■ ANNOTATION

Sport after total hip arthroplasty: undoubted progress but still some unknowns

R. M. D. Meek,
R. Treacy,
A. Manktelow,
J. A. Timperley,
F. S. Haddad

From Queen Elizabeth University Hospital, Glasgow, UK

In this review, we discuss the evidence for patients returning to sport after hip arthroplasty. This includes the choices regarding level of sporting activity and revision or complications, the type of implant, fixation and techniques of implantation, and how these choices relate to health economics. It is apparent that despite its success over six decades, hip arthroplasty has now evolved to accommodate and support ever-increasing patient demands and may therefore face new challenges.

Cite this article: *Bone Joint J* 2020;102-B(6):661–663.

Total hip arthroplasty (THA) has been described as the operation of the century.[1] When Sir John Charnley reflected on his creation, he determined that his implant could endure for 30 years, but not with the patient playing football.[2] Although they may be influenced by the advice of their surgeons, patients are free, and usually able, to undertake the activities they wish postoperatively. The reality of what patients achieve in terms of both intensity and duration of activity is often different from what they report, and from what they are advised that they should carry out. A mismatch between expectations and outcome can contribute to 15% of patients reported to be dissatisfied with their outcome despite having good functional scores.[3] Under the Montgomery ruling,[4] we should be prepared to advise individual patients on the level of sport to which they can expect to return and to the potential complications, including the wear and fixation related consequences, that could result.

Previous reviews of the literature[5-7] have reported that participation in sporting activity following joint arthroplasty is common and is principally determined by the preoperative patient activity levels, body mass index, and patient age. Post-arthroplasty, the total time spent performing sporting activity was not reported to change, but activity tends to be at a lower intensity. It is theorized that excessive motion at the biological interface of more than 30 μm to 150μm will to lead to fibrous tissue formation, rather than osseointegration.[8] It is also suggested that this can be improved by topographic modification at the nanoscale level of the surface of uncemented devices.[9] Alternatively, polymethylmethacrylate used in the fixation of hip implants has demonstrated osseointegration over a long postoperative period.[10] However, given there is no reported correlation with sporting activity increasing the prevalence of failure of either fixation it appears the present fixations and bearings are adequate in the short- to medium-term for amateur sporting activity.[5]

It also appears that, at present, there is no substantial literature reporting an association with early activity and arthroplasty complications such as fracture or instability. Indeed, recent evidence around early dislocation would suggest that a disregard of precautions and active return to lifestyle activity may actually be beneficial.[11,12] This may, to some extent, have been influenced by improved surgical technique for existing approaches and the evolution of soft-tissue preserving approaches, combined with increasing femoral head size and improved implant positioning facilitated by various devices and surgical strategies. The latest data reported from the National Joint Registry of England Wales and the Isle of Man demonstrated 96% survival at five years, even in patients under 20 years of age at the time of arthroplasty.[13]

This leaves three key issues to be considered:

1. Choice of activity post-hip surgery and early failure. There is no evidence as yet that hip implants fail earlier with increased sporting activity, but not many studies report beyond ten years follow-up. The results of implants such as the Birmingham hip resurfacing (Smith & Nephew, Warwick, UK) and THAs such as the Exeter (Stryker, Newbury, UK) have been impressive in young patients under 40 years of age in terms of survival,[14-17] although the indications for surgery in these young patients are varied and activity levels are not reported in detail. More evidence is required on sub-stratifying the level of sporting activity achieved in these cohorts, which would allow more accurate evaluation of whether long-term survival in the very active is indeed inferior. There have been limited reports that high

Correspondence should be sent to R. M. D. Meek; email: rmdmeek@doctors.org.uk

doi:10.1302/0301-620X.102B6.BJJ-2020-0208 $2.00

Bone Joint J 2020;102-B(6):661–663.

University of California, Los Angeles (UCLA) score activity has not reduced the survivorship of hip resurfacing arthroplasties.[18] However, the UCLA score is subject to ceiling effects and does not differentiate active from extremely active patients leading Amstutz and Le Duff to report on the new "quantity of activity" equation avoiding this.[19] From 806 hip resurfacings assessed by this measure, there was still no specific type of postoperative sporting activity associated with detrimental survivorship.[19] With surgeons appearing to be less restrictive on the activities of patients post-THA, it will be interesting to see if their survival is also as good at 20 years when exposed to more extreme activities and sports.

2. Choices of implant and technique. Some evidence reports bone-saving hip surgery is superior in highly functioning athletes,[20] with gait analysis reporting a return to practically normal patterns.[21,22] Determining an accurate assessment of true activity levels, perhaps by monitoring activity in different cohorts using wearable devices, would allow further comparison.

Early data on bicompartmental knee arthroplasties with either patient-specific instruments or robotic assistance, utilizing new patient-reported outcome measures (PROMs) not subject to ceiling effects, report differential benefits at the high functional end of activity.[23] Similarly, robotic-arm assisted THA has been reported to show improved accuracy in restoring the native centre of rotation, better preservation of the combined offset, and more precise acetabular component positioning within the safe zones of inclination and anteversion compared with conventional manual THA.[24] Whether this will translate into demonstrable superior functional outcomes and return to high-level sport with no worsening of the implant survival is still to be reported. In addition, studies need to be carried out to prove whether robot technology can be used in conjunction with tendon-sparing approaches[25] to improve function. As above, Amstutz reports that well-designed and implanted hip resurfacing arthroplasties permitted patients to return to unlimited sporting activities when assessed using a quantity of activity equation. It will be interesting to see if THAs subjected to higher activity levels and recreational sport can attain these results.[19]

As discussed above, a problem with the assessment of outcome after arthroplasty by PROM scores is that all of the traditionally used measures are subject to ceiling effects; these are particularly problem when attempting to demonstrate differences between highly functioning groups. More specific objective outcome measurements are required to record and evaluate the functional outcome and potential benefits of surgical intervention in these patients.[26] Other recent research has identified the longer-term longitudinal outcomes of PROMs with particular patient risk factors for deterioration.[27] Having identified these factors, it will be interesting to establish whether optimization of the modifiable risk factors for PROM deterioration will lead to improved long-term prognosis. At the very least it will provide additional information to guide the expectations of both patients and surgeons.

Recent biomechanical research has demonstrated the potential importance, and perhaps a lack of existing understanding of the hip joint capsule, as it passively restrains extreme range of motion, protecting the native hip from impingement, dislocation, and edge-loading.[28] With standard THA, the reduced femoral head size can impair this protective biomechanical function. However, the choice of more anatomical larger head sizes raises more questions than answers given the issues concerning taper issues and accelerated wear.[29]

3. Choices in relation to health economics. Can we afford an operation that takes significantly longer or costs more, such as a robotic tricompartmental knee, a hip resurfacing, or a large head ceramic on ceramic bearing, for all appropriate patients keen to enjoy enhanced levels of activity, or is it only the selected athlete who should be chosen? Will increasing the volume of activity reduce the cost and make this more available to all patients? Will improved survival of the implant and better functional activity, if proven, justify the cost?

Ethical, moral, and practical health economic decisions will be required by surgeons and commissioners and managers, supported by central data sources, and existing and future literature, to determine what is best for the patient and the local health care environment. Information from co-ordinated trials and big datasets will be vital to achieve this aim. For example, further research on the known 3D effects of spino-pelvic relationship and kinematics[30] may be conducted on high-functioning athletes and the reported results could be extended to other patient groups.

Despite its success over six decades, hip arthroplasty has now evolved to accommodate and support ever-increasing patient demands and may therefore face new challenges. It is clear that no single implant can cater for the needs of every patient. Advances in technology, technique, biomaterials, and training, alongside improved methods of assessment and better communication, will equip surgeons to meet this challenge. The associated health economics may prove complex and will require input from multiple parties. Ultimately, all stakeholders must ensure that our patients' interests remain paramount as we seek to facilitate and support their desire to return to activity post-hip surgery.

Take home message

- There is no evidence as yet that hip implants fail earlier with increased sporting activity in the short- to medium-term.
- Present fixations and bearings would appear to be adequate in the short- to medium-term for amateur sporting activity.
- The associated health economics of using more expensive techniques and implants may prove complex and will require input from multiple parties.

References

1. **Learmonth ID**, **Young C**, **Rorabeck C**. The operation of the century: total hip replacement. *Lancet*. 2007;370(9597):1508–1519.
2. **Charnley J**. Arthroplasty of the hip. A new operation. *Lancet*. 1961;1(7187):1129–1132.
3. **Shan L**, **Shan B**, **Suzuki A**, **Nouh F**, **Saxena A**. Intermediate and long-term quality of life after total knee replacement: a systematic review and meta-analysis. *J Bone Joint Surg Am*. 2015;97(2):156–168.
4. **Chan SW**, **Tulloch E**, **Cooper ES**, **et al**. Montgomery and informed consent: where are we now? *BMJ*. 2017;357:j2224.
5. **Jassim SS**, **Douglas SL**, **Haddad FS**. Athletic activity after lower limb arthroplasty: a systematic review of current evidence. *Bone Joint J*. 2014;96-B(7):923–927.
6. **Krismer M**. Sports activities after total hip arthroplasty. *EFORT Open Rev*. 2017;2(5):189–194.
7. **Hoorntje A**, **Janssen KY**, **Bolder SBT**, **et al**. The effect of total hip arthroplasty on sports and work participation: a systematic review and meta-analysis. *Sports Med*. 2018;48(7):1695–1726.

8. **Garino JP**, **Beredjiklian PK**. *Adult reconstruction & arthroplasty: core knowledge in orthopaedics*. Philadelphia: Mosby/Elsevier, 2007:108–146.
9. **Jemat A**, **Ghazali MJ**, **Razali M**, **Otsuka Y**. Surface modifications and their effects on titanium dental implants. *Biomed Res Int*. 2015;2015(6):791725.
10. **Schmalzried TP**, **Kwong LM**, **Jasty M**, **et al**. The mechanism of loosening of cemented acetabular components in total hip arthroplasty. Analysis of specimens retrieved at autopsy. *Clin Orthop Relat Res*. 1992;274:60–78.
11. **Kornuijt A**, **Das D**, **Sijbesma T**, **van der Weegen W**. The rate of dislocation is not increased when minimal precautions are used after total hip arthroplasty using the posterolateral approach: a prospective, comparative safety study. *Bone Joint J*. 2016;98-B(5):589–594.
12. **Dietz MJ**, **Klein AE**, **Lindsey BA**, **et al**. Posterior hip precautions do not impact early recovery in total hip arthroplasty: a multicenter, randomized, controlled study. *J Arthroplasty*. 2019;34(7S):S221–S227.
13. **Metcalfe D**, **Peterson N**, **Wilkinson JM**, **Perry DC**. Temporal trends and survivorship of total hip arthroplasty in very young patients: a study using the National Joint Registry data set. *Bone Joint J*. 2018;100-B(10):1320–1329.
14. **Matharu GS**, **McBryde CW**, **Pynsent WB**, **Pynsent PB**, **Treacy RB**. The outcome of the Birmingham Hip Resurfacing in patients aged < 50 years up to 14 years post-operatively. *Bone Joint J*. 2013;95-B(9):1172–1177.
15. **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(1):113–120.
16. **Lewthwaite SC**, **Squires B**, **Gie GA**, **Timperley AJ**, **Ling RS**. The Exeter Universal hip in patients 50 years or younger at 10-17 years' follow up. *Clin Orthop Relat Res*. 2008;466(2):324–331.
17. **Schmitz MW**, **Bronsema E**, **de Kam DC**, **et al**. Results of the cemented Exeter femoral component in patients under the age of 40: an update at ten to 20 years' follow-up. *Bone Joint J*. 2017;99-B(2):192–198.
18. **Liu F**, **Gross TP**. High impact sports after metal-on-metal hip resurfacing arthroplasty. *Orthopaedic Proceedings*. 2013:328–328.
19. **Amstutz C**, **Le Duff MJ**. Infographic: Effects of physical activity on long-term survivorship after metal-on-metal hip resurfacing arthroplasty. *Bone Joint J*. 2019;101-B(10):1184–1185.
20. **Hellman M**, **Ford M**, **Barrack R**. Is there evidence to support an indication for surface replacement arthroplasty? A systematic review *Bone Joint J*. 2019;101-B(Supple_A):32–40.
21. **Micera G**, **Moroni A**, **Orsini R**, **et al**. In gait analysis evaluation of the ability to resume high impact sports in patients treated with hip resurfacing arthroplasty. *Orthopaedic Proceedings*. 2019:61–61.
22. **Wiik AV**, **Lambkin R**, **Cobb JP**. Gait after Birmingham Hip Resurfacing: an age-matched controlled prospective study. *Bone Joint J*. 2019;101-B(11):1423–1430.
23. **Robinson PG**, **Clement ND**, **Hamilton D**, **et al**. A systematic review of robotic-assisted unicompartmental knee arthroplasty: prosthesis design and type should be reported. *Bone Joint J*. 2019;101-B(7):838–847.
24. **Kayani B**, **Konan S**, **Thakrar R**, **Huq S**, **Haddad FS**. Assuring the long-term total joint arthroplasty: a triad of variables. *Bone Joint J*. 2019;101-B(Supple_A):11–18.
25. **Timperley J**. In the SPAIRE technique (spare piriformis and internus, repair externus) for hip arthroplasty is safe and effective. 2018:8–8.
26. **Konan S**, **Hossain F**, **Patel S**, **Haddad FS**. Measuring function after hip and knee surgery: the evidence to support performance-based functional outcome tasks. *Bone Joint J*. 2014;96-B(11):1431–1435.
27. **Galea VP**, **Rojanasopondist P**, **Ingelsrud LH**, **et al**. Longitudinal changes in patient-reported outcome measures following total hip arthroplasty and predictors of deterioration during follow-up: a seven-year prospective international multicentre study. *Bone Joint J*. 2019;101-B(7):768–778.
28. **Logishetty K**, **van Arkel RJ**, **KCG Ng**, **et al**. Hip capsule biomechanics after arthroplasty: the effect of implant, approach, and surgical repair. *Bone Joint J*. 2019;101-B(4):426–434.
29. **Berstock J**, **Whitehouse M**, **Duncan C**. Trunnion corrosion: what surgeons need to know in 2018. *Bone Joint J*. 2018;100-B(1_Supple_A):44–49.
30. **Vigdorchik J**, **Eftekhary N**, **Elbuluk A**, **et al**. Evaluation of the spine is critical in the workup of recurrent instability after total hip arthroplasty. *Bone Joint J*. 2019;101-B(7):817–823.

Author information:
R. M. D. Meek, BSc (Hons), MD, FRCS (Tr & Orth), Professor, Queen Elizabeth University Hospital, Glasgow, UK.

R. Treacy, MBChB, MD, FRCS, FRCS Orth, Consultant, Royal Orthopaedic Hospital, Birmingham, UK.

A. Manktelow, MBBS, BSc, FRCS (Ed) , FRCS (Orth), Consultant, University Hospital, Queen's Medical Centre, Nottingham, UK.

J. A. Timperley, FRCS (Ed), DPhil (Oxon), Professor, Princess Elizabeth Orthopaedic Centre, Royal Devon & Exeter NHS Foundation Trust, Exeter Hip Unit, Exeter, UK.

F. S. Haddad, BSc, MD(Res), FRCS(Tr&Orth), Professor of Orthopaedic Surgery, University College London Hospitals NHS Foundation Trust, London, UK.

Funding statement:
No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

ICMJE COI statement:
R. M. D. Meek reports board membership by The Bone & Joint Journal, and payment for lectures (including service on speakers' bureaus) from Palacademy and Johnson & Johnson, all of which are unrelated to this article. R. Treacy reports board membership and consultancy from Jointmedica unrelated to this article. J. A. Timperley reports patents (planned, pending, or issued), royalties, and payment for development of educational presentations from Stryker, all of which are unrelated to this article. F. S. Haddad reports editorial board membership by The Bone & Joint Journal and the Annals of the Royal College Of Surgeons, consultancy and royalties from Smith & Nephew, Corin, MatOrtho, and Stryker, and payment for lectures (including service on speakers' bureaus) from Smith & Nephew and Stryker, all of which are unrelated to this article.

This article was primary edited by A. Liddle.