BIRMINGHAM HIP◊ Resurfacing (BHR◊) System – long-term survivorship and clinical outcomes at 20 years

Summary

- The BIRMINGHAM HIP Resurfacing (BHR) System provides a bone-conserving alternative to total hip arthroplasty (THA) for young, active male patients.[1]
- BHR demonstrates similarly high survivorship compared with other currently available hip resurfacing arthroplasty (HRA) prostheses at 15 years and, with the longest registry data, shows good survivorship up to 20 years.[1]
- BHR patients demonstrate significant post-operative improvements in functional outcomes, including reductions in stiffness, and restoration of mobility and gait, potentially permitting them to maintain a highly active lifestyle.[2–8]
- Patients report improvements in quality of life, reductions in pain, and are more satisfied with how their joint is performing following BHR implantation, compared with both pre-operative scores[4, 5, 9] and other resurfacing hips.[10]

The potential advantages of HRA versus THA

HRA provides a bone-conserving alternative to THA in younger, active male patients. In contrast to THA, in which the femoral head is removed and replaced by a prosthesis, HRA involves resurfacing of the femoral head. Where indicated, HRA possesses numerous potential advantages over THA,[11, 12] as illustrated in Figure 1.

Based on data from the two largest national joint replacement registries (Australian Orthopaedic Association National Joint Replacement Registry [AOAJNRR; n=11,892]; UK National Joint Registry [UK NJR; n=14,731]), HRA shows excellent survivorship in the indicated cohort at 20 years (Figure 1).[1, 13] In male patients aged <55 years, HRA demonstrates >89% survivorship at 18 years following surgery.[13]

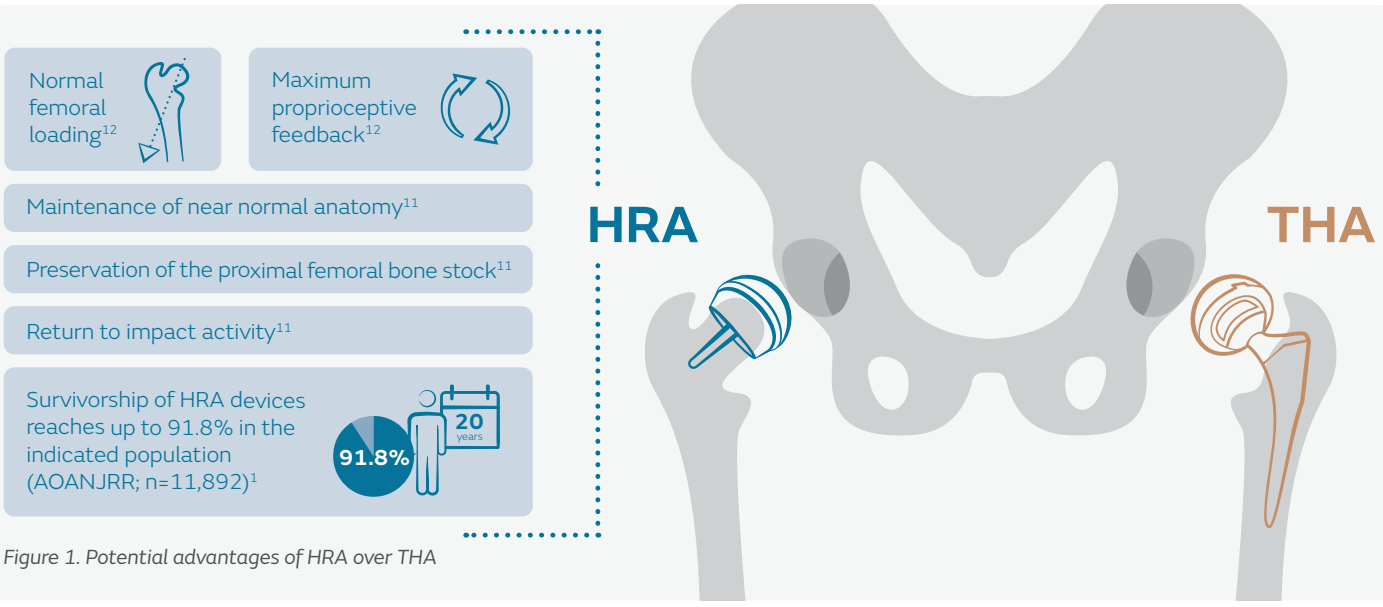


Figure 1. Potential advantages of HRA over THA

BHR

BHR was first implanted in 1997 and remains one of the most commonly implanted and well-studied HRA prostheses.[11] Today BHR is indicated for use in male patients requiring primary HRA due to non-inflammatory arthritis (degenerative joint disease) such as osteoarthritis, traumatic arthritis, avascular necrosis, or inflammatory arthritis such as rheumatoid arthritis.[15] BHR has been contraindicated for use in females since 2015, and femoral component sizes ≤46 mm are no longer available. By conserving more bone, younger patients preserve future surgery options, including a THA, if later indicated.

BIRMINGHAM HIP Resurfacing (BHR) System

OPEP awarded the below rating for its use with males only and for sizes 48–62mm only:[14]

15A*

Excellent long-term survivorship†

With over 20 years of clinical history, much of the BHR◊ survivorship data include all patients initially indicated for this prosthesis. Long-term survivorship data for BHR are available from the AOANJRR and the UK NJR (as the latter does not provide BHR data stratified by sex, we report on the former) and mid- to long-term clinical trials.[1] In an analysis of male BHR patients using AOANJRR data, survivorship remained higher for BHR compared with other HRA prostheses at 18 years (Figure 2).[16]

Registry data are corroborated by the literature, with studies reporting excellent mid- to long-term survivorship in BHR patients which, when stratified by sex, is further improved in males.[17, 18] In a study of 226 BHR patients (79.8% male), implant survivorship was reported to be 99.4% (95% confidence interval [CI]: 98.4%, 100%) in males at 15 years.[18] Further studies have demonstrated similar results. Survivorship was 97% at 13 years in an analysis of 2,241 consecutive male BHR patients.[17] In another study that included 280 primary BHR hip procedures, all-cause survivorship was 96.0% (95% CI: 93.1%, 98.9%) amongst male patients <65 years old at the time of procedure.[8]

Survivorship is higher for BHR, compared with all HRA prostheses, at 18 years (92.4% vs 84.0%, respectively; n=15,081; 100% male)[16]

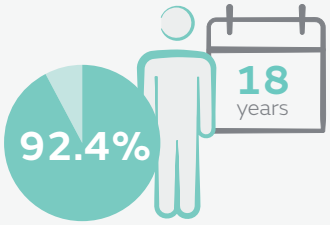


Figure 2. BHR demonstrates superior survivorship compared with alternative HRA procedures at 18 years in the indicated population[16]

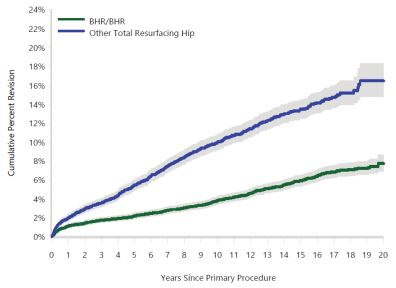
Reasons for revisions

According to the AOANJRR, in male patients, ~70% of BHR revisions can be attributed to three events: loosening, fracture and metal-related pathology.[1] However, when compared with other HRA prostheses, BHR performs statistically significantly better than the class average in terms of revision rate (p<0.001; Figure 3).[16]

Significantly lower risk of all-cause revision compared with all other HRA prostheses (58% reduction; p<0.001)

Lower rate of revision due to metal-related pathology (0.9 vs 3.6%)

Figure 1: Cumulative Percent Revision of Primary Total Resurfacing Hip Replacement by Model (All Diagnoses)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs	9 Yrs
BHR/BHR	8801	8594	8393	8203	8035	7858	7642	7436	7108	6808
Other Total Resurfacing Hip	6821	6361	5922	5501	5210	4880	4556	4297	4128	3943

Number at Risk	10 Yrs	11 Yrs	12 Yrs	13 Yrs	14 Yrs	15 Yrs	16 Yrs	17 Yrs	18 Yrs	19 Yrs	20 Yrs
BHR/BHR	6444	6027	5447	4897	4318	3700	3051	2374	1699	1018	378
Other Total Resurfacing Hip	3769	3574	3211	2736	2183	1658	1135	683	351	181	79

Lower rate of revision due to loosening (1.6 vs 3.5%)

Lower rate of revision due to fracture (1.3 vs 2.3%)

Figure 3. Cumulative percent revision and reasons for revision at 20 years for BHR compared with all other HRA prostheses in male patients, based on AOANJRR registry data[16§]

§Smaller component sizes were included in this analysis. HR = hazard ratio. This figure includes Figure 1 from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR), Automated Industry Report System (AIRS), ID No.5815 for Smith+Nephew, BHR Total Resurfacing Hip, (Procedures from 1 September 1999–25 January 2022), Accessed 14 November 2022, AOA, Adelaide: 1–16.[16]

Additional clinical outcomes

Functional outcomes

Survivorship is an important measure of the success of HRA implants; however, it represents just one outcome. Functional outcomes and health-related quality of life (HRQoL) provide a measure of the benefits to patients beyond implant survivorship. BHR patients have demonstrated improved functional outcomes compared with pre-operation and THA patients, including reduced stiffness and restoration of mobility and gait, that may help patients maintain a highly active lifestyle (Figure 4).[2–8] Of note, better outcomes are observed in the indicated population,[9, 19] and in cases where the surgeon is experienced with HRA.[20]

†Clinical outcomes data were sourced from the two largest joint replacement registries (AOANJRR and the UK NJR) and long-term clinical trials which, where possible, include only the indicated population. See Table 1 within the additional information for patient populations within each dataset.

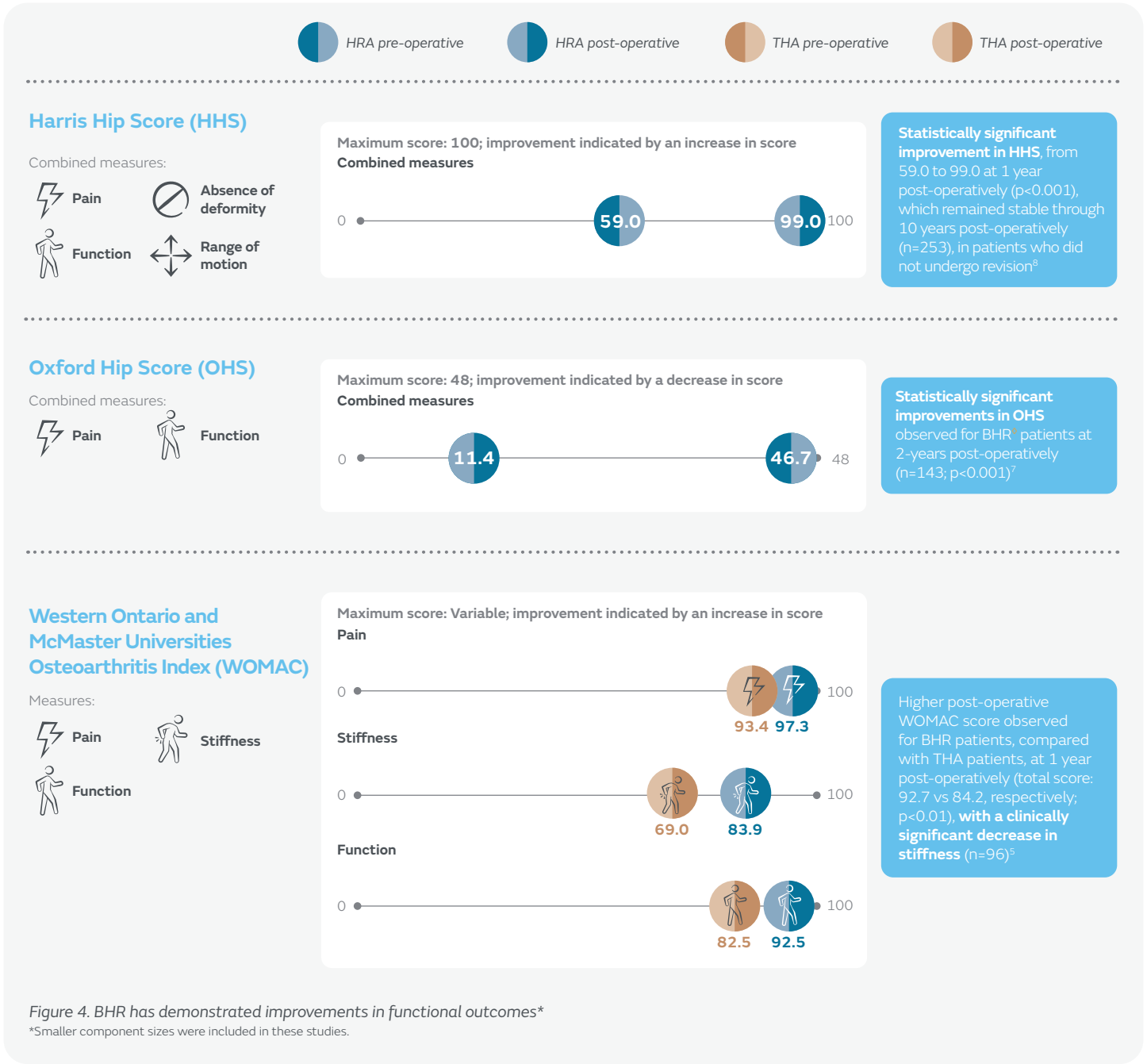


*Figure 4. BHR has demonstrated improvements in functional outcomes**

*Smaller component sizes were included in these studies.

HRQoL

Patients consistently report improvements from pre-operative HRQoL scores, via SF Health Survey (SF-12 or SF-36), Veteran's Rand 12 or 36 and EQ-5D, following BHR implantation.[4, 5, 18, 21] BHR patients also report higher post-operative HRQoL scores when compared with THA patients (Figure 5),[5, 22] and when compared with all other HRA prostheses.[10] In addition, studies have shown BHR patients experience substantial reductions in pain and improvements in satisfaction, activity and overall health status post-operatively which can be maintained for up to ten years.[4, 8, 9]

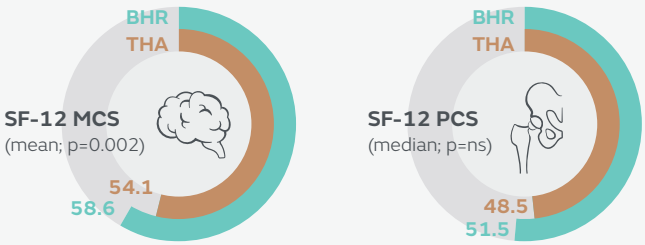


Figure 5. BHR demonstrates improvements in post-operative HRQoL compared with THA, at a median follow up time of 36.2 months for BHR and 62.3 months for THA[22]

MCS = mental component summary; PCS = physical component summary.

Radiographic stability and osteolysis

Radiographic component migration and/or loosening and the occurrence of osteolysis are both significant complications following hip procedures.[23] Overall, limited radiographic migration/loosening has been observed in BHR◊ patients,[2–5, 9, 17, 21] with low rates of osteolysis.[3, 6, 9, 17] In a study of 280 primary BHR procedures, 5 revisions due to femoral loosing, 2 due to osteolysis and 1 due to acetabular loosening were reported at 10 years post-operatively.[8] In the 218 hips that remained unrevised after 10 years (n=218), limited radiographic loosening was observed alongside 10 cases of osteolysis.[8]

Whole blood metal ions

Whole blood metal ion levels may provide an indication of the extent of wear after HRA procedures.[8, 24] Median whole blood cobalt (Co) and chromium (Cr) levels increased at 1 year post-operation compared to pre-operative levels (Co: 0.12 vs 1.5 parts per billion (ppb), p<0.001; Cr: 0.6 vs 1.7ppb, p<0.001) in one study of BHR patients (n=253) with a minimum of 9.5 years follow up.[8] These metal ion concentrations remained stable between 1 and 5 years post-operation (Co: p=0.3; Cr: p=0.13), before significantly decreasing at 10 years post-operation (Co: 1.3ppb, p<0.001; Cr: 1.4ppb, p<0.001). The number of patients with postoperative Co and/or Cr levels at >7ppb remained similar over time (3.4% at 1 year and 4.4% at 10 years post-operation, p=0.60).[8]

Conclusions

BHR is one of the most commonly utilised and well-studied HRA prostheses, with a 20-year clinical history, and has been awarded the ODEP rating, 15A*.[14] Long-term survivorship data from the two largest joint replacement registries show that BHR possesses a similarly high survivorship rate compared with other HRA implants,[1, 13, 16] and demonstrates lower rates of revision due to metal-related pathology, loosening or fracture.[16] Moreover, BHR patients demonstrate substantial improvements in functional outcomes,[2–8] quality of life[4, 5, 18, 21, 22] and satisfaction,[4, 9] both post-operatively and in comparison to THA. BHR protheses show good radiographic stability[2–5, 9, 17, 21] and low rates of osteolysis;[3, 6, 9, 17] stable whole blood metal ion levels between 1 and 5 years post-operation have been observed in one study with a minimum of 9.5 years follow up.[8] Ultimately, BHR may provide younger or more active male patients with a bone-conserving, anatomically improved alternative to THA that may support an active lifestyle.

Additional information

Table 1. Characteristics of patient populations for included studies

Study	Patients, n	Hips, n	% male	Mean age, years (range)
Ford (2018)[2]	314	360	86.4	52.0 (22.8–81.6)
Jonas (2019)[3]	51	54	75.9	49.8 (18.0–67.0)
Sandiford (2014)[4]	107	109	42	44.0 (21.0–65.0)
Fink Barnes (2014)[5]	80	89	100	52.7 (35.0–64.0)
Konopka (2018)[6]	21	23	NR	NR
Pérez-Moro (2019)[7]	145	145	80.7	49.5 (NR)
Su (2021)[8]*	253	280	73.6	51.3 (22.0–72.0)
Coulter (2012)[9]	213	230	66	52.1 (18.0–82.0)
McMinn (2011)[17]	NR	3,095	72.4	53.0 (13.0–86.0)
Scholes (2019)[18]	226	238	79.8	45.0† (NR)
Carrothers (2011)[19]	NR	5,000	67	52.5 (13.0–87.0)
Aulakh (2014)[20]	4,535	5,000	NR	NR
Oak (2017)[21]	479	541	72.3	53.0 (14.0–80.1)
Ortiz-Declet (2017)[22]	42	42	100	49.1 (NR)

*This study by Su et al. reports on results from mixed male/female populations using certain implant sizes that are no longer available. Smith & Nephew, Inc., no longer distributes the 46mm diameter and smaller femoral heads and corresponding acetabular cup components for the BHR◊ System that were part of this evidence, and contraindicates the use of the device for females.
†Denotes median, not mean. NR = not recorded.

Statements from registries

We thank the patients and staff of all the hospitals in England, Wales and Northern Ireland who have contributed data to the National Joint Registry. We are grateful to the Healthcare Quality Improvement Partnership (HQIP), the NJR Steering Committee and staff at the NJR Centre for facilitating this work. The views expressed represent those of the authors and do not necessarily reflect those of the National Joint Registry Steering Committee or the Health Quality Improvement Partnership (HQIP) who do not vouch for how the information is presented.

The data from the NJR: BHR Resurfacing Head implant summary report[10] used in this material was obtained from the NJR Supplier Feedback System. The Healthcare Quality Improvement Partnership ("HQIP") and/or the National Joint Registry ("NJR") take no responsibility for the accuracy, currency, reliability and correctness of any data used or referred to in this report, nor for the accuracy, currency, reliability and correctness of links or references to other information sources and disclaims all warranties in relation to such data, links and references to the maximum extent permitted by legislation.

The AOANJRR has taken every care to ensure that the data supplied (AOANJRR Hip, Knee & Shoulder Arthroplasty: BHR Total Resurfacing Hip automated industry report 3508)[16] are accurate but does not warrant that the data are error free and does not accept any liability for errors or omissions in the data.

References

1. Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) Hip, Knee & Shoulder Arthroplasty: 2022 Annual Report. Available at: https://aoanjrr.sahmri.com/annual-reports-2022. Accessed 25 October 2022. **2.** Ford MC, Hellman MD, Kazarian GS, Clohisy JC, Nunley RM, Barrack RL. Five to ten-year results of the Birmingham hip resurfacing implant in the U.S.: a single institution's experience. *J Bone Joint Surg Am*. 2018;100:1879–1887. **3.** Jonas SC, Whitehouse MR, Bick S, Bannister GC, Baker RP. An 18-year comparison of hybrid total hip replacement and Birmingham hip resurfacing in active young patients. *Hip Int*. 2019;29:630–637. **4.** Sandiford NA, Ahmed S, Doctor C, East DJ, Miles K, Apthorp HD. Patient satisfaction and clinical results at a mean eight years following BHR arthroplasty: results from a district general hospital. *Hip Int*. 2014;24:249–255. **5.** Fink Barnes LA, Johnson SH, Patrick DA, Jr., Macaulay W. Metal-on-metal hip resurfacing compared with total hip arthroplasty: two to five year outcomes in men younger than sixty five years. *Int Orthop*. 2014;38:2435–2440. **6.** Konopka JF, Buly RL, Kelly BT, Su EP, McLawhorn AS. The effect of prior hip arthroscopy on patient-reported outcomes after total hip arthroplasty: an institutional registry-based, matched cohort study. *J Arthroplasty*. 2018;33:1806–1812. **7.** Pérez-Moro OS, Fernández-Cuadros ME, Neira-Borrajo I, Aranda-Izquierdo E, Albaladejo-Florin MJ, Llopis-Miró R. Short and mid-term outcomes and functional results in metal-on-metal hip resurfacing arthroplasty at 5 years follow-up: the Spanish experience. *BMC Musculoskelet Disord*. 2019;20:172. **8.** Su EP, Ho H, Bhal V, et al. Results of the first U.S. FDA-approved hip resurfacing device at 10-year follow-up. *J Bone Joint Surg Am*. 2021;103:1303–1311. **9.** Coulter G, Young DA, Dalziel RE, Shimmin AJ. Birmingham hip resurfacing at a mean of ten years: results from an independent centre. *J Bone Joint Surg Br*. 2012;94:315–321. **10.** National Joint Registry for England, Wales and Northern Ireland: BHR Resurfacing Head implant summary report. 18 May 2022. Copy available from Smith & Nephew on request. Accessed 12 August 2022. **11.** Sershon R, Balkissoon R, Valle CJ. Current indications for hip resurfacing arthroplasty in 2016. *Curr Rev Musculoskelet Med*. 2016;9:84–92. **12.** Smith & Nephew. The advantages of hip resurfacing with BIRMINGHAM HIP. Available at: https://www.smith-nephew.com/education/resources/video/2019/reconstruction/nahks-2019/the-advantages-of-hip-resurfacing-with-birminghamhip/#. Accessed 12 August 2022. **13.** National Joint Registry for England, Wales and Northern Ireland: 19th Annual Report. Available at: https://reports.njrcentre.org.uk. Accessed 25 October 2022. **14.** Orthopaedic Data Evaluation Panel (ODEP). BIRMINGHAM HIP™ RESURFACING DEVICE. Available at: http://www.odep.org.uk/product.aspx?pid=167. Accessed 12 August 2022. **15.** Smith & Nephew. Birmingham Hip Resurfacing System. Surgical Technique. 04727 V2 45670103 REVC 01/18. Available at: https://www.smith-nephew.com/global/surgicaltechniques/recon/04727%20v2%2045670103%20revc%20us%20bhr%20surgical%20technique%2001.18hr.pdf. Accessed 12 August 2022. **16.** Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR), Automated Industry Report System (AIRS), ID No.5815 for Smith+Nephew, BHR Total Resurfacing Hip, (Procedures from 1 September 1999–25 January 2022), Accessed 14 November 2022, AOA, Adelaide: 1–16. **17.** McMinn DJ, Daniel J, Ziaee H, Pradhan C. Indications and results of hip resurfacing. *Int Orthop*. 2011;35:231–237. **18.** Scholes CJ, Ebrahimi M, Farah SB, et al. The outcome and survival of metal-on-metal hip resurfacing in patients aged less than 50 years: a prospective observational cohort study with minimum ten-year follow-up. *Bone Joint J*. 2019;101-b:113–120. **19.** Carrothers AD, Gilbert RE, Richardson JB. Birmingham hip resurfacing in patients who are seventy years of age or older. *Hip Int*. 2011;21:217–224. **20.** Aulakh TS, Jayasekera N, Singh R, Patel A, Kuiper JH, Richardson JB. Hip resurfacing arthroplasty: a new method to assess and quantify learning phase. *Acta Orthop Belg*. 2014;80:397–402. **21.** Oak SR, Strnad GJ, O'Rourke C, Higuera CA, Spindler KP, Brooks PJ. Mid-term results and predictors of patient-reported outcomes of Birmingham hip resurfacing. *J Arthroplasty*. 2017;32:110–118. **22**. Ortiz-Declet VR, Iacobelli DA, Yuen LC, Perets I, Chen AW, Domb BG. Birmingham hip resurfacing vs total hip arthroplasty: a matched-pair comparison of clinical outcomes. *J Arthroplasty*. 2017;32:3647–3651. **23.** Mushtaq N, To K, Gooding C, Khan W. Radiological imaging evaluation of the failing total hip replacement. *Front Surg*. 2019;6:35. **24.** De Smet K, De Haan R, Calistri A, et al. Metal ion measurement as a diagnostic tool to identify problems with metal-on-metal hip resurfacing. *J Bone Joint Surg Am*. 2008;90:202–208.

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