



Pseudarthroses Septiques



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Service de Chirurgie de l'Arthrose et du Sport

CRIOAC CHU GRENOBLE - ALPES

DIU des Infections Ostéo-Articulaires

6 – 7 Décembre 2022

Définitions

- PSEUDARTHROSE : Défaut de consolidation osseuse > 6 mois
- SEPTIQUE : Origine infectieuse ...

Problématiques

- Faire consolider la fracture
- Eradiquer l'infection...
- Rétablir la fonction

=> Infection ostéo-articulaire complexe / difficile à traiter

ARC (A.C. Masquelet)

A : Assèchement

R : Réparation des parties molles

C : Comblement / Consolidation

Prise en charge

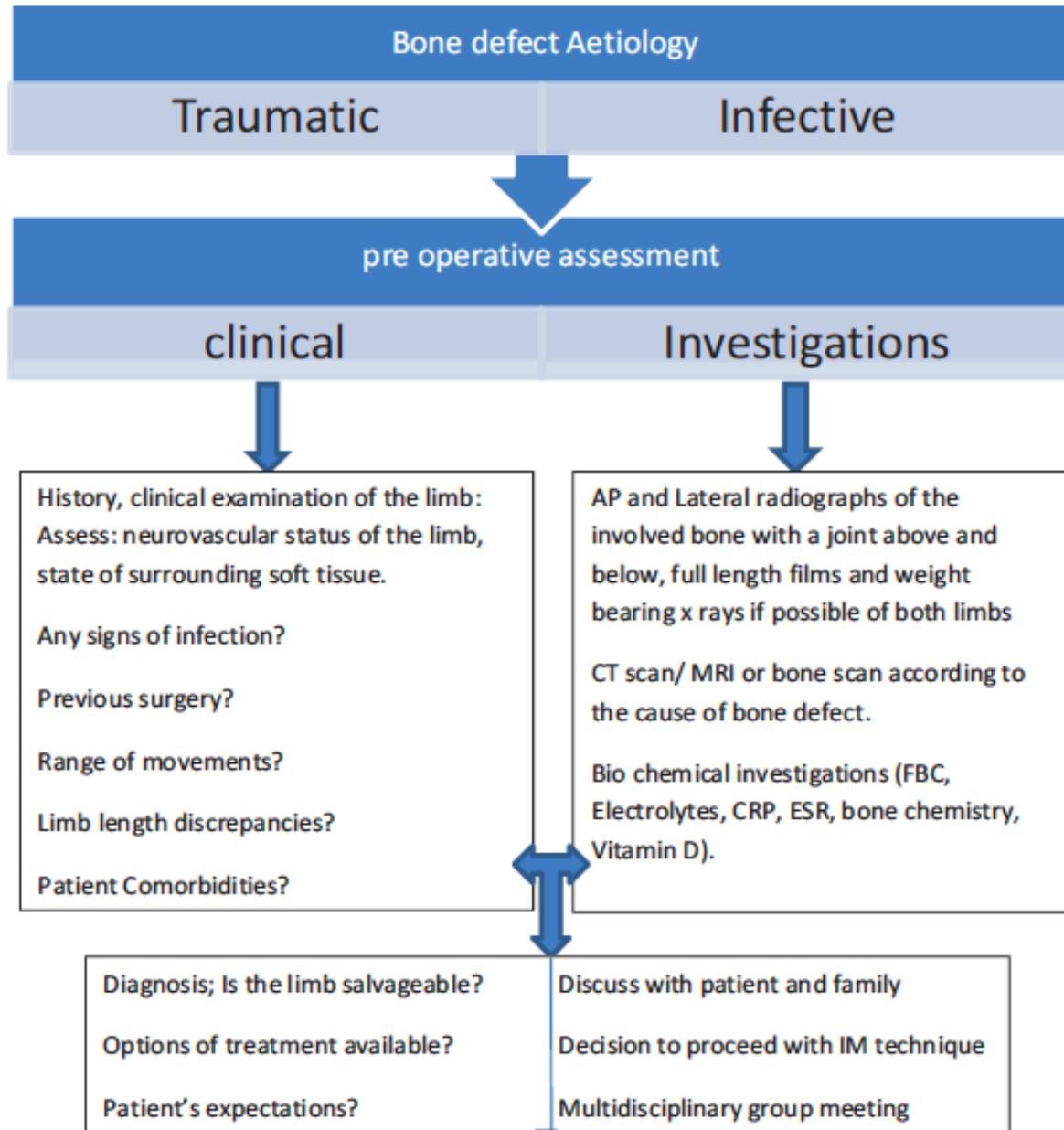
- **Approche Multi - Disciplinaire +++ : CRIOAC**

- Chirurgiens : Orthopédiste / Plasticien
- Infectiologue
- Micro - biologiste

- **Traitement personnalisé +++**

- Localisation et Résection
- Pathogène (s)
- Type(s) de fixation

=> Projet thérapeutique



- Bilan Rx
- TDM
- Scintigraphie osseuse + PNN
- CRP
- Bilan nutritionnel +++
- NFS / Bilan hépatique (Antibiotiques)

Pseudarthrose septique

- **Procédure en Un Temps :**

- Rare +++ => Risque d'échec
- Perte de substance osseuse modérée
- Germe identifié
- Pas de problème de couverture cutanée

- **Procédure en Deux Temps :**

- Le plus souvent +++
- Gestion de l'os infectée et de la perte osseuse
- Gestion téguments
- Gestion de l'infection

Dans tous les cas

- Abord précautionneux : Décortication
- **Ablation de tout le matériel et des corps étrangers +++**
- **Excision large « carcinologique »** de l'os infecté et des tissus mous
=> Séquestres +++
- Comblement éventuel par matériel inerte => Spacer en ciment (MI)
- Drainage et Fermeture => Lambeaux (Même temps / Différé)
- Stabilisation => Fixateur externe / Autres...

Dans tous les cas

- Prélèvements **bactériologiques multiples (5-7)** : avant toute antibiothérapie

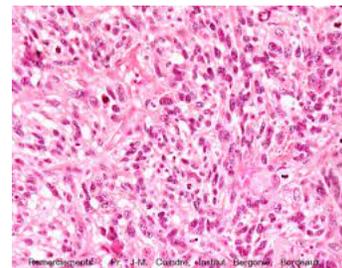


- Prélèvement **anatomo-pathologique** : recherche de signes d'ostéite
- Prélèvements **fongiques +++**



- Antibiothérapie à discuter avec l'équipe d'infectiologie (**RCP+++**)

- **Prévoir couverture cutanée – Lambeaux +++**



Dans tous les cas

- **Lutte contre la Dénutrition +++**
- **Arrêt du tabac +++**
- Equilibration Diabète
- Revascularisation (Echo-Doppler artériel)



Déficits Osseux : Plusieurs Moyens

- **Greffe spongieuse / cortico-spongieuse**
- **GITF : Greffe Inter-Tibo-Fibulaire**
- **Transfert osseux vascularisé : Fibula vascularisé**
- **Technique membrane induite de Masquelet**
- **Substitut osseux ?**

Déficits Osseux : Plusieurs Moyens

- **Greffe spongieuse / cortico-spongieuse**
 - Perte de substance modérée
 - Pas de problème de revêtement cutané
 - Un temps possible
- Ostéosynthèse interne stable (Plaque / Clou)
- Prise de crête iliaque
- Association avec précurseurs de granulocytes
=> de 70% (n=40) à 90% (n=40) de guérison...



Single-stage treatment of infected tibial non-unions and osteomyelitis with bone marrow granulocytes precursors protecting bone graft

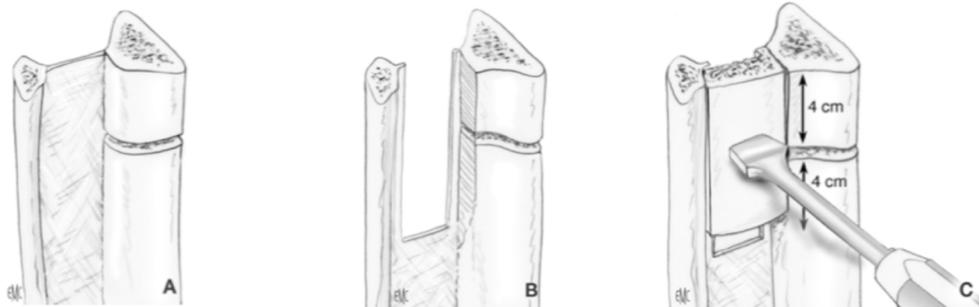
Philippe Hernigou¹ · Arnaud Dubory¹ · Yasuhiro Homma¹ · Charles Henri Flouzat Lachaniette¹ · Nathalie Chevallier¹ · Helene Rouard¹

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Déficits Osseux : Plusieurs Moyens

- **Greffe inter-tibio-fibulaire (GITF)**

=> Pontage perte de substance tibiale à l'aide d'un greffon crête iliaque



Déficits Osseux : Plusieurs Moyens

- **Fibula libre / vascularisée**

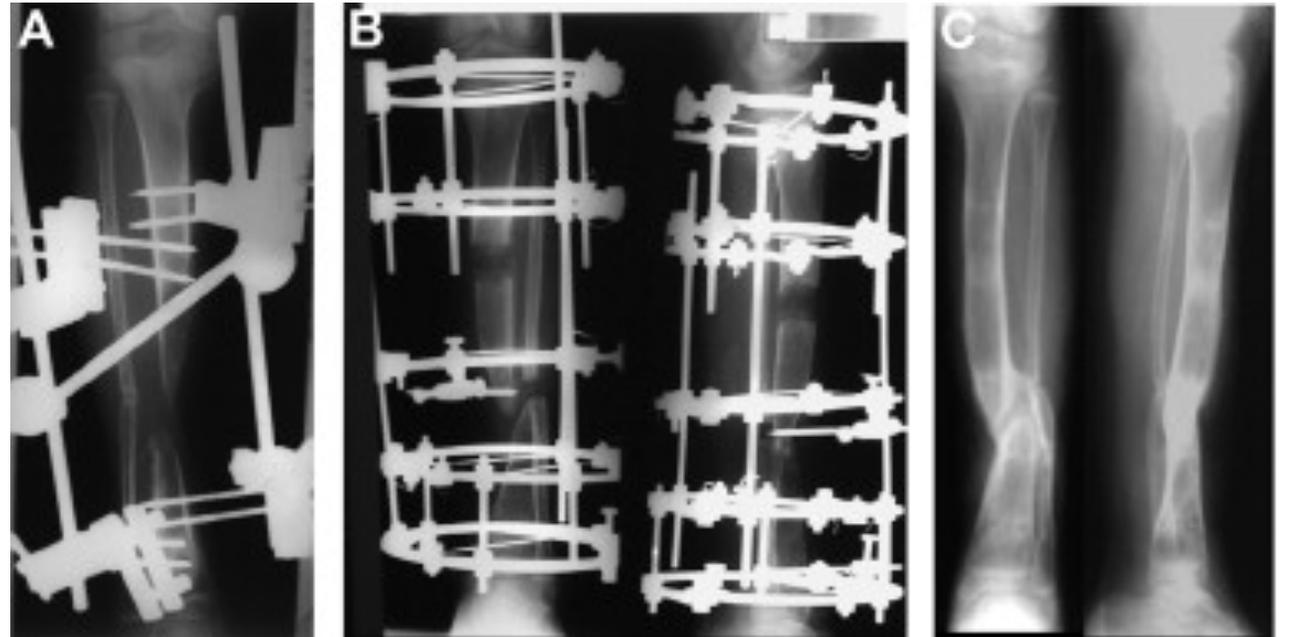
=> Pontage de perte de substance tibiale par fibula vascularisée homo ou contro-latérale

- de 5 à 25 cm environ de perte de substance
- Meilleur taux de consolidation si vascularisation
- Palette cutanée
- Morbidité du site donneur (=> jusqu'à 89%...)



Défauts Osseux : Plusieurs Moyens

- **Ascenseur**
 - Fixateur externe (Ilizarov)



- **Comblent la perte de substance : Ostéogénèse en distraction**
=> Mobiliser au niveau même du segment lésé un cylindre osseux vivant avec ses attaches musculo-aponévrotiques pour combler une perte de substance osseuse.

Déficits Osseux : Plusieurs Moyens

- **Technique de la Membrane Induite (MASQUELET) +++**
 - 2 temps.
 - **1er Temps :**
 - Débridement et excision complète des tissus infectés
 - Fixateur externe pontant la perte de substance osseuse
 - Réalisation d'une entretoise en ciment (+ AB) recouvrant les extrémités osseuses saines
 - Couverture cutanée
 - **2^{ème} temps : Après 6 – 8 semaines.**
 - Incision Membrane induite (Facteurs de croissance +++)
 - Ablation du ciment
 - Greffe osseuse massive (Crête iliaque / Reamer)
 - Ostéosynthèse (plaque vissée / Clou)

=> Consolidation en 6 – 17 mois...



Membrane Induite : Résultats

- 84 patients => 41 pseudarthroses septiques
- 90% consolidations (76/84)
- Délai moyen consolidation : 14,4 mois
- Pas d'effet perte osseuse sur la consolidation
- Tendence consolidation plus rapide sur membre supérieur
- 6,1 ITV avant consolidation => GRAVITE +++

- 6 amputations (Tibia) !



Symposium SoFCOT 2010



Masquelet technique: myth or reality? A systematic review and meta-analysis

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^dDepartment of Trauma and Orthopaedics, University College London Hospitals, London, UK

Membrane Induite : Résultats

- **18% d'échecs** (Infections et/ou Pseudarthroses)

- **Complications sites donneurs**

- Crête iliaque : 19,37%
- RIA (tibia / Fémur) : 6%

- **Consolidation : 89,7%**

- **4% Amputations**

Table 11. Outcomes and follow up

	Infections healed						Time to heal (weeks)						Follow up (months)											
	Infect cases	Yes	(%)	No	(%)	N° Cases	Union	%	Non union/ amput	%	Non union	%	Amput	%	Min	Max	Mean	SD	After stage	Min	Max	Mean	SD	
Apard	7	6	85.7	1	14.3	12	11	91.7	1	8.3	1	8.3	0	0.0	48	376	158	111.2	ns	12	94	39.5	27.8	
Azi	23	16	69.6	7	30.4	33	30	90.9	3	9.1	2	6.1	1	3.0	16	60	34	9.2	1	12	61	27	15.9	
Donegan	4	3	75.0	1	25.0	11	10	90.9	1	9.1	1	9.1	0	0.0	-	-	32.29	0	2	12	48	-	-	
El Alfy	17	15	88.2	2	11.8	17	14	82.4	3	17.6	3	17.6	0	0.0	24	76	40	-	2	14	38	23	-	
Gupta	8	6	75.0	2	25.0	9	6	66.7	3	33.3	0	0.0	0	0.0	32	52	42	-	2	18	24	21.5	-	
Karger	41	41	100.0	0	0.0	84	76	90.5	8	9.5	2	2.4	6	7.1	-	-	57.6	0	1	12	264	-	-	
Kawakami	6	6	100.0	0	0.0	6	6	100.0	0	0.0	0	0.0	0	0.0	12	24	15.33	4.68	2	36	72	50.7	0	
Luo	7	7	100.0	0	0.0	7	7	100.0	0	0.0	0	0.0	0	0.0	-	-	-	-	-	41	150	86.7	37.2	
Masquelet	24	22	91.7	2	8.3	31	29	93.5	2	6.5	0	0.0	2	6.5	-	-	16	0	ns	12	168	-	-	
Moghaddam	35	32	91.4	3	8.6	50	40	80.0	10	20.0	7	14.0	3	6.0	12	60	34.40	11.6	2	12	12	12	0	
Obert	0	-	-	-	-	9	6	66.7	3	33.3	2	22.2	1	11.1	12	56	32	-	ns	12	-	-	-	
Olesen	3	3	100.0	0	0.0	8	8	100.0	0	0.0	0	0.0	0	0.0	23.7	40.7	31.77	7.01	ns	9	20.8	13.2	-	
Scholz	13	13	100.0	0	0.0	13	13	100.0	0	0.0	0	0.0	0	0.0	12	24	18.92	-	ns	9	24	13	0	
Stafford	7	6	85.7	1	14.3	27	24	88.9	3	11.1	2	7.4	1	3.7	-	-	0	-	ns	12	12	12	0	
Taylor	7	5	71.4	2	28.6	69	62	89.9	7	10.1	5	7.2	2	2.9	6	208	26.6	29.3	2	12	64	23.8	14.2	
Wang	32	32	100.0	0	0.0	32	32	100.0	0	0.0	0	0.0	0	0.0	12	36	19.6	7.35	ns	24	32	27.5	-	
Zappaterra	3	3	100.0	0	0.0	9	9	100.0	0	0.0	0	0.0	0	0.0	18.4	210.8	64.04	63.76	2	6	52.7	16.01	15.94	
Weighted Mean																								15.75
Total	237	216	91.1	21	8.9	427	383	89.7	44	10.3	25	5.9	16	4										

Legend: %=% of total patients for each study; amput=amputations; ns=non specified.

Membrane Induite : Résultats

- 12 patients (9 T / 2F / 1 Arthrodeuse genou)
- Masquelet + Clou + Greffe (RIA)
- 100% consolidation => Corticalisation 1,6 mois / Consolidation 9 mois

> Orthop Traumatol Surg Res. 2022 Nov;108(7):103395. doi: 10.1016/j.otsr.2022.103395. Epub 2022 Sep 6.

Masquelet's induced membrane technique associated with Reamer Irrigation Aspiration grafting and intramedullary Nailing (MaRIAN) for chronic diaphyseal osteomyelitis of the lower limb

Marianne Cuvillier ¹, Jean-François Meucci ², Céline Cazoria ², Anne Carricajo ², Thomas Neri ², Bertrand Boyer ²

Affiliations + expand

PMID: 36084914 DOI: 10.1016/j.otsr.2022.103395

Tableau 4
État de l'art de la prise en charge des pseudarthroses septiques.

	Population	Ostéosynthèse	Greffe	Résultats	Délai moyen de consolidation (mois)	Recul
Apard et al. [31]	12 patients dont 7 septiques	ECM	Crêtes iliaques antérosup et postérosup	5 récurrences infectieuses	Non précisé	39,5 mois
Azi et al. [32]	33 patients	Plaque FE ECM	Crête iliaque	1 fracture de clou 90 % de consolidation	8,5	2 ans
Stafford et al. [33]	6 patients avec ECM seul	Plaque	Diminution de la quantité de greffe avec ECM	90 % de consolidation	8,63	32 mois
Siboni et al. [34]	21 patients	Plaque FE Plâtre	Crête iliaque	89 % de consolidation	16	36 mois
Baud et al. [35]	33 patients	Plaque FE Plâtre ECM	RIA Crête iliaque Allogreffe	61 % de consolidation	10	3,3 ans
Masquelet et al. [19]	18 patients Dont 14 septiques	FE	Non précisé	100 % de consolidation	4	15 ans

FE : Fixateur Externe ; ECM :Enclouage Centro-Médullaire.

Table 2. Different surgical techniques for treating chronic osteomyelitis

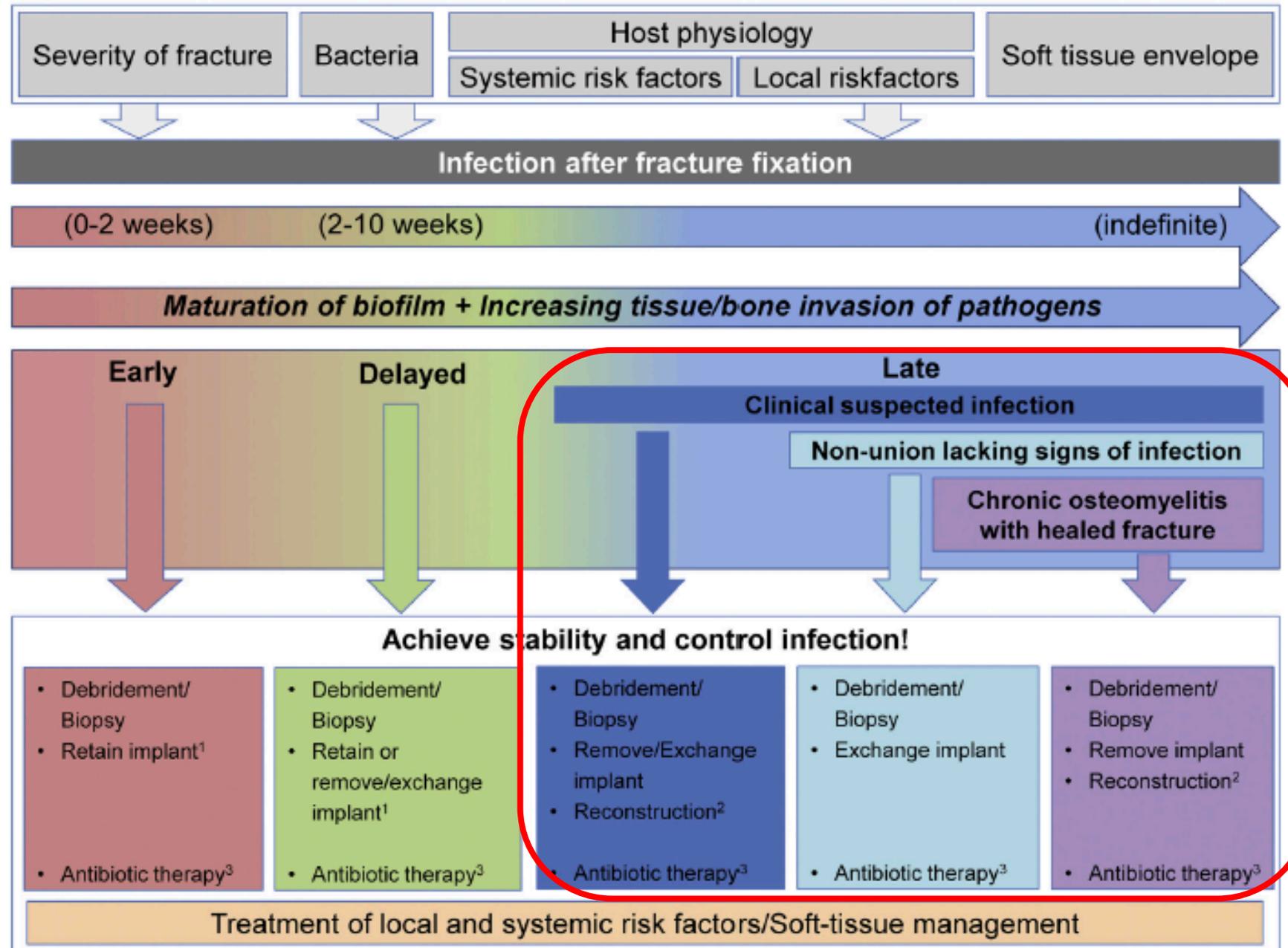
Surgical technique	Advantages	Disadvantages
Conventional reaming of the IM canal	<ul style="list-style-type: none"> - Clearance of intramedullary sepsis 	<ul style="list-style-type: none"> - Risk of fracture - Risk of bleeding - Need for fenestration of the distal diaphysis to allow drainage of the irrigation fluids
RIA technique	<ul style="list-style-type: none"> - Clearance of intramedullary sepsis - Less traumatic than convectional reaming 	<ul style="list-style-type: none"> - Risk of fracture - Risk of bleeding
Primary bone grafting / bone graft substitutes	<ul style="list-style-type: none"> - Single-stage procedure - Superior osteoconductivity and osteoinductivity of the bone graft 	<ul style="list-style-type: none"> - Confined to small defects / limited availability of bone graft - Risk of early resorption / highly depends on the soft tissue bed - Risk of relapse of infection - Graft incorporation is slow and unreliable - Donor site morbidity
Antibiotic-impregnated cement spacers / cement nails / antibiotic beads	<ul style="list-style-type: none"> - Slow release of high concentrations of antibiotics, avoiding their systemic effects - Easy to mix - form into various shapes and sizes - Cement nails can provide some stability to associated fractures 	<ul style="list-style-type: none"> - Lack of biodegradability in some carriers / need for two-stage procedures - Concern that they can act as a foreign body, therefore harbouring infection - Increased risk of antibiotic resistance - Depends on good soft-tissue coverage
Bioactive glass	<ul style="list-style-type: none"> - Anti-microbial, osteoconductive and angiogenic properties 	<ul style="list-style-type: none"> - Two-stage procedure - Increased risk of antibiotic resistance - Limited availability of bone graft - Can be associated with prolonged healing and recovery time
Induced membrane (Masquelet) technique	<ul style="list-style-type: none"> - Combines the advantages of antibiotic-impregnated cement spacers with those of delayed bone grafting - The induced membrane is highly vascularised, rich in growth and osteoinductive factors - Offers a confined space for the application of the bone graft 	<ul style="list-style-type: none"> - Distraction is often limited because of the neurovascular bundle contracture - Can be associated with pain for distraction > 2 cm - Pin-site complications - Need for specialised equipment - Need for re-interventions
Circular external fixation devices and bone transport	<ul style="list-style-type: none"> - Increased blood flow in the area of corticotomy - Minimally-invasive nature 	

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Take Home Message

- **Prise en charge difficile +++**
- **Approche multi-disciplinaire +++**
- **Lutte contre les tares médicales :**
 - Dénutrition
 - Diabète
 - Problème artériel
- **Antibiothérapie(s) prolongées +++**
- **Technique(s) chirurgicale(s) rigoureuse(s) :**
=> Excision/Comblement/fixation/couverture
- **Chaque cas est unique +++**



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