are unhappy with the outcome, complaining of pain, instability, swelling, or reduced range of motion. This book addresses the need for improved diagnostic and treatment guidelines for this challenging group of patients.
The book opens by discussing the basics of TKA and the various causes of failure and pain. Diagnostic aspects are considered in detail, with attention to advances in clinical investigation, laboratory analysis, and, in particular, imaging techniques. Furthermore, state of the art diagnostic algorithms are presented that will assist in identifying the source of the problem in individual cases. Specific pathology-related treatment options, including conservative approaches and salvage and revision TKA strategies, are then explained, with identification of the pitfalls and key points of each treatment. Future perspectives are briefly considered, and a series of cases are presented that cover clinical scenarios frequently encountered in daily clinical practice.
The evidence-based, clinically focused guidance provided in this book, written by internationally renowned experts, will assist surgeons in ensuring that patients with an unsatisfactory result of TKA receive the most effective management.The book will also be helpful for general practitioners, physiotherapists, industry technicians, and engineers.
Orthopedics, Surgical Orthopedics & Sports Medicine
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A Comprehensive Review and Management Guide
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