

# CERAMIC HIP RESURFACING

Next Generation of Hip Arthroplasty?

**BIOLOX<sup>®</sup>**  
**MATERIAL  
MATTERS<sup>®</sup>**

## REFERENCES

- Gerhardt D, Mors TGT, Hannink G, Van Susante JLC. Resurfacing hip arthroplasty better preserves a normal gait pattern at increasing walking speeds compared to total hip arthroplasty. *Acta Orthop*. 2019;90(3):231-236. doi:10.1080/17453674.2019.1594096.
- Zhao HY, Kang PD, Xia YY, Shi XJ, Nie Y, Pei FX. Comparison of Early Functional Recovery After Total Hip Arthroplasty Using a Direct Anterior or Posterolateral Approach: A Randomized Controlled Trial. *J Arthroplasty*. 2017;32(11):3421-3428. doi:10.1016/j.arth.2017.05.056.
- Logishetty K, Rudran B, Cobb JP. Virtual reality training improves trainee performance in total hip arthroplasty: a randomized controlled trial. *Bone Joint J*. 2019;101-B(12):1585-1592. doi:10.1302/0301-620X.101B12.BJJ-2019-0643.R1.
- Cobb JP, Kannan V, Brust K, Thevendran G. Navigation reduces the learning curve in resurfacing total hip arthroplasty. *Clin Orthop Relat Res*. 2007;463:90-97. doi:10.1097/BLO.0b013e318126c0a5.
- Van Der Straeten C. Hip resurfacing arthroplasty in young patients: international high-volume centres' report on the outcome of 11,382 metal-on-metal hip resurfacing arthroplasties in patients ≤50 years at surgery. *Hip Int*. 2020;1120700020957354. doi:10.1177/1120700020957354.
- Logishetty K, Muirhead-Allwood SK, Cobb JP. Hip resurfacing – what is its role in modern orthopaedics? *Bone & Joint 360*. 2020;9(1):4-9. doi:10.1302/2048-0105.91.360742.
- Total hip replacement and resurfacing arthroplasty for end-stage arthritis of the hip. *Technology appraisal guidance [TA304]*. Published February 26, 2014 www.nice.org.uk/guidance/ta304. Accessed June 10, 2021.
- FDA Executive Summary Memorandum - Metal-on-Metal Hip Implant Systems. Prepared for the June 27-28, 2012 Meeting of the Orthopaedic and Rehabilitation Devices Advisory Panel. Gaithersburg Hilton, Gaithersburg, Maryland.
- European Commission, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). *Opinion on The safety of Metal-on-Metal joint replacements with a particular focus on hip implants*. 2014. [https://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenihr\\_o\\_042.pdf](https://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_042.pdf). Accessed June 10, 2021.
- Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). *Hip, Knee & Shoulder Arthroplasty: 2020 Annual Report*, Adelaide; AOA, 2020: 1-474. [Accessed from: <https://aoanjrr.sahmri.com/annualreports-2020>].
- Further reading: de Villiers D, Richards L, Tuke M, Collins S. Ceramic resurfacing: the future and challenges. *Ann Joint*. 2020;5(12):1-6. doi:10.21037/aoj.2019.12.11.
- Further reading: Saracco A, Grassi A, Romagnoli M, et al. Reduced-dose computed tomography is the most accurate method to measure ceramic hip resurfacing cup version. *Eur J Radiol*. 2020;128:109040. doi:10.1016/j.ejrad.2020.109040.
- Piconi C, Porporati A A. Bioinert Ceramics: Zirconia and Alumina. *Handbook of Bioceramics and Biocomposites*. doi:10.1007/978-3-319-09230-0\_4-1. Springer International, 2015.
- Hanawa T (2019) Titanium–Tissue Interface Reaction and Its Control With Surface Treatment. *Front. Bioeng. Biotechnol*. 7:170. doi:10.3389/fbioe.2019.00170.
- Porporati A A, Piconi C, Mettang M, Deisinger U, Reinhardt C, Pitto R. Ceramics for artificial joints: The relevance of material biocompatibility. in: *Bioceramics*. <https://doi.org/10.1016/B978-0-08-102999-2.00012-0>. Elsevier, 2021.
- de Villiers D, Collins S. Resistance of a novel ceramic acetabular cup to critical impact loads. *J Engineering in Medicine* 2020. doi:10.1177/0954411920941383.
- de Villiers D, Collins S. Wear of large diameter ceramic-on-ceramic hip bearings under standard and microseparation conditions. *Biotribology*. 2020; 21:100117. doi:10.1016/j.biotri.2020.100117.
- Asif I M. *Characterisation and Biological Impact of Wear Particles from Composite Ceramic Hip Replacements*. [PhD thesis]. Leeds, UK: University of Leeds; 2018. [etheses.whiterose.ac.uk/20563](https://etheses.whiterose.ac.uk/20563). Accessed March 6, 2020.
- Cunningham BW, Hallab NJ, Hu N, McAfee PC. Epidural application of spinal instrumentation particulate wear debris: a comprehensive evaluation of neurotoxicity using an in vivo animal model. *J Neurosurg Spine*. 2013;19(3):336-350. doi:10.3171/2013.5.SPINE13166. Epub 2013 Jun 28.
- Kretzer JP, Mueller U, Streit MR, et al. Ion release in ceramic bearings for total hip replacement: Results from an in vitro and an in vivo study. *Int Orthop*. 2018;42(1):65-70. doi:10.1007/s00264-017-3568-1.
- Porporati AA, Piconi C, Mettang M, Deisinger U, Reinhardt C, Pitto R. 12 - Ceramics for artificial joints: The relevance of material biocompatibility. In: Osaka A, Narayan R, eds. *Bioceramics From Macro to Nanoscale. Elsevier Series on Advanced Ceramic Materials*. Elsevier; 2021. doi:10.1016/B978-0-08-102999-2.00012-0. Accessed November 10, 2020.
- Pitto RP, Sedel L. Periprosthetic joint infection in hip arthroplasty: Is there an association between infection and bearing surface type? *Clin Orthop Relat Res*. 2016;474(10):2213-2218. doi:10.1007/s11999-016-4916-y.
- Lenguerrand E, Whitehouse MR, Beswick AD, et al. Risk factors associated with revision for prosthetic joint infection after hip replacement: a prospective observational cohort study. *Lancet Infect Dis*. 2018;18(9):1004-1014. doi:10.1016/S1473-3099(18)30755-2.



# CERAMIC HIP RESURFACING

Next Generation of Hip Arthroplasty?

**BIOLOX<sup>®</sup>**  
**MATERIAL  
MATTERS<sup>®</sup>**

## REFERENCES

- Maccauro G, Cittadini A, Magnani G, et al. In vivo characterization of Zirconia Toughened Alumina material: a comparative animal study. *Int J Immunopathol Pharmacol.* 2010;23(3):841-846. doi:10.1177/039463201002300319.
- Savarino L, Baldini N, Ciapetti G, Pellacani A, Giunti A. Is wear debris responsible for failure in alumina-on-alumina implants? *Acta Orthop.* 2009;80(2):162-167. doi:10.3109/17453670902876730.
- Maccauro G, Bianchino G, Sangiorgi S, et al. Development of a new zirconia-toughened alumina: promising mechanical properties and absence of in vitro carcinogenicity. *Int J Immunopathol Pharmacol.* 2009;22(3):773-779. doi:10.1177/039463200902200323.
- Tsaousi A, Jones E, Case CP. The in vitro genotoxicity of orthopaedic ceramic (Al<sub>2</sub>O<sub>3</sub>) and metal (CoCr alloy) particles. *Mutat Res.* 2010;697(1-2):1-9. doi:10.1016/j.mrgentox.2010.01.012.
- Esposito C, Maclean F, Campbell P, Walter WL, Walter WK, Bonar SF. Periprosthetic tissues from third generation alumina-on-alumina total hip arthroplasties. *J Arthroplasty.* 2013;28(5):860-866. doi:10.1016/j.arth.2012.10.021.
- Madanat R, Laaksonen I, Graves SE, Lorimer M, Muratoglu O, Malchau H. Ceramic bearings for total hip arthroplasty are associated with a reduced risk of revision for infection. *Hip Int.* 2018;28(3):222-226. doi:10.1177/1120700018776464.
- Bordini B, Stea S, Castagnini F, Busanelli L, Giardina F, Toni A. The influence of bearing surfaces on periprosthetic hip infections: analysis of thirty nine thousand, two hundred and six cementless total hip arthroplasties. *Int Orthop.* 2019;43(1):103-109. doi:10.1007/s00264-018-4097-2.
- Sorrentino R, Cochis A, Azzimonti B, et al. Reduced bacterial adhesion on ceramics used for arthroplasty applications. *J Eur Ceram Soc.* 2018;38(3):963-970. doi:10.1016/j.jeurceramsoc.2017.10.008.
- Trampuz A, Maiolo EM, Winkler T, Perka C. Biofilm formation on ceramic, metal and polyethylene bearing components from hip joint replacement systems. *Orthopaedic Proceedings.* 2016;98-B(SUPP 10):80-80. doi:10.1302/1358-992X.98BSUPP\_10.ISTA2015-080.
- Beraudi A, Stea S, De Pasquale D, et al. Metal ion release: also a concern for ceramic-on-ceramic couplings? *Hip Int.* 2014;24(4):321-326. doi:10.5301/hipint.5000132.
- Kocagöz SB, Underwood RJ, MacDonald DW, Gilbert JL, Kurtz SM. Ceramic heads decrease metal release caused by head-taper fretting and corrosion. *Clin Orthop Relat Res.* 2016;474(4):985-994. doi:10.1007/s11999-015-4683-1.
- Thomas P, Stea S. *Metal Implant Allergy and Immuno-Allergological Compatibility Aspects of Ceramic Materials.* Heidelberg, Germany: Springer-Verlag Berlin Heidelberg; 2015.
- Bergschmidt P, Bader R, Ganzer D, et al. Ceramic femoral components in total knee arthroplasty - two year follow-up results of an international prospective multi-centre study. *Open Orthop J.* 2012;6:172-178. doi:10.2174/1874325001206010172.
- Sharplin P, Wyatt MC, Rothwell A, Frampton C, Hooper G. Which is the best bearing surface for primary total hip replacement? A New Zealand Joint Registry study. *Hip Int.* 2017;28(4):352-362. doi:10.5301/hipint.5000585.
- Peters RM, Van Steenberghe LN, Stevens M, Rijk PC, Bulstra SK, Zijlstra WP. The effect of bearing type on the outcome of total hip arthroplasty. *Acta Orthop.* 2018;89(2):163-169. doi:10.1080/17453674.2017.1405669.
- Higuchi Y, Seki T, Hasegawa Y, Takegami Y, Morita D, Ishiguro N. 32-mm ceramic-on-ceramic total hip arthroplasty versus 28-mm ceramic bearings: 5- to 15-year follow-up study. *Hip Int.* 2019;29(1):65-71. doi:10.1177/1120700018760971.
- Toni A, Giardina F, Guerra G, et al. 3rd generation alumina-on-alumina in modular hip prosthesis: 13 to 18 years follow-up results. *Hip Int.* 2017;27(1):8-13. doi:10.5301/hipint.5000429.
- Kim YH, Park JW, Kulkarni SS, Kim YH. A randomised prospective evaluation of ceramic-on-ceramic and ceramic-on-highly cross-linked polyethylene bearings in the same patients with primary cementless total hip arthroplasty. *Int Orthop.* 2013;37(11):2131-2137. doi:10.1007/s00264-013-2036-9.
- Piconi C, Porporati AA, Streicher RM. Ceramics in THR bearings: behavior under off-normal Conditions. *Key Eng Mat.* 2014;631:3-7. doi:10.4028/www.scientific.net/kem.631.3.
- Lee R, Essner A, Wang A, Jaffe WL. Scratch and wear performance of prosthetic femoral head components against crosslinked UHMWPE sockets. *Wear.* 2009;267(11):1915-1921. doi:10.1016/j.wear.2009.03.034.
- De Fine M, Terrando S, Hintner M, Porporati AA, Pignatti G. Pushing Ceramic-on-Ceramic in the most extreme wear conditions: A hip simulator study. *Orthop Traumatol Surg Res.* 2020;S1877-0568(20)30184-5. doi:10.1016/j.otsr.2020.05.003.
- Caravaca C, Porporati AA, Streicher R. Wettability of bearing couples: how to prepare the surfaces. *Orthopaedic Proceedings.* 2016;98-B(SUPP 7):67.
- Panagiotidou A, Meswania J, Osman K, et al. The effect of frictional torque and bending moment on corrosion at the taper interface: an in vitro study. *Bone Joint J.* 2015;97-B(4):463-472. doi:10.1302/0301-620X.97B4.34800.
- Kurtz SM, Kocagöz SB, Hanzlik JA, et al. Do ceramic femoral heads reduce taper fretting corrosion in hip arthroplasty? A retrieval study. *Clin Orthop Relat Res.* 2013;471(10):3270-3282. doi:10.1007/s11999-013-3096-2.
- Kurtz SM, Kocagöz S, Arnholt C, Huet R, Ueno M, Walter WL. Advances in zirconia toughened alumina biomaterials for total joint replacement. *J Mech Behav Biomed Mater.* 2014;31:107-116. doi:10.1016/j.jmbm.2013.03.022.
- Vrbka M, Nečas D, Bartošik J. Determination of a friction coefficient for THA bearing couples. *Acta Chir Orthop Traumatol Cech.* 2015;82(5):341-347.



# CERAMIC HIP RESURFACING

Next Generation of Hip Arthroplasty?

**BIOLOX<sup>®</sup>**  
**MATERIAL  
MATTERS<sup>®</sup>**

## REFERENCES

- Grupp TM, Holderied M, Mulliez MA, et al. Biotribology of a vitamin E-stabilized polyethylene for hip arthroplasty – Influence of artificial ageing and third-body particles on wear. *Acta Biomater.* 2014;10(7):3068–3078. doi:10.1016/j.actbio.2014.02.052.
- Nikolaou VS, Edwards MR, Bogoch E, Schemitsch EH, Waddell JP. A prospective randomized controlled trial comparing three alternative bearing surfaces in primary total hip replacement. *J Bone Joint Surg Br.* 2012;94-B(4):459-465. doi:10.1302/0301-620X.94B4.27735.
- Higuchi Y, Hasegawa Y, Seki T, Komatsu D, Ishiguro N. Significantly Lower Wear of Ceramic-on-Ceramic Bearings Than Metal-on-Highly Cross-Linked Polyethylene Bearings: A 10- to 14-Year Follow-Up Study. *J Arthroplasty.* 2016;31(6):1246-1250. doi:10.1016/j.arth.2015.12.014.
- Higuchi Y, Seki T, Morita D, Komatsu D, Takegami Y, Ishiguro N. Comparison of wear rate between ceramic-on-ceramic, metal on highly cross-linked polyethylene, and metal-on-metal bearings. *Rev Bras Ortop (Sao Paulo).* 2019;54(3):295-302. doi:10.1055/s-0039-1691762.
- Zietz C, Bergschmidt P, Lange R, Mittelmeier W, Bader R. Third-body abrasive wear of tibial polyethylene inserts combined with metallic and ceramic femoral components in a knee simulator study. *Int J Artif Organs.* 2013;36(1):47-55. doi:10.5301/ijao.5000189.
- Wyles CC, McArthur BA, Wagner ER, Houdek MT, Jimenez-Almonte JH, Trousdale RT. Ceramic femoral heads for all patients? An argument for cost containment in hip surgery. *Am J Orthop (Belle Mead NJ).* 2016;45(6):E362-E366.
- Carnes KJ, Odum SM, Troyer JL, Fehring TK. Cost analysis of ceramic heads in primary total hip arthroplasty. *J Bone Joint Surg Am.* 2016;98(21):1794-1800. doi:10.2106/JBJS.15.00831.
- Kurtz SM, Lau E, Baykal D, Odum S, Springer BD, Fehring TK. Are ceramic bearings becoming cost-effective for all patients? *J Arthroplasty.* 2018;33(5):1352-1258. doi:10.1016/j.arth.2017.12.011.
- Kurtz SM, Lau E, Baykal D, Odum SM, Springer BD, Fehring TK. Are ceramic bearings becoming cost-effective for all patients within a 90-day bundled payment period? *J Arthroplasty.* 2019;34(6):1082-1088. doi:10.1016/j.arth.2019.01.074.

The H1<sup>®</sup> Anatomic Ceramic Hip Resurfacing made of BIOLOX<sup>®</sup>delta is in clinical investigation in the EU and UK by Embody Orthopaedic Ltd. The H1<sup>®</sup> is investigational device tested in a clinical study approved by MHRA and NHS, respectively. The H1<sup>®</sup> Anatomic Ceramic Hip Resurfacing is not approved by any authorities and is not commercially available. The products are not cleared or approved by the FDA for distribution in the United States.

The H1<sup>®</sup> (Embody Ltd.) is undergoing Clinical Investigations approved by the UK Health Research Authority.

All statements are provided for educational purposes. For product, safety, and risk information, always refer to the labeling of the legal manufacturer

BIOLOX<sup>®</sup>delta, BIOLOX<sup>®</sup>OPTION, BIOLOX<sup>®</sup> and CeramTec are registered trademarks of the CeramTec Group, Germany.

H1<sup>®</sup> is a registered trademark of Embody Limited. Images and content provided by Embody Limited are subject to copyright. All rights reserved.

