

Original research

Patients are Most Interested in Which Hip Arthroplasty Approach? A 15-year Google Trends Analysis

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ARTICLE INFO

Article history:

Received 6 June 2022

Received in revised form

25 July 2022

Accepted 27 July 2022

Available online 21 September 2022

Keywords:

Arthroplasty

Total hip arthroplasty

Google Trends

Direct anterior approach

Public interest

ABSTRACT

Background: The purpose of this analysis was to assess the public interest in total hip arthroplasty (THA) based on approach by analyzing Google Trends online search volume trends between 2007 and 2021.

Methods: Data were obtained by querying the Google Trends online search tool for key terms and phrases relating to anterior, posterior, lateral, and minimally invasive approaches to THA. Data from January 2007 to December 2021 were utilized. Relative search volume (RSV) was generated for each THA approach group based on historical search volume trends in the United States.

Results: Over the 15-year period, Google Trends Search Data demonstrated a statistically significant increase ($P < .001$) in the RSV for all 4 major hip arthroplasty approaches. The growth in public interest for anterior hip arthroplasty was significantly greater than the growth for posterior ($P = .02$) and minimally invasive hip arthroplasty ($P = .02$). The difference in RSV growth between lateral and anterior approaches was not significant ($P = .88$). The average RSV for anterior hip arthroplasty was 59.0, which was significantly greater than the average RSV of all other groups.

Conclusions: The anterior approach to hip arthroplasty has demonstrated a consistent and statistically significant increase in RSV over the past 15 years that has outpaced the increases observed in the posterior and minimally invasive approaches. Despite the increase in public awareness and interest for anterior approach hip arthroplasty, it is yet to demonstrate any long-term clinical benefits over other approaches.

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Introduction

Since its inception, total hip arthroplasty (THA) has become one of the most commonly performed surgeries in the United States [1,2]. The procedure is known to improve functional outcomes and reduce pain in those suffering from end-stage hip osteoarthritis [3]. With the advancement of THA, many operative options including patient positioning, bearing materials, implant designs, and surgical approaches have been developed. Specifically, the procedure has been completed through an anterior, anterolateral, lateral, or posterior approach, with various modifications of these traditional approaches also reported. [4] Additionally, some approaches have

also been marketed as “minimally invasive” including the 2-incision posterior approach, mini-anterior approach, and mini-posterior approach. [5–8]

Despite abundant research in these areas, it remains unclear which approach is clinically superior. In the United States, orthopedic surgeons have long debated the optimal or preferred hip arthroplasty approach. A recent meta-analysis comparing the anterior to the posterior approach determined that current evidence does not demonstrate clear superiority of the anterior or posterior approach, and the approach should be chosen based on surgeon expertise and patient preference. [9] However, advertising and public media have suggested that the anterior approach and minimally invasive approach lead to better outcomes and are associated with “less pain” after surgery, “faster recovery,” quicker healing, and fewer postoperative complications without offering definitive evidence. [10–12] Such campaigns are likely to influence public opinion despite lack of consistent evidence. For example, a

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study conducted by Daas et al. found that up to 68% of patients enter orthopedic offices with a strong preference for the direct anterior approach and cite the abovementioned reasons. [13]

With the availability of medical information online, patients are increasingly searching for health-related information. [14] One powerful tool for analyzing this patient interest is Google Trends, which is a search engine tool that tracks search frequency and relative interest of terms and phrases. In the field of orthopedic surgery, previous studies have demonstrated that patients are increasingly researching treatment and procedure types like platelet-rich plasma and stem cell injections, elective spine surgery, robotic hip and knee arthroplasty, and many others. [15,16,22–24] Therefore, the purpose of this study is to examine trends in patient interest for THA, specifically for the anterior, posterior, lateral, and minimally invasive approaches. We hypothesize there will be greater patient interest for the anterior approach of THA spanning the past 15 years.

Material and Methods

Google Trends

Google Trends (Alphabet Inc., Mountain View, CA) is a free, open-source online tool that tracks and tabulates online search engine volumes over time and across geography [17]. For a search term of interest, Google Trends presents the search metadata as a relative search volume (RSV). RSV is the search volume of a term as compared to the peak popularity of the same search term over a given time period and within specified geographic bounds. During the time period, the peak popularity of a search term is given a 100, and all other time points will have an RSV less than 100 [18]. When comparing multiple terms in the same Google Trends search, the RSV for all terms will be in relation to the term with the peak popularity (ie, the term popularities are compared to each other rather than being analyzed independent of each other).

Search queries

The search queries conducted in this analysis were done in accordance with previous Google Trends analyses in hip and knee arthritis. [15] The most common search terms relating to posterior, anterior, and lateral approach hip arthroplasty were searched within Google Trends. Additionally, terms related to minimally invasive hip arthroplasty were also searched. Because minimally invasive hip arthroplasty is a broad term that represents a variety of procedure types and approaches, multiple terms were considered together under the umbrella of “minimally invasive.” [19–21] Table 1 contains all the search terms used in this analysis for the 4 groups: posterior, anterior, lateral, and minimally invasive hip arthroplasty. (Table 1)

Temporal trends

To analyze the temporal trends in the public interest for anterior, posterior, lateral, and minimally invasive hip arthroplasty, the abovementioned search terms were compiled into a database. The database contained RSV data for each search term over a 15-year time period from January 1, 2007, to December 31, 2021. Once these data were collected, best-fit linear, quadratic, and exponential growth models were used to model the growth in public interest that each of these hip arthroplasty types experienced. Each model type's strength was assessed by calculating standard measures of accuracy including the mean absolute percentage error, mean absolute deviation, and the mean squared deviation. These metrics all assess the strength and accuracy of a model in representing the rate

Table 1

Total hip arthroplasty google trends search terms.

Google Trends search term
anterior hip replacement
anterior hip replacement surgery
anterior hip arthroplasty
direct anterior hip replacement
anterior total hip replacement
anterior hip surgery
posterior hip replacement
posterior hip arthroplasty
posterior approach hip replacement
posterior approach to hip
superpath
superpath hip replacement
minimally invasive hip
minimally invasive hip replacement
minimally invasive hip replacement surgery
lateral hip replacement
lateral hip arthroplasty
lateral approach hip replacement
lateral total hip
lateral total hip replacement

of change observed. The slopes of the linear regression models were compared with a 2-tailed t-test to determine if a linear model was significantly different than the slope of another linear model.

An additional direct comparison was made between the 4 groups simultaneously by constructing a Google Trends search with the following search terms: “anterior hip replacement,” “posterior hip replacement,” “lateral hip replacement,” and “minimally invasive hip replacement.” Google Trends permits up to 5 terms to be concomitantly compared, and these search terms represented the most representative term for each approach type. This comparison allowed the RSV values for each search term to be normalized and directly comparable between the 4 groups. This comparison allowed the growth in search volume for a particular approach type to be better contextualized in relation to the other types of approaches being studied.

Results

Anterior hip arthroplasty

Over the 15-year period between January 1, 2007, and December 31, 2021, Google Trends Search Data demonstrated a statistically significant increase ($P < .001$) in the RSV for anterior hip arthroplasty with an R^2 value of 0.58. The linear regression model was the most representative model type and had the best measures of accuracy. (Fig. 1) Additionally, the slope of increase in public interest for anterior hip arthroplasty was significantly greater than the slopes for posterior ($P = .02$) and minimally invasive hip arthroplasty ($P = .02$) over the same time period. However, the anterior hip arthroplasty slope was not significantly greater than the lateral hip arthroplasty slope ($P = .87$). The percent change in relative annual search volumes between 2007 and 2021 increased by 1692.5% for the anterior hip arthroplasty group.

Posterior hip arthroplasty

Between January 1, 2007, and December 31, 2021, the Google Trends Search Data demonstrated a statistically significant increase ($P < .001$) in the RSV of posterior hip arthroplasty with an R^2 of 0.53. These data were also best represented by the linear regression model which had the best measures of accuracy of the 3 model types. (Fig. 2) The posterior hip arthroplasty slope of increase was significantly less than the slope of increase in anterior ($P = .02$) and lateral groups ($P = .02$). There was no significant difference between

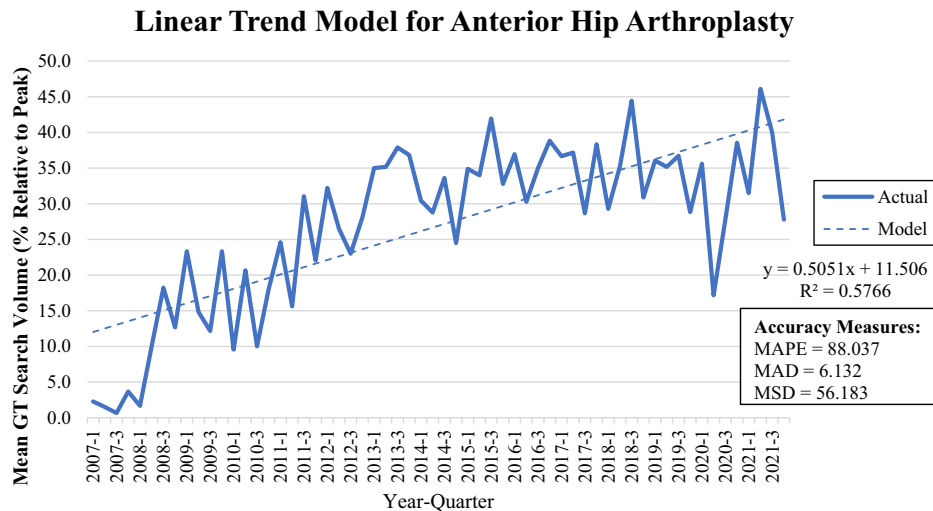


Figure 1. Linear trend model for anterior hip arthroplasty. MAD, mean absolute deviation; MAPE, mean absolute percentage error; MSD, the mean squared deviation. GT, Google Trends.

the posterior and minimally invasive groups ($P = .88$). The percent change in relative annual search volumes between 2007 and 2021 increased by 289.5% for the posterior hip arthroplasty group.

Lateral hip arthroplasty

Between January 1, 2007, and December 31, 2021, the Google Trends Search Data demonstrated a statistically significant increase ($P < .001$) in the RSV of lateral hip arthroplasty with an R^2 of 0.58. These data were best represented by the linear regression model which had the best measures of accuracy of the 3 model types. (Fig. 3) The lateral hip arthroplasty slope of increase was significantly greater than the slope of increase in posterior ($P = .02$) and minimally invasive groups ($P = .01$). However, there was no significant difference between the lateral and anterior groups ($P = .87$). The percent change in relative annual search volumes between 2007 and 2021 increased by 305.2% for the lateral hip arthroplasty group.

Minimally invasive hip arthroplasty

Between January 1, 2007, and December 31, 2021, the Google Trends Search Data demonstrated a statistically significant increase ($P < .001$) in the RSV of minimally invasive hip arthroplasty with an R^2 of 0.55. Similarly, the linear regression model was also the best representation of the increase in public interest (Fig. 4). The slope of increase demonstrated by the linear regression models for posterior and minimally invasive hip arthroplasty was not significantly different ($P = .88$). The percent change in relative annual search volumes between 2007 and 2021 increased by 344.5% for the minimally invasive hip arthroplasty group.

Anterior, posterior, lateral, and minimally invasive hip arthroplasty compared

During the January 1, 2007, to December 31, 2021, time period, anterior hip arthroplasty showed the greatest degree of public

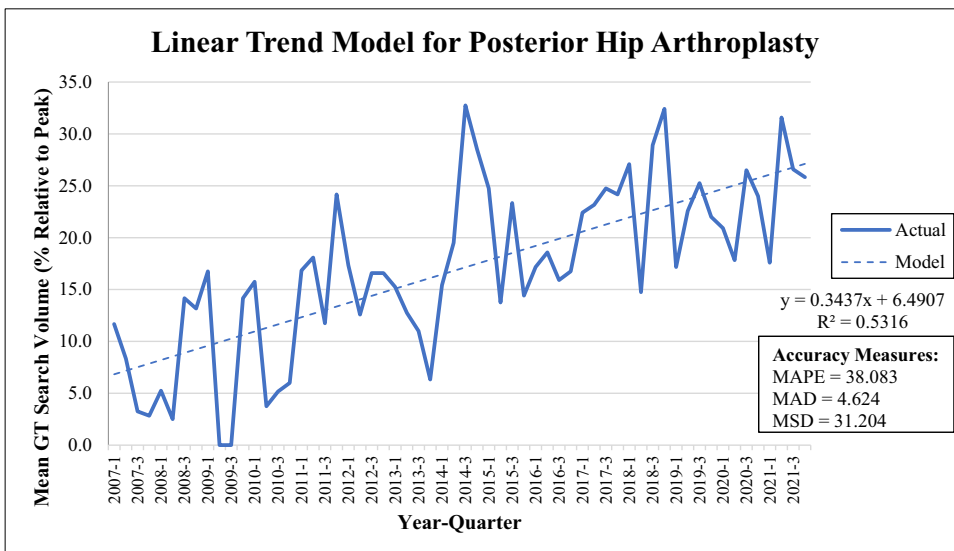


Figure 2. Linear trend model for posterior hip arthroplasty. GT, Google Trends.

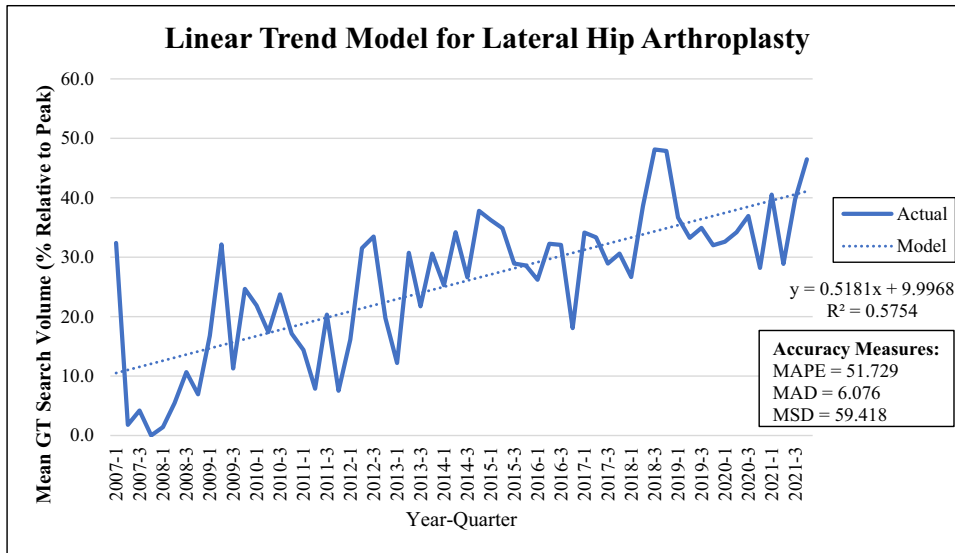


Figure 3. Linear trend model for lateral hip arthroplasty. MI, minimally invasive.

interest when directly compared to posterior, lateral, and minimally invasive hip arthroplasty. (Fig. 5) The slope of the anterior hip arthroplasty linear regression line was 0.52 compared to a slope of 0.01 for posterior, 0.10 for lateral, and 0.05 for minimally invasive hip arthroplasty. Similarly, the anterior arthroplasty trend lines showed a substantially better R^2 value (0.69) than posterior (0.002) and minimally invasive (0.04) ones.

Moreover, the average RSV over the time period for anterior hip arthroplasty was 59.0 which was significantly greater than the average RSV of posterior (average RSV = 14.7; $P < .001$), lateral (average RSV = 4.3; $P < .001$), and minimally invasive (average RSV = 6.1; $P < .001$) hip arthroplasty groups. The average RSV of posterior hip arthroplasty over this time period was also significantly greater than the average RSV of minimally invasive hip arthroplasty ($P < .001$) and lateral hip arthroplasty ($P < .001$). Moreover, the minimally invasive hip arthroplasty group also had a significantly greater RSV than the lateral group ($P < .001$).

Discussion

Over the past 15 years, the public interest in hip arthroplasty measured by Google Trends RSV has seen a significant increase. In particular, the anterior approach has seen a substantial growth in interest while the posterior hip arthroplasty search terminology has reflected much lower growth in public interest. Moreover, when the 4 hip arthroplasty approaches were compared with relation to each other and their collective peak RSVs, the anterior hip arthroplasty approach also demonstrated a significantly greater degree of public interest over the study time period. This comparison is particularly useful in the context of a growing number of internet users and Google search queries observed during the time frame of our analysis. The individual RSV growth for each hip arthroplasty approach is likely influenced by the observed growth in search queries; however, the direct comparison between approach types provides a normalized comparison for public

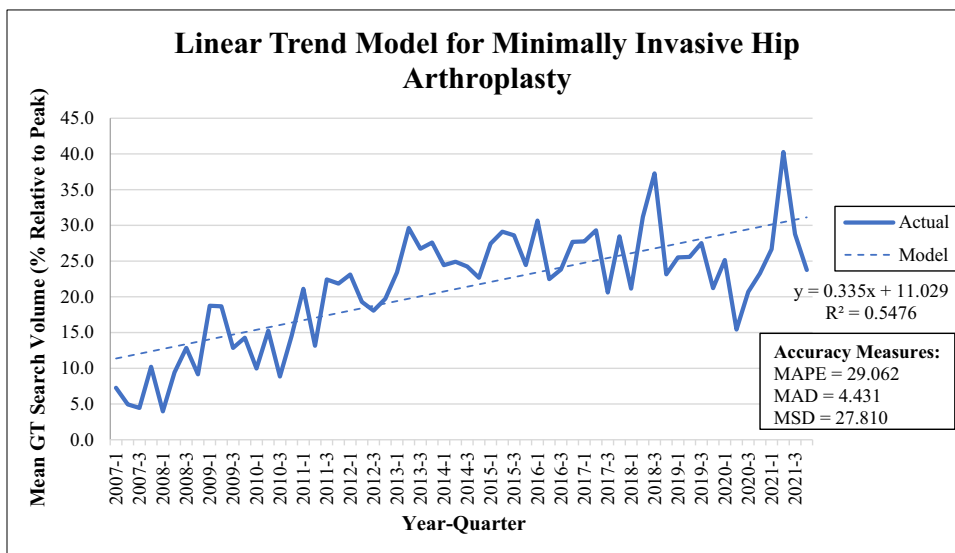


Figure 4. Linear trend model for minimally invasive hip arthroplasty.

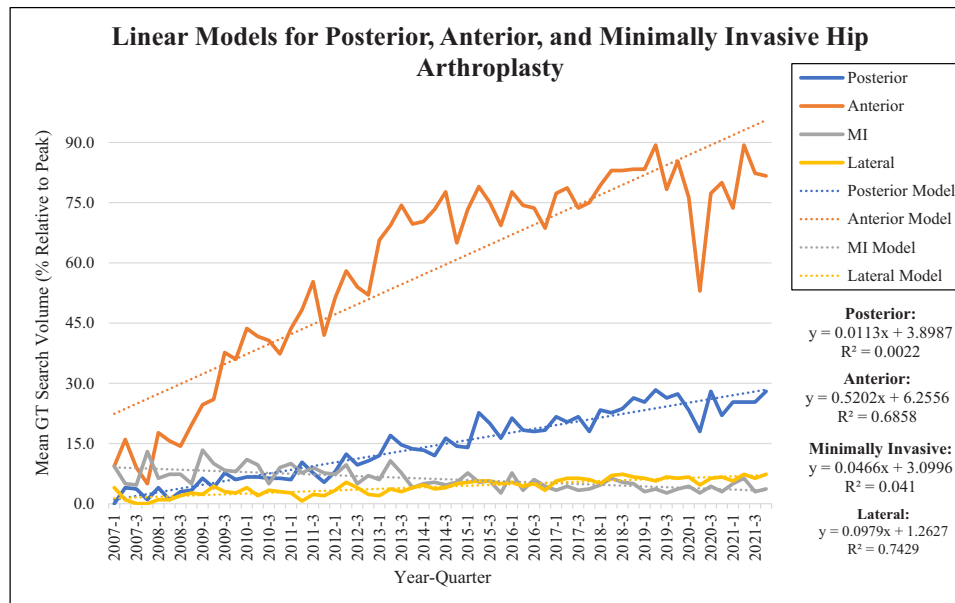


Figure 5. Linear models for posterior, anterior, and minimally invasive hip arthroplasty.

interest. Together, these findings confirm our initial hypothesis that the anterior hip arthroplasty approach has garnered the most public interest over the past 15 years.

Our investigation adds to the growing but limited body of literature regarding public interest in medical procedures, and to our knowledge, it represents the first analysis of data representing information seeking trends regarding the different hip arthroplasty approaches commonly offered to orthopedic patients. Our study reports an increasing rate of Google searches relating to hip arthroplasty with the anterior approach reflecting the most growth in public interest and the largest current share of public interest. This finding is consistent with literature reports documenting a growing rate of utilization of hip arthroplasty procedures worldwide and a growing interest and utilization of the anterior approach. [25,26] However, no previous study has examined the degree of public interest and interest search volume for hip arthroplasty approaches. A study by Cohen et al. [16] analyzed the growth in public interest for both hip and knee arthroplasties between 2009 and 2017. While they also found growing public interest for hip arthroplasty, they failed to analyze the 4 primary hip arthroplasty approaches and which were more popular.

Interestingly, the clinical outcomes associated with direct anterior approach THA are likely not the primary driver of the observed increase in RSV. Despite its growing popularity and utilization, there is still uncertainty in the orthopedic community as to whether the direct anterior approach is clinically superior to other hip arthroplasty approaches. The arthroplasty literature has previously reported an increased complication rate, lack of clinical superiority, and a steep learning curve as reasons why the direct anterior approach should not necessarily be performed over other common approaches [26–33]. Therefore, the rapid increase in patient interest for direct anterior hip arthroplasty procedures is likely unrelated with the reported clinical outcomes associated with this procedure.

Several previous studies have reported a large increase in marketing at many levels of the health-care infrastructure as a primary driving force for the rapid uptick in direct anterior hip arthroplasty over the past 2 decades. [12,34,35] In fact, in an analysis by Mohan et al., [35] the authors describe the substantial online marketing campaigns distributed by hospitals, surgeons, and the orthopedic

industry for the direct anterior approach for total hip replacement. The authors also call into question the quality of the distributed, easily accessible information on the procedure. [35] Despite being aware of the uncertain benefits of the direct anterior approach, orthopedic surgeons elect to perform the procedure nonetheless due to increased pressure from patients. Approximately 43% of surgeons performing the direct anterior approach have reported that over half of their patients request this approach. [26] Moreover, 76% of orthopedic surgeons have reported an increased market share as a result of performing the direct anterior approach for their THA patients. [26] Substantial pressure is being applied on surgeons to continue performing this approach as patients consume increasing amount of marketing advocating for this procedure.

Surprisingly, the minimally invasive hip arthroplasty search terminology, while showing significant growth in search popularity over the past 15 years, did not reflect the same considerable increase in search volume that the direct anterior approach demonstrated. This was unexpected as there has been a documented rise in popularity of this procedure type across all orthopedic surgery services. [36–38] This finding may be explained by considering what classifies as “minimally invasive” when referring to hip arthroplasty. Lesser known and/or marketed procedures and more nuanced naming are likely to impact the RSV generated by Google Trends. This may explain the lesser slope observed with the minimally invasive group than with the anterior approach group.

Limitations

The presented study has several limitations. First, Google Trends is limited in its scope at assessing national and international search volumes. Google Trends fails to capture demographics, detailed geographic locations, specific search terms, and the absolute number of searches performed on a specific search term. As a result, any subsequent analyses will be limited and will lack some degree of granularity in reporting specific details hidden within the data. Additionally, the use of Google Trends search volume analysis does not afford analyses of searches performed with other search engines. Moreover, since 2007, there has been tremendous growth in the access to the internet and the number of search engine queries

performed each year. The findings in this analysis must be interpreted in the context of background growth in internet search volume. Finally, the current analysis and its interpretation depend on a close relationship between measured online search volumes and actual patient interest in a subject. While it remains unclear how closely these 2 factors correlate with one another, our study and other similar studies purport that online search volumes is a reliable proxy measurement for patient interest.

Conclusions

The direct anterior approach to THA has demonstrated a consistent, significant increase in RSV over the past 15 years that has significantly outpaced the increases observed in the posterior, lateral, and minimally invasive approaches. Despite the increase in public awareness and interest for anterior approach hip arthroplasty, uncertainty still exists as to its clinical benefit. Therefore, increased amounts of patient-focused marketing campaigns conducted by numerous stakeholders may be an important factor in this significant rise in public interest.

Conflicts of interest

David G. Deckey is an editorial or governing board member of the *Journal of Arthroplasty*. All other authors declare no potential conflicts of interest.

For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2022.07.017>.

References

- [1] Knight SR, Aujla R, Biswas SP. Total hip arthroplasty - over 100 years of operative history. *Orthop Rev (Pavia)* 2011;3:e16. <https://doi.org/10.4081/or.2011.e16>.
- [2] Henry M, Rong LQ, Wingo M, Rahouma M, Girardi LN, Gaudino M. The evidence on the ten most common surgical interventions in the United States from 1970 to 2018. *Ann Surg* 2019;270:e16. <https://doi.org/10.1097/SLA.0000000000003258>.
- [3] Grayson CW, Decker RC. Total joint arthroplasty for persons with osteoarthritis. *PM R* 2012;4:S97–103. <https://doi.org/10.1016/j.pmrj.2012.02.018>.
- [4] Moretti VM, Post ZD. Surgical approaches for total hip arthroplasty. *Indian J Orthop* 2017;51:368–76. https://doi.org/10.4103/ortho.IJOrtho.317_16.
- [5] Procyk S. Initial results with a mini-posterior approach for total hip arthroplasty. *Int Orthop* 2007;31:17–20. <https://doi.org/10.1007/s00264-007-0435-5>.
- [6] Cheng T, Feng JG, Liu T, Zhang XL. Minimally invasive total hip arthroplasty: a systematic review. *Int Orthopaedics (Sicot)* 2009;33:1473–81. <https://doi.org/10.1007/s00264-009-0743-z>.
- [7] Sculco TP. Minimally invasive total hip arthroplasty: in the affirmative 1 No benefits or funds were received in support of this study. *The J Arthroplasty* 2004;19:78–80. <https://doi.org/10.1016/j.artd.2004.02.021>.
- [8] Mirza AJ, Lombardi Jr AV, Morris MJ, Berend KR. A mini-anterior approach to the hip for total joint replacement: optimising results. *The Bone Joint J* 2014;96-B:32–5. <https://doi.org/10.1302/0301-620X.96B11.34348>.
- [9] Higgins BT, Barlow DR, Heagerty NE, Lin TJ. Anterior vs. Posterior approach for total hip arthroplasty, a systematic review and meta-analysis. *The J Arthroplasty* 2015;30:419–34. <https://doi.org/10.1016/j.artd.2014.10.020>.
- [10] Anbari K. Advantages and disadvantages of anterior hip replacement. *Arthritis-Health*. <https://www.arthritis-health.com/surgery/hip-surgery/advantages-and-disadvantages-anterior-hip-replacement> [accessed 17.03.22].
- [11] Anterior or posterior hip replacement, which is better? | Banner. <https://www.bannerhealth.com/healthcareblog/better-me/is-anterior-total-hip-replacement-better-than-posterior>.
- [12] Shofoluwe AI, Naveen NB, Inabathula A, et al. Internet promotion of direct anterior approach total hip arthroplasty by members of the American association of hip and knee surgeons. *The J Arthroplasty* 2018;33:167–170.e1. <https://doi.org/10.1016/j.artd.2017.08.015> [accessed 17.03.22].
- [13] den Daas A, Reitsma EA, Knobben BAS, Ten Have BLEF, Somford MP. Patient satisfaction in different approaches for total hip arthroplasty. *Orthop Traumatol Surg Res* 2019;105:1277–82. <https://doi.org/10.1016/j.otsr.2019.08.003>.
- [14] Tan SS-L, Goonawardene N. Internet health information seeking and the patient-physician relationship: a systematic review. *J Med Internet Res* 2017;19:e9. <https://doi.org/10.2196/jmir.5729>.
- [15] Cohen SA, Zhuang T, Xiao M, Michaud JB, Amanatullah DF, Kamal RN. Google trends analysis shows increasing public interest in platelet-rich plasma injections for hip and knee osteoarthritis. *The J Arthroplasty* 2021;36:3616–22. <https://doi.org/10.1016/j.artd.2021.05.040>.
- [16] Cohen SA, Cohen LE, Tijerina JD, et al. Google trends as a tool for evaluating public interest in total knee arthroplasty and total hip arthroplasty. *J Clin Transl Res* 2021;7:456–66.
- [17] Google Trends, Google Trends. <https://trends.google.com/trends/?geo=US> [accessed 21.02.22].
- [18] FAQ about Google Trends data - Trends Help. <https://support.google.com/trends/answer/4365533?hl=en> [accessed 21.02.22].
- [19] Ilchmann T, Gersbach S, Zwicky L, Clauss M. Standard transgluteal versus minimal invasive anterior approach in hip arthroplasty: a prospective, consecutive cohort study. *Orthop Rev (Pavia)* 2013;5:e31. <https://doi.org/10.4081/or.2013.e31>.
- [20] Goebel S, Steinert AF, Schillinger J, et al. Reduced postoperative pain in total hip arthroplasty after minimal-invasive anterior approach. *Int Orthopaedics (Sicot)* 2012;36:491–8. <https://doi.org/10.1007/s00264-011-1280-0>.
- [21] Oinuma K, Eingartner C, Saito Y, Shiratsuchi H. Total hip arthroplasty by a minimally invasive, direct anterior approach. *Oper Orthop Traumatol* 2007;19:310–26. <https://doi.org/10.1007/s00064-007-1209-3>.
- [22] Michel CR, Dijanic C, Sudah S, Kerrigan D, Cohen J. Has public interest in elective spine surgery returned to pre-COVID 19 levels? A Google trends analysis. *Cureus* 2022;14:e22858. <https://doi.org/10.7759/cureus.22858>.
- [23] Strotman PK, Novicoff WM, Nelson SJ, Browne JA. Increasing public interest in stem cell injections for osteoarthritis of the hip and knee: a Google trends analysis. *J Arthroplasty* 2019;34:1053–7. <https://doi.org/10.1016/j.artd.2019.03.002>.
- [24] Brinkman JC, Christopher ZK, Moore ML, Pollock JR, Haglin JM, Bingham JS. Patient interest in robotic total joint arthroplasty is exponential: a 10-year Google trends analysis. *Arthroplasty Today* 2022;15:13–8. <https://doi.org/10.1016/j.artd.2022.02.015>.
- [25] Pabinger C, Geissler A. Utilization rates of hip arthroplasty in OECD countries. *Osteoarthr Cartil* 2014;22:734–41. <https://doi.org/10.1016/j.joca.2014.04.009>.
- [26] Patel NN, Shah JA, Erens GA. Current trends in clinical practice for the direct anterior approach total hip arthroplasty. *The J Arthroplasty* 2019;34:1987–1993.e3. <https://doi.org/10.1016/j.artd.2019.04.025>.
- [27] Hartford JM, Bellino MJ. The learning curve for the direct anterior approach for total hip arthroplasty: a single surgeon's first 500 cases. *Hip Int* 2017;27:483–8. <https://doi.org/10.5301/hipint.5000488>.
- [28] Graves SC, Dropkin BM, Keeney BJ, Lurie JD, Tomek IM. Does surgical approach affect patient-reported function after primary THA? *Clin Orthop Relat Res* 2016;474:971–81. <https://doi.org/10.1007/s11999-015-4639-5>.
- [29] Christensen CP, Karthikeyan T, Jacobs CA. Greater prevalence of wound complications requiring reoperation with direct anterior approach total hip arthroplasty. *J Arthroplasty* 2014;29:1839–41. <https://doi.org/10.1016/j.artd.2014.04.036>.
- [30] Russo MW, Macdonell JR, Paulus MC, Keller JM, Zawadzky MW. Increased complications in obese patients undergoing direct anterior total hip arthroplasty. *J Arthroplasty* 2015;30:1384–7. <https://doi.org/10.1016/j.artd.2015.03.002>.
- [31] Jewett BA, Collis DK. High complication rate with anterior total hip arthroplasties on a fracture table. *Clin Orthop Relat Res* 2011;469:503–7. <https://doi.org/10.1007/s11999-010-1568-1>.
- [32] Sculco TP. Anterior approach in THA improves outcomes: opposes. *Orthopaedics* 2011;34:e459–61. <https://doi.org/10.3928/01477447-20110714-29>.
- [33] Sauder N, Vestergaard V, Siddiqui S, et al. The AAHKS clinical research award: No evidence for superior patient-reported outcome scores after total hip arthroplasty with the direct anterior approach at 1.5 Months postoperatively, and through a 5-year follow-up. *The J Arthroplasty* 2020;35:S15–21. <https://doi.org/10.1016/j.artd.2020.02.008>.
- [34] Massin P. SFHG (Société française de la hanche et du genou, French Hip, Knee Society). Marketing the direct anterior approach to the hip: is the industry overstepping its role? *Orthop Traumatol Surg Res* 2016;102:277–8. <https://doi.org/10.1016/j.otsr.2016.04.001>.
- [35] Mohan R, Yi PH, Hansen EN. Evaluating online information regarding the direct anterior approach for total hip arthroplasty. *J Arthroplasty* 2015;30:803–7. <https://doi.org/10.1016/j.artd.2014.12.022>.
- [36] Conditt MA, Roche MW. Minimally invasive robotic-arm-guided unicompartmental knee arthroplasty. *JBJS* 2009;91:63–8. <https://doi.org/10.2106/JBJS.H.01372>.
- [37] Staub BN, Sadrameli SS. The use of robotics in minimally invasive spine surgery. *J Spine Surg* 2019;5:S31–40. <https://doi.org/10.21037/jss.2019.04.16>.
- [38] Pospischill M, Kranzl A, Attwenger B, Knahr K. Minimally invasive compared with traditional transgluteal approach for total hip arthroplasty: a comparative gait analysis. *JBJS* 2010;92:328–37. <https://doi.org/10.2106/JBJS.H.01086>.