



**8<sup>th</sup> Advanced Course  
on Knee Surgery**



**Periprosthetic infection**

***Surgical management for acute case***

*Francesco Benazzo*

# PROSTHETIC JOINT INFECTIONS

## Treatment

General Orthopaedics

EOR | VOLUME 6 | SEPTEMBER 2021  
DOI: 10.1302/2058-5241.6.210008  
www.efortopenreviews.org



EFORT open reviews

### Management strategies for prosthetic joint infection: long-term infection control rates, overall survival rates, functional and quality of life outcomes

Theofilos Karachalios<sup>1,2</sup>  
George A. Komnos<sup>1</sup>

- DAIR (debridement, antibiotics, and implant retention), one-stage and two-stage revision surgery are the most common management strategies for prosthetic joint infection (PJI) management. Our knowledge concerning their efficacy is based on short to medium-term low-quality studies.
- Most studies report infection recurrence rates or infection-free time intervals. However, long-term survival rates of the infection-free joints, functional and quality of life outcome data are of paramount importance.
- DAIR, one-stage and two-stage revision strategies are not unique surgical techniques, presenting several variables. Infection control rates for the above strategies vary from 75% to 90%, but comparisons are difficult because different indications and patient selection criteria are used in each strategy.
- Recent outcome data show that DAIR and one-stage revision in selected patients (based on host, bacteriological, soft tissue and type of infection criteria) may present improved functional and quality of life outcomes and

and 4% after revision.<sup>1,2</sup> It is also the most common reason for early revision (Fig. 1).<sup>3</sup> PJI has a severe impact on morbidity and mortality rates, and quality of life is severely affected in these patients. Diagnosis of PJI is sometimes difficult and any delays can lead to multiple surgeries, lower survival rates and impairment of function and quality of life.<sup>5</sup> Optimal treatment of PJI remains controversial. The most widely used management strategies are one-stage and two-stage revisions.<sup>6</sup> DAIR (debridement, antibiotics, and implant retention) is also indicated for early or acute infections. Other strategies, with specific indications, which are less popular and produce poorer results, include antibiotic suppression, arthrodesis, and even amputation.<sup>6</sup> The cost of management of PJI patients is quite high when compared to primary arthroplasties.<sup>7,8</sup> As a result, economic health providers and health administrators have recently focused on the PJI problem, asking for detailed comparative clinical outcome data and the introduction of

Optimal treatment of PJI remains controversial

DAIR (debridement, antibiotics, implant retention) Is ...indicated for early or acute infection

# PROSTHETIC JOINT INFECTIONS

## Treatment options



(DAIR - Debridement And Implant Retention)

Acute

One-stage revision

Two-stage revision

Chronic

# ACUTE PROSTHETIC JOINT INFECTIONS: Treatment

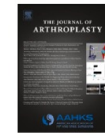
The Journal of Arthroplasty 34 (2019) S393–S397



Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: [www.arthroplastyjournal.org](http://www.arthroplastyjournal.org)



Hip and Knee Section, Treatment, Algorithm: Proceedings of International Consensus on Orthopedic Infections



**Question 1: Should early postoperative infection and acute hematogenous infection be treated and managed differently?**

**Recommendation:**

There is no evidence to support the notion that early postoperative infection and acute hematogenous infection should be treated differently as long as the onset of symptoms is < 4 weeks (favorable <7 days). Implants are well-fixed, no sinus tract exists, and the isolated infecting organism is sensitive to an antimicrobial agent.

**Level of Evidence:** Moderate

**94% CONSENSUS**

**< 4 Weeks from Symptoms  
(favorable < 7 days)**

**No differences between early  
postop and acute  
hematogenous**

*T. Chotanaphuti et al. / The Journal of Arthroplasty 34 (2019) S393–S397*

# ACUTE PROSTHETIC JOINT INFECTIONS: Treatment

The Journal of Arthroplasty 34 (2019) S399–S419



Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: [www.arthroplastyjournal.org](http://www.arthroplastyjournal.org)



Hip and Knee Section, Treatment, Debridement and Retention of Implant: Proceedings of International Consensus on Orthopedic



**Question 2: Is debridement, antibiotics, and implant retention (DAIR) an emergency procedure for patients with acute PJI or should patient optimization be implemented before surgery to enhance the success of this procedure?**

**Recommendation:**

**Debridement, antibiotics, and implant retention (DAIR) is not an emergency procedure but should be performed on an urgent basis when the patient with acute PJI is medically and surgically optimized.**

**Level of Evidence: Limited**

**Delegate Vote: Agree: 97%, Disagree: 3%, Abstain: 0% (Unanimous, Strongest Consensus)**

**97% CONSENSUS**

# PROSTHETIC JOINT INFECTIONS

## Treatment options

### (DAIR – Debridement, Antibiotics, Implant Retention)

- Approximately 2/3's will fail this form of treatment
- Acute infections: best chance of cure
- Streptococcal infections: up to 65% success rate
- Staph infections = predictor of failure
- MRSA infections have approximately 80% failure rate

Fehring TK, et al. CORR 471. 2013  
Koyonos L, et al. CORR 469. 2011.  
Odum SM, et al. J Arthroplasty 2011.  
Bradbury T, et al. J Arthroplasty. 2009.

**SIMPLE IRRIGATION AND DEBRIDEMENT: VERY LOW EFFICACY**

Study	Year	No. of patients included in review (knees)	Mean F/U in years	Organisms	No. of reinfection percentage	Level of evidence
Duque et al. [1]	2016	67	4	SA 24, MRSA 5, strep 4, entro 3, psuedo 3	21(31%)	IV R
He et al. [33]	2016	11	5	SA 1, CNS 1, Strep 7	2(18%)	IV R
Holmberg et al. [35]	2015	129	3	SA 53, CNS 33, Strep 7, poly mic 30	29(22.4%)	IV R
Font-Vizcarra et al. [31]	2012	35	7	GP 14, GN 21	6(17%)	III
Bradbury et al. [28]	2009	19	4	MRSA	16(84%)	IV R
Zhang et al. [34]	2017	35 (25 P - 10 R)	4	SA 14, MRSA 4, CNS 5	24(14 P- 10R)(68%)	IV R
Chung et al. [38]	2014	16 Arthroscopic	3	SA 4, SBH 5, MH 2,MRSA 1, CNS 1	6(37.5%)	IV R
Kim et al. [54]	2015	28	4	MRS 11, Neg cult. 8, SA 2, other staph 3	11(39%)	IV R
Kim et al. [55]	2015	101	9	SA 30, CNS 26, Gram neg 38, strep 14	44(44%)	IV R
Klare et al. [36]	2018	99	2	Staph 32, Strep 19, MRSA 11	35(35%)	IV R
Koh et al. [56]	2015	52	3	SA 11, CNS 19, MRS 19, Strep 7	15(28.8%)	IV R
Konigsberg et al. [32]	2014	22	2	Staphylococcus	5(22.7%)	IV R
Matsumoto et al. [43]	2015	50	4	SA 25, CAN 10, Strep 4	22(44%)	IV R
Parvizi et al. [30]	2009	11	2	MRSA, MRSE, PA, Proteus, Entrobacter	6(54%)	IV
Siddiqui et al. [29]	2013	12	2	MRSA	8(66%)	IV R
Son et al. [37]	2017	25	3	Neg Growth 12, SA 2 MRSE 2, MRSA 1, Strep 5	3(12%)	IV R
• Stryker [57]	2013	72	4	SA 12, CNS 7, Strep 7	20(27%)	IV R
• Vilchez et al. [31]	2011	35	2	SA	11(31%)	IV P
Wang et al. [27]	2015	16	5	MRSA 6, SA 4, CNS 3	0	IV P

# PROSTHETIC JOINT INFECTIONS

Clin Orthop Relat Res (2017) 475:419–429  
DOI 10.1007/s11999-016-4977-y

Clinical Orthopaedics  
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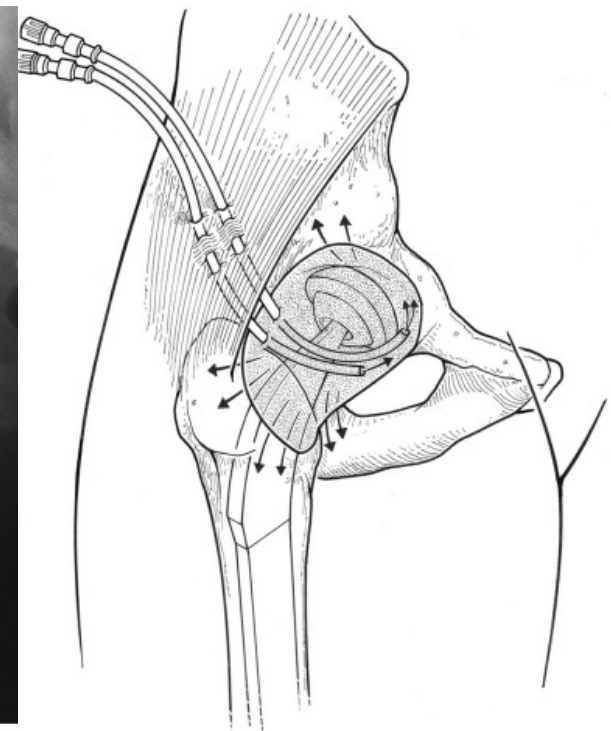
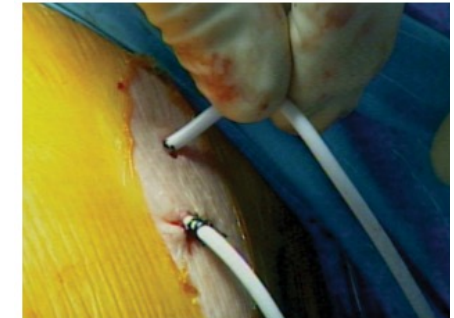


SYMPOSIUM: 2016 HIP SOCIETY PROCEEDINGS

## One-stage Revision With Catheter Infusion of Intraarticular Antibiotics Successfully Treats Infected THA

Leo A. Whiteside MD, M. E. Roy PhD

- 21 patients
- Infusion of Vancomycin for 6 weeks
- 20 out of 21 (95%) patients were apparently free from infection
- Fup 63 months (range 25-157).





# PROSTHETIC JOINT INFECTIONS

Looking for a treatment:

- Effective
- In acute cases
- Germ-specific
- Local antibiotic
- Less invasive



# PROSTHETIC JOINT INFECTIONS

## Treatment options

(DAIR - Debridement And Implant Retention

(DAPRI - Debridement + Antibiotic Pearls + Retention of Implants

One-stage revision

Two-stage revision

Acute

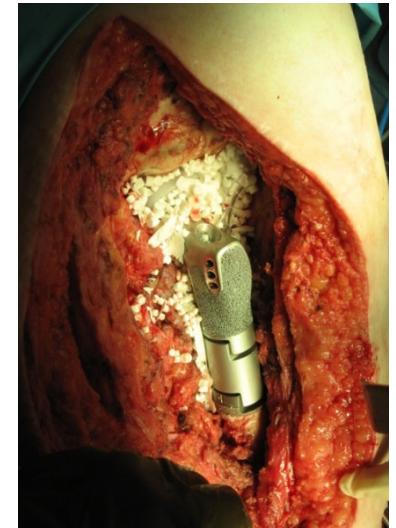
Chronic

# PROSTHETIC JOINT INFECTIONS

## Debridement + Antibiotic Pearls + Retention of Implants (DAPRI)

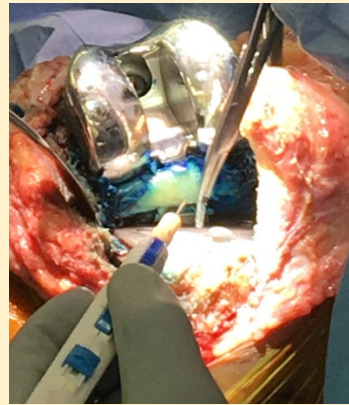
- Only in acute setting (4 weeks from symptoms; +favorable < 7 days)
- Known Bacteria (Antibiogram from Culture or NGS)
- Custom-made Pearls
- Success rate up to 80%

Indelli PF, Calanna F, Leonardi E: ISAKOS 2019  
Calanna F, Risitano S, Indelli PF et al.: J Orthopaed Surg 2019

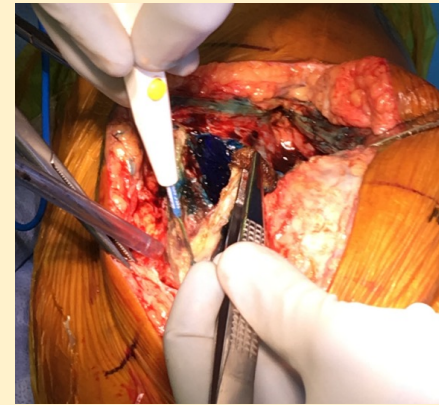


# DAPRI

## 1. BIOFILM IDENTIFICATION

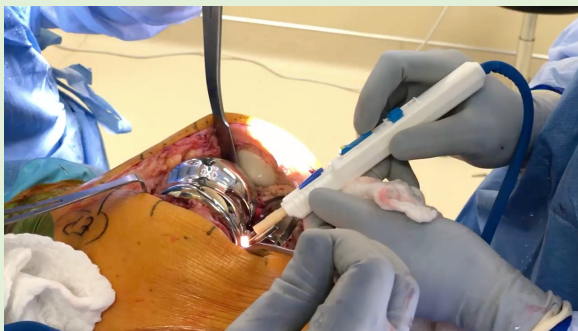


Debridement Tumor-like  
Radical sinovectomy



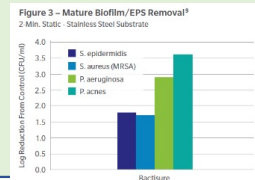
40 cc Saline  
10 cc 0.5% MB

## 2. DEGRADATION OF BIOFILM



Argon Beam

- 60 Watts
- 50° C



Irrigation with Acetic Acid

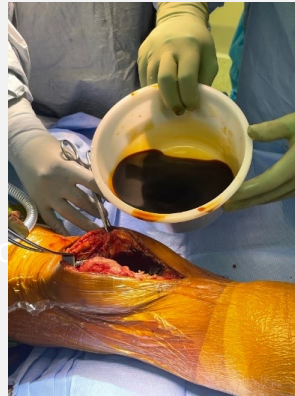
- 1 L Acetic Acid
- Pulsed lavage
- 1 L Saline



# DAPRI

## 3. REMOVAL OF MICROORGANISM AND LAVAGE OF THE JOINT

### A. Scrub with Clorexidin Brush



### C. Custom made calcium sulfate pearls Stimulan with antibiotic (chosen on the basis of the antibiogram)



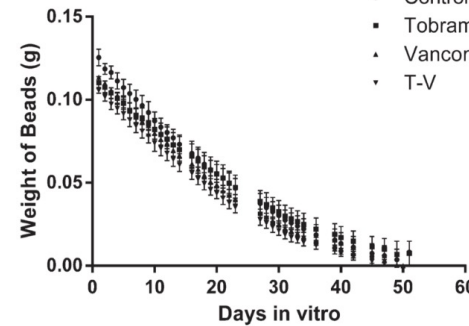
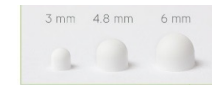
B. Lavage (30cc of Betadine 10% with 1Lt of Saline solution 0.9%, left in the joint for 3 min, than aspirated and irrigated again with 1Lt of Saline solution (Rothman Institute Protocol, Philadelphia).

## 4. REVISION OF Polyethylene

# Antibiotic Added Beads

Custom made calcium sulfate pearls Stimulan with antibiotic (chosen on the basis of the antibiogram)

- Physiological pH
- Hydrophilic
- Easy and rapid mixing
- Rapid absorption
- It doesn't leave nidus
- Controlled purity
- No hydroxyapatite, insoluble impurities or PMMA debris
- Easily mixed with liquid and powder antibiotics



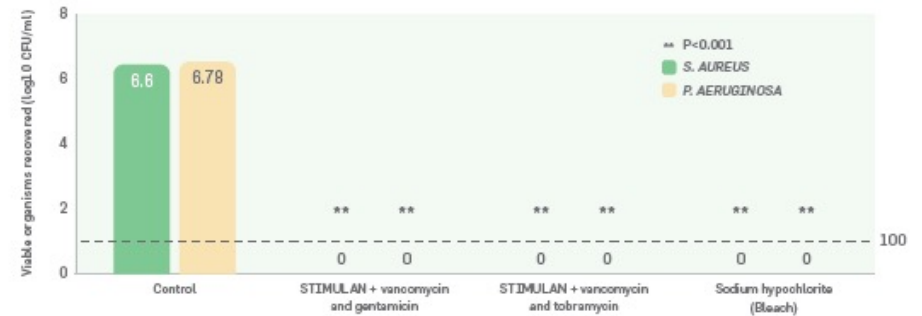
- Control
- Tobramycin
- ▲ Vancomycin
- ▼ T-V

Roberts et al, J Bio Mat Res 2014

Antibiotic elution up to 40 days

## Proven action against biofilms<sup>10</sup>

No viable organisms were recovered from pre-formed biofilms.



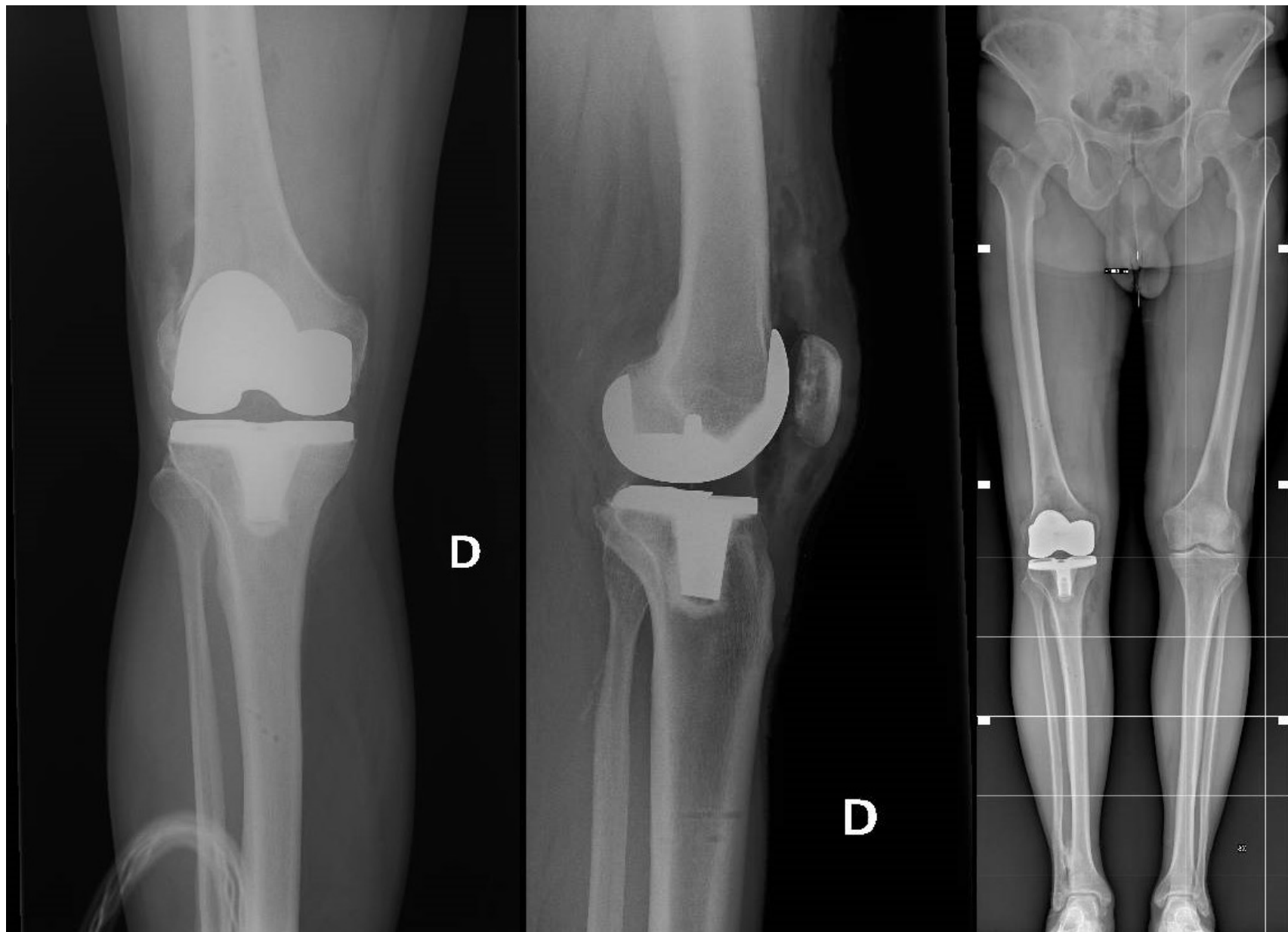
In vitro study determining the efficacy of antibiotic-loaded STIMULAN beads against *Pseudomonas aeruginosa* and *Staphylococcus aureus* biofilms.

B.A.  
M,  
64yo



B.A.  
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64yo

TKA  
5/6/2021





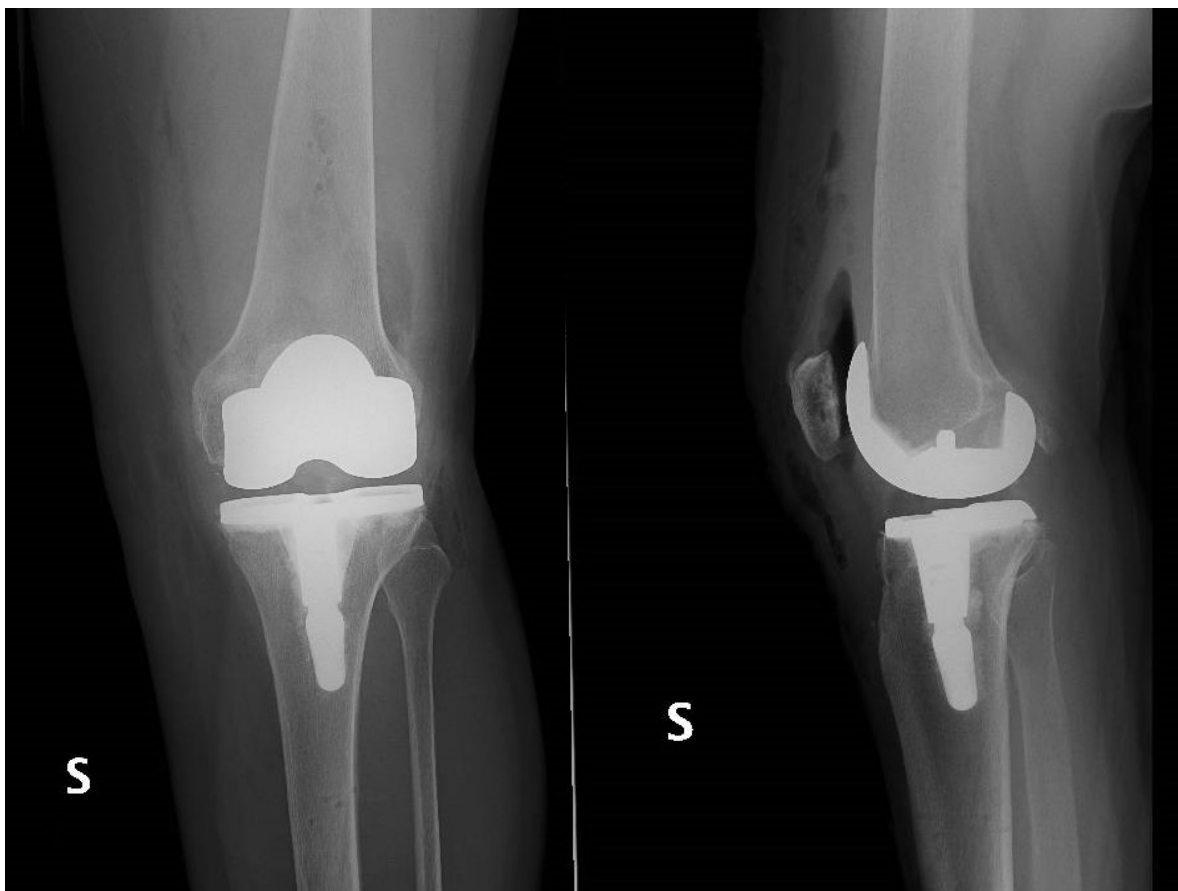
B.A.  
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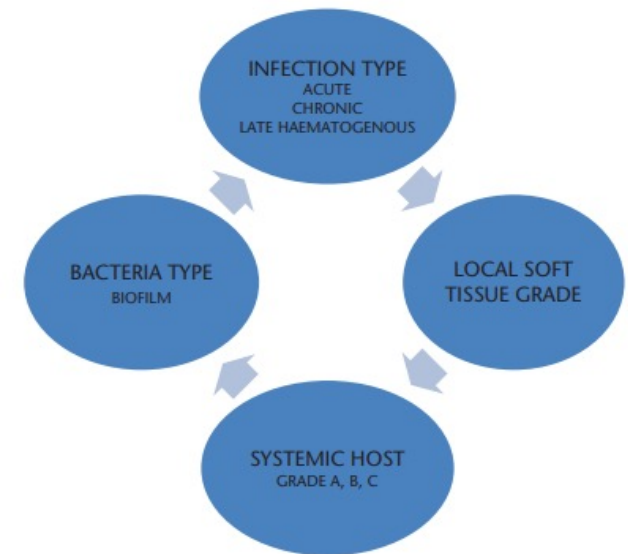
DAPRI  
31/8/2020



# PROSTHETIC JOINT INFECTIONS

## Ideal treatment

- Efficacy
- Germ-specific
- Local antibiotic
- Aim: Act on factors that influence outcomes of treatments



# PROSTHETIC JOINT INFECTIONS

## Antibiotic spacers

Review > Arch Bone Jt Surg. 2020 Jan;8(1):11-20. doi: 10.22038/abjs.2019.42018.2141.

### The Use of Antibiotic Impregnated Cement Spacers in the Treatment of Infected Total Joint Replacement: Challenges and Achievements

Omid Shahpari<sup>1</sup>, Alireza Mousavian<sup>1</sup>, Nafise Elahpour<sup>1</sup>, Michael-Alexander Malahias<sup>2</sup>,  
Mohammad H Ebrahimzadeh<sup>1</sup>, Ali Moradi<sup>1,3</sup>

- Antibiotics can cause renal failure
- Local administration of antibiotics may have many advantages



Table 2. Cement/antibiotic formulations with their corresponding complications

Study	No. of Patient	Cement/Antibiotic Formulation	Complications
Jung et al.	82 (hip spacers)	0.5 g gentamicin and 2 g vancomycin / 40 g cement	5 cases of acute renal failure (80).
Hsieh et al.	42 (hip spacers)	480 mg liquid gentamicin + 3 g vancomycin / 40 g of cement	0.5 mg/DL increase in serum creatinine (81).
Springer et al.	36 knees 34 patients	10.5g vancomycin + 12.5 g gentamicin / 40 g cement	no complications reported (13).
Dovas et al.	a 61-year-old patient	high-dose gentamicin-vancomycin impregnated cement	acute renal failure (82).
Evans et al.	44 (total 54 periprosthetic infections)	4 g vancomycin + 4.6 g tobramycin / 40 cement	no complications reported (29).

# Customized intraoperatively molded articulating cement spacers for two-stage revisions TKA with major bone defects

European Journal of Orthopaedic Surgery & Traumatology 2021

Stefano Marco Paolo Rossi<sup>1</sup>  · Marta Medetti<sup>2</sup> · Loris Perticarini<sup>1</sup> · Matteo Ghiara<sup>2</sup> · Francesco Benazzo<sup>1,3</sup>

4 groups: Static, articulating molded, customized molded and metal on Poly



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4 groups: Static, Articulating molded, Customized molded and Metal and Poly

Outcomes		SS	MAS	CMAS	HS
<i>OKS</i>					
Pre-op		12.3 (3)	12.5 (2)	12.3 (3)	12.3 (3)
With spacer		13.3 (2)	22.3 (2)	23.3 (2)	28.3 (2)
Final f-u		29.1 (4)	34.1 (4)	33.4 (4)	35.1 (4)
<i>Staphylococcus</i> species 70%		( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)
<i>EQ 5D</i>					
Pre-op		0.22 (0.7)	0.22 (0.6)	0.21 (0.7)	0.23 (0.7)
With spacer		0.30 (0.5)	0.50 (0.5)	0.50 (0.4)	0.62 (0.5)
Final f-u		0.69 (0.5)	0.77 (0.5)	0.76 (0.5)	0.77 (0.5)
Methicillin-/vancomycin-resistant 35%		( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)
Methicillin-resistant <i>Staphylococcus aureus</i> 65%					
Other organisms 10%					
<i>EQ VAS</i>					
Pre-op		25.2 (3)	24.2 (3)	24.7 (2)	24.5 (3)
With spacer		40 (3)	45 (5)	45 (4)	60 (4)
Final f-u		73.1 (3)	78.1 (3)	77.1 (3)	79.1 (3)
		( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)	( <i>P</i> < 0000.1)

# Antibiotic Added Beads





## TAKE HOME MESSAGE

- Diagnosis and treatment of Prosthetic Joint Infections are still challenging
- Implant retention is indicated in acute post-op and in hematogenous cases (< 4 weeks from symptoms), with microorganism identification.
- In acute cases, DAIR is nowadays an indication of choice, but it is not always successful (65.9%)
- Pathological tissue removal and a “local delivery” of antibiotic (+ several weeks of systemic antibiotic) therapy seems to be a good option
- Antibiotic Added Beads can be used in acute cases (DAPRI procedure) but may be used in one-stage, two-stage (and prevention)