

Periprosthetic joint infections can be life-threatening complications

Joint replacement is one of the most common and most successful procedures in orthopaedics. A periprosthetic joint infection as a consequence of the procedure only occurs in up to 2% of all primary joint replacements but in up to 5% of all revision surgery.

Periprosthetic joint infections may be very serious complications and are usually associated with high morbidity and mortality comparable to that seen in cancer patients. Antibiotic prophylaxis and minimising risk factors associated with infection must therefore be given the utmost attention.

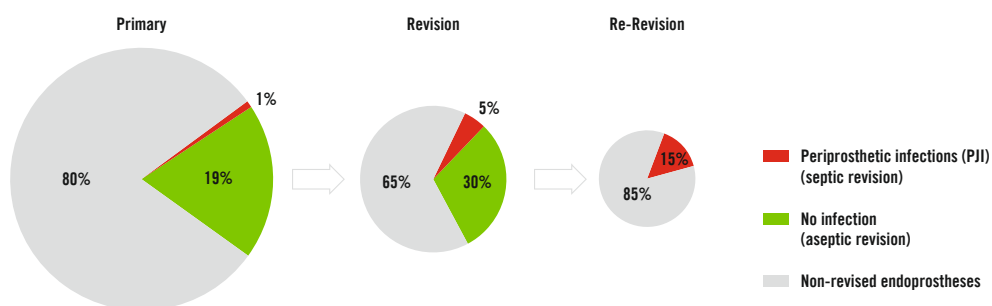
When is a periprosthetic joint infection present?

PJIs are infections that may result from bacterial colonisation of the implant and the adjacent soft tissue. Along with pain, clinical symptoms include local redness, excessive heat and, with chronic infection, loosening of the prosthesis, wound dehiscence, fistula formation and secretion. The infection can occur either peri-operatively or post-operatively, that is, during or after the surgery, as a result of bacterial contamination of the surgical site or haematogenous dissemination of pathogens from a remote infection site in the body. It is still being discussed how to best diagnose a periprosthetic infection. Microbiological criteria (microbial detection by culturing tissue samples or synovial fluid), serological parameters (e.g. CRP value, granulocyte count) and histological findings are differentially weighted and compared while taking clinical symptoms into account.

Why is the number of periprosthetic infections rising?

- The absolute number of arthroplasties is increasing.
- The number of revision surgeries is growing because of higher life expectancy. Revision surgery generally has a higher risk of infection.
- The proportion of patients with risk factors (e.g. advanced age, obesity) and comorbidities (e.g. diabetes) is increasing.

Risk of infection and repeat surgical procedures in Arthroplasty



Risk factors for PJI



Patient dependent
(e.g. obesity, diabetes,
nicotine/alcohol abuse)



Surgery dependent
(e.g. prolonged
operating time)



Implant dependent
(e.g. mega-prostheses)

Literature

- Abdulkarim A et al. Cemented versus uncemented fixation in total hip replacement: a systematic review and meta-analysis of randomized controlled trials. *Orthop Rev (Pavia)* 2013; Mar; 15; 5(1): e8.
- AWMF Leitlinie AK Krankenhaus und Praxishygiene, Stand 2013
- Benito N et al. Etiology of Surgical Site Infections after Primary Total Joint Arthroplasties. *Journal of Orthopaedic Research* 2014; May: 633–637.
- Bert JM, et al. The incidence of tibial component loosening in cemented total knee arthroplasty when the tibial stem is not cemented. Presented at the American Academy of Orthopaedic Surgery Meeting, Orlando 2000.
- Biehl G et al. Experimentelle Untersuchungen über die Wärmeentwicklung im Knochen bei der Polymerisation von Knochenzement. *Arch. Orthop.- Unfall-Chir.* 1974; 78: 62–69.
- Billi F, et al. Techniques for improving the initial strength of the tibial tray-cement interface bond. *Bone Joint J* 2019; 101-B (1 Supple A): 53–58.
- Bökeler U et al. The Influence of a Modified 3rd Generation Cementation Technique and Vacuum Mixing of Bone Cement on the Bone Cement Implantation Syndrome (BCIS) in Geriatric Patients with Cemented Hemiarthroplasty for Femoral Neck Fractures. *Medicina.* 2022; 58(11):1587.
- Breusch [1] S, Malchau H. Optimal Cementing Technique – The Evidence: What is modern cementing technique? In: Breusch S, Malchau H eds. *The Well-Cemented Total Hip Arthroplasty.* Berlin/Heidelberg/New York: Springer Verlag 2005; 147–148.
- Breusch [2] S et al. Der Stand der Zementiertechnik in Deutschland. *Z. Orthop.* 1999; 137: 101–107.
- Breusch [3] J, et al. Lavage technique in total hip arthroplasty: jet lavage produces better cement penetration than syringe lavage in the proximal femur. *J Arthroplasty.* 2000; 15 (7): 921–927.
- Breusch [4] S et al. Zementierte Hüftendoprothetik – Verminderung des Fettembolierisikos mittels gepulster Druckspülung. *Orthopäde* 2000; 29: 578–586.
- Chawda M et al. Comparison of cemented vs uncemented acetabular component positioning using an imageless navigation system. *J Arthroplasty* 2009; Dec; 24(8): 1170–1173.
- Christie J. Medullary lavage reduces embolic phenomena and cardiopulmonary changes during cemented hemiarthroplasty. *J Bone Joint Surg(Br)* 1995; 77: 456–459.
- Darre, E et al. Skin protection against methylmethacrylate. *Acta Orthop. Scand.* 1987; 58: 236–238.
- DeLuise M, Scott CP. Addition of hand-blended generic tobramycin in bone cement: effect on mechanical strength. *Orthopedics* 2004; Dec; 27(12): 1289–1291.
- Dunne NJ, et al. The relationship between porosity and fatigue characteristics. *Biomaterials* 2003; 24 (2): 239–245.
- Donaldson AJ et al. Bone cement implantation syndrome. *Br J Anaesth.* 2009; Jan; 102(1): 12–22.
- Eich G. A microbiology guide. In: Ochsner P: *Infections of the musculoskeletal system, Grandvaux: Swiss orthopaedics in-house-publisher* 2014: 208–231.
- Engesaeter [1] LB et al. Antibiotic prophylaxis in total hip arthroplasty: effects of antibiotic prophylaxis systemically and in bone cement on the revision rate of 22,170 primary hip replacements followed 0–14 years in the Norwegian Arthroplasty Register. *Acta Orthop Scand* 2003; 74(6): 644.
- Engesaeter [2] LB. The Norwegian Hip Register – The Influence of Cement and Antibiotics on the clinical Results of Primary Prostheses. In: Walenkamp G. *Local Antibiotics in Arthroplasty.* Stuttgart/New York: Thieme Verlag 2007.
- Hargrove R et al. Does pulse lavage reduce hip hemiarthroplasty infection rates. *J Hosp Infect.* 2006; 62(4): 446–449.
- Helwig P et al. Tibial cleaning method for cemented total knee arthroplasty: An experimental study *Indian J Orthop.* 2013; 47 (1): 18–22.
- Gehrke T et al. Cemented femoral fixation: A North Atlantic divide. *Seminar in Arthroplasty* 2016; 27:8-10.
- Geier J et al. Allergy diagnostics in suspected implant intolerance: practical approach. A Position Paper of the German Contact Dermatitis Research Group (DKG). *Hautarzt* 2008; 59(7): 594–559
- Griffith R et al. Safety guideline: reducing the risk from cemented arthroplasty for hip fracture 2015. *Anaesthesia* 2015; 70:623-626.
- Guenther D et al: Allergic reactions in arthroplasty: myth or serious problem? *Int Orthoped.* 2016; Feb; 40(2): 239–244.
- Heraeus Medical GmbH [1]. Safety Data Sheet PALACOS® R+G 1x40 INT, Version 4. 0, 18. 07. 2018
- Heraeus Medical GmbH [2]. Instructions for Use PALACOS® R+G, Revision status: 2017–03
- Humez M et al: Registerdaten zur zementierten Endoprothetik. *Orthopädie* 2024;53, 163–175.
- Izakovicova P, Borens O, Trampuz A. Periprosthetic joint infection: current concepts and outlook. *EFORT Open Rev.* 2019; Jul; 4(7): 482–494.
- Jiranek WA, Hanssen AD, Greenwald AS. Antibiotic-loaded bone cement for infection prophylaxis in Total Joint Replacement. *J Bone Joint Surg Am.* 2006; Nov; 88(11): 2487–2500.

- Khanuja HS et al. Revisiting cemented femoral fixation in hip arthroplasty. *The Journal of Bone and Joint Surgery* 2022; 104 (11): 1024-1033.
- Kühn [1] KD. *Bone Cements. Up-to-Date Comparison of Physical and Chemical Properties of Commercial Materials.* Berlin/Heidelberg/New York: Springer Verlag 2000.
- Kühn [2] KD. *Knochenzemente für die Endoprothetik.* Heidelberg: Springer Verlag 2001.
- Kühn [3] KD. *PMMA Cements. Are we aware what we are using?* Heidelberg: Springer Verlag 2014.
- Kühn [4] KD, Höntzsch D. *Augmentation mit PMMA-Zement.* *Unfallchirurg* 2015; 118/9: 737–748.
- Kühn [5] KD, Lieb E, Berberich C. *PMMA Bone Cement: What is the role of local Antibiotics?* *Maitrise Orthopedique* 2016; 243: 1–15.
- Kühn [6] KD, Renz N, Trampuz A. *Lokale Antibiotikatherapie.* *Unfallchirurg* 2017; 120(7): 561–572.
- Kühn [7] KD. *Bone Cements. Up-to-Date Comparison of Physical and Chemical Properties of Commercial Materials.* Berlin/Heidelberg/New York: Springer Verlag 2000.
- Kunutsor SK et al. Debridement, antibiotics and implant retention for periprosthetic joint infections: a systematic review and meta-analysis of treatment outcomes.** *J Infect* 2018;77:479–488.
- Lombardi Jr AV, et al. *Surface-cementation of the tibial component in total knee arthroplasty.* *Proceedings 65th Annual Meeting of the American Academy of Orthopaedic Surgeons,* New Orleans, LA 1–4, 1998.
- Lutz MJ, et al. *The effect of cement gun and cement syringe use on tibial cement mantle in total knee arthroplasty.* *J Arthroplasty* 2009; 24 (3): 461–467.
- Malchau H et al. *Prognosis of Total Hip Replacement – Update and Validation of Results from the Swedish National Hip Arthroplasty Register 1979 – 1998.* *The international journal of risk and safety in medicine* 1996; 8(1): 27–45.
- Malhotra A et al. *PMMA Cements in Revision Surgery.* In: Kühn KD, ed. *Management of Periprosthetic Joint Infection.* Berlin: Springer Verlag 2018; 243–255.
- Maloney WJ, Schmalzried T, Harris WH. *Analysis of long-term cemented total hip arthroplasty retrievals.* *Clin Orthop Relat Res.* 2002; Dec; 405: 70–78.
- Matthews JJ et al. *Combined syringe cement pressurisation and intra-osseous suction: An effective technique in total knee arthroplasty.* *Acta orthopaedica Belgica* 2009; 75(5): 637–41
- Miller MA, et al. *Increased initial cement–bone interlock correlates with reduced total knee arthroplasty micro-motion following in vivo service.* *J Biomech* 2014; 47 (10): 2460–2466.
- Neut D et al. *The effect of mixing on gentamicin release from polymethylmethacrylate bone cements.* *Acta Orthop Scand* 2003; 74(6): 670–676.
- Niki Y et al. *How much sterile saline should be used for efficient lavage during total knee arthroplasty? Effects of pulse lavage irrigation on removal of bone and cement debris.* *Journal of Arthroplasty* 2007; 22(1): 95–99.
- NJR Implant Summary Report: Summary. Report. HP_Cement_Palacos Antibiotic. 17/05/2019. 19:20.
- Olerud F, Olsson C, Flivik G. *Comparison of Refobacin Bone Cement and Palacos with Gentamicin in total hip arthroplasty: an RSA study with two years follow-up.* *Hip int.* 2013; 24(1): 56–62.
- Olsen M et al. *The role of bone cement for the development of intraoperative hypotension and hypoxia and its impact on mortality in hemiarthroplasty for femoral neck fractures.* *Acta Orthopaedica* 2020; 91 (3):293-298.
- Otto-Lambertz et al. Periprosthetic infection in joint replacement – diagnosis and treatment.** *Dtsch Arztebl Int* 2017; 114(20); 347–353.
- Padmanabhan T, Thomas S. *Methyl methacrylate permeability of dental and industrial gloves.* *The New York state dental journal* 2009; 75(4): 40–42.
- Park SH, et al. *Cement-cement interface strength: influence of time to apposition.* *J Biomed Mater Res* 2001; 58 (6): 741–746.
- Perez-Mañanes R, Vaquero J, Villanueva-Martinez M. *An experimental study of bone cement penetration in total knee arthroplasty depending on cementing technique used.* *Trauma (Spain)* 2012; 23(1): 48–58.
- Rassir R et al. *What Are the Frequency, Related Mortality, and Factors Associated with Bone Cement Implantation Syndrome in Arthroplasty Surgery?* *Clinical orthopaedics and related research* 2021; 479 (4), S. 755–763.
- Refsum AM, et al. *Cementing technique for primary knee arthroplasty: a scoping review.* *Acta Orthop* 2019; 90 (6): 582–589.
- Sanz-Ruiz, P, Villanueva-Martinez M, Berberich C. *Benefit and Risks of Antibiotic-Loaded Bone Cements.* In: Kühn KD, ed. *Management of Periprosthetic Joint Infection.* Berlin: Springer Verlag 2018; 217–228.
- Satalich JR et al. *Cementation in total hip arthroplasty: history, principles, and technique.* *EFORT Open Reviews* 2022; 7(11): 747–757
- Schlegel [1] UJ et al. *Efficacy of vacuum bone cement mixing systems in reducing methylmethacrylate fume exposure: comparison of 7 different mixing devices and handmixing.* *Acta Orthop Scand* 2004; 75: 559–566.
- Schlegel [2] UJ et al. *Pulsed lavage improves fixation strength of cemented tibial components.* *Int Orthop.* 2011; Aug; 35(8): 1165–1169.

- Schönherr et al. Zement in der Hüftendoprothetik – ein Update. OUP 2017; 4: 202–206.
- Seeger JB, et al. The effect of bone lavage on femoral cement penetration and interface temperature during Oxford unicompartmental knee arthroplasty with cement. *J Bone Joint Surg Am* 2013; 95 (1): 48–53.
- Sellei, RM. Die pulsierende Jet Lavage zur Hochdruckspülung in der zementierten Hüftendoprothetik/The pulsatile jet lavage as high pressure lavage in cemented total hip arthroplasty. Aachen: RWTH Aachen University [Diss.] 2005.
- Sharkey PF, et al. Why are total knee arthroplasties failing today? *Clin Orthop Relat Res* 2002; 404: 7–13.
- Sigmund IK et al. Mixing Technique of PMMA – Bone Cement Determines the Ideal Insertion Time Point in Cemented Arthroplasty. *J Surg.* 2018; JSUR-1153.
- Simpson et al. In vitro-Freisetzung von Antibiotika aus SmartSet HV- und Palacos R-Knochenzement. *Orthopäde* 2005; 34(12): 1255–1262.
- Spierings P. Properties of Bone Cement: Testing and Performance of Bone Cements. In: Breusch S, Malchau H eds. *The Well-Cemented Total Hip Arthroplasty*. Berlin/Heidelberg/New York: Springer Verlag 2005; 67–78.
- Springer BD et al. Cemented femoral stem fixation: back to the future. *JArthroplasty* 2023; 38(7): 38–44
- Sprowson AP et al. The use of high-dose dual-impregnated antibiotic-laden cement with hemiarthroplasty for the treatment of a fracture of the hip. *Bone Joint J.* 2016; 98-B: 1534–1541.
- Steiner O et al. Is benzoyl peroxide detectable under physiological conditions in orthopaedic cement? *Int. J. Nano and Biomaterials* 2021;10(1): 34-49
- Takahashi E et al. The influence of cement thickness on stem subsidence and cement creep in a collarless polished tapered stem: When are thick cement mantles detrimental? *Bone Joint Res.* 2017; 6(5): 351–357.
- Thomas [1] P. Allergic reactions to implant materials. *Orthopäde* 2003; 32: 60–64.
- Thomas [2] P et al. Charakteristika von 200 Patienten mit Verdacht auf Implantatallergie im Vergleich zu 100 beschwerdefreien Endoprothesenträgern. *Orthopäde* 2013; 8: 607–613.
- Thomsen M et al. Fracture load for periprosthetic femoral fractures in cemented versus uncemented hip stems: an experimental in vitro study. *Orthopedics* 2008; 31(7): 653.
- Toksvig-Larsen S. Cement interface temperature in hip arthroplasty. *Acta Orthop Scand* 1991; 62(2): 102–105.
- Trampuz A. Implant-associated biofilm. In: Ochsner P: *Infections of the musculoskeletal system*, Grandvaux: Swiss orthopaedics in-house publisher, 2014: 208–231.
- Vanlommel J et al. Cementing the tibial component in total knee arthroplasty: which technique is the best? *J Arthroplasty* 2011; 26(3): 492–496.
- Wahlig H. Kinetics of the liberation of antibiotics from bone cements--results of comparative studies in vitro and in vivo. *Chirurgie und Orthopädie* 1987; 31: 221–226.
- Webb JC, Spencer RF. The role of polymethylmethacrylate bone cement in modern orthopaedic surgery. *J Bone Joint Surg Br* 2007; 89(7): 851–857.
- Wang JS. The benefit of Vacuum Mixing. In: Breusch S, Malchau H, eds. *The Well-Cemented Total Hip Arthroplasty*, Springer Verlag 2005; 107–112.
- Whitehouse MR, Atwal NS, Pabbruwe M, Blom AW, Bannister GC. Osteonecrosis with the Use of Polymethylmethacrylate Cement for Hip Replacement: Thermal-Induced Damage Evidenced In Vivo by Decreased Osteocyte Viability. *Eur Cells Mater* 2014; 27: 50–63.
- Wilkinson JM, et al. Effect of mixing technique on the properties of acrylic bone-cement. *J Arthroplasty* 2000; 15 (5): 663–667.
- Wittmann D et al. Gentamicin allergy as an unexpected 'hidden' cause of complications in knee arthroplasty. *Contact Dermatitis* 2018; 78(4): 293–294.
- Wouthuyzen-Bakker M et al. Failure After 2-stage Exchange Arthroplasty for Treatment of Periprosthetic Joint Infection: The Role of Antibiotics in the Cement Spacer. In: *Clin Infec Dis.* **2018; 68(12): 2087–2093**
- Zmistowski B, Parvizi J. A quarter of patients treated for PJI dead within 5 years. *Orthopedics Today* 2013.