



Original article

Patient satisfaction in different approaches for total hip arthroplasty

Annick den Daas^a, Evelien A. Reitsma^b, Bas A.S. Knobben^b, Bas L.E.F. Ten Have^b,
Matthijs P. Somford^{c,*}

^a Department of Orthopaedics, OCON, Hengelo, Netherlands

^b Department of Orthopaedics, Martini Hospital, Groningen, Netherlands

^c Department of Orthopaedics, Rijnstate Hospital, Wagnerlaan 55, 6815 AD, Arnhem, Netherlands



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ABSTRACT

Background: At present, the posterolateral, the direct lateral and direct anterior approach (DAA) are the most frequently used techniques for total hip arthroplasty (THA), however there is no clear superiority of one of the approaches based on clinical outcome measures. The goal of this study is to lead the patient and the surgeon to an optimal treatment by providing them with relevant information based on patient reported outcome measures (PROMs).

Methods: Patient satisfaction and hip function one year postoperatively were investigated retrospectively in a cohort of patients who underwent hip replacement surgery by DAA on one hip and by posterolateral or direct lateral approach on the contralateral hip. Additionally, a control group who underwent the DAA bilaterally was used for comparison.

Results: No difference in hip function was found between the DAA and the posterolateral or direct lateral approach, measured with the Hip disability and Osteoarthritis Outcome Score (HOOS) questionnaire at least one year postoperatively to the last THA in the study group. Also in the control group no difference was found between the hips. However, the overall scores of the control group were higher, although not statistically significant, than those of the study group ($p = 0.055$). And a majority of the study group preferred the DAA (68%), with the reasons reported being faster recovery, less sleeping disturbance and earlier mobilization.

Conclusion: As expected, the postoperative hip function is similar, but patients' preference is not. The latter result might be true or possibly influenced by preoperative psychological factors and mental health. The DAA and the posterolateral or direct lateral approaches have shown to lead to a similar hip function, but a majority of patients subjectively prefer the DAA.

Level of evidence: III.

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1. Introduction

Total hip arthroplasty (THA) is one of the most successful orthopaedic surgical procedures [1]. It is a cost-effective procedure that leads to an increase in quality of life, relieves pain, and improves function for patients with end-stage joint deterioration due to osteoarthritis or rheumatoid arthritis [2,3]. At present, the posterolateral and the direct lateral approach are the most frequently used techniques, respectively 45% and 42% [4]. Another approach, which is gaining popularity, is the direct anterior approach (DAA). In The Netherlands approximately 6% of THA's

are placed using this approach annually, worldwide it is estimated to be 10% [5].

The possible benefit of the DAA is that it causes less soft tissue damage, because it follows the internervous and intermuscular planes [6]. However, recent studies questioned this benefit and its possible influence on long term functional outcome [7–9]. The posterolateral approach on the other hand is still the most frequently used approach, even though this approach violates the posterior hip capsule and muscular structures, which may be associated with increased risk of dislocation. [10]–[11] Lastly, the direct lateral approach is accompanied by the risk of abductor weakness caused by damage to the gluteus medius muscle [12].

The patient reported outcome measures (PROMs) gained more popularity by clinicians and investigators in the field of total joint arthroplasty [13]. PROMs are validated questionnaires on health or quality of life which are self-completed by patients.

* Corresponding author.

E-mail address: mp.somford@hotmail.com (M.P. Somford).

Our primary research aim is to investigate whether there is a difference in hip function measured with PROMs at least one year after surgery between the DAA and the posterolateral or direct lateral approach. The secondary research aim is to investigate patient satisfaction about the approaches, and the rationale behind their preference. Overall, the goal of the study is to lead the patient and the surgeon to an optimal treatment by providing them with relevant information, since the satisfaction of the patient is of major importance next to clinical outcome measures.

2. Materials and methods

2.1. Study design

In this retrospective cohort study the satisfaction and hip function of patients who underwent hip replacement surgery by the DAA on one side and hip replacement surgery by posterolateral or direct lateral approach on the contralateral side previously is assessed using PROMs.

2.2. Participants

Inclusion criteria for the study were patients who underwent THA by DAA between the second half of 2012 and the end of 2014 and received a THA by posterolateral approach or direct lateral approach on the contralateral side beforehand. Patients operated on in the first half of 2012 and 2011 were excluded because it has been stated in the scientific literature that the DAA has a learning curve and the procedure was introduced in our hospital in early 2011 [14,15]. Further exclusion criteria were revision surgery on the hip and an inability to understand spoken or written Dutch, which was assessed by phone when requesting the patients for their participation. This formed the primary study group of patients with a DAA approached hip on one side and a THA implanted through a posterolateral or direct lateral approach on the other side. Additionally a control group was formed from the same period with patients who underwent THA on both sides by DAA, and the same exclusion criteria applied. This second group was added to show that there are no differences in both sides when the same approach is used. Baseline patient characteristics were extracted from the patient files.

All DAA THA were operated on a regular OR table with fluoroscopy. The release performed was the inferior and superior capsular release no further than the posterior side of the calcar and no less than needed to properly lift the femur for exposure.

2.3. Procedures

A database of hip surgeries performed in our hospital per year, was used for the inclusion process. Files were checked for bilateral THA on x-rays; after that the surgical reports were reviewed. Lastly it was verified that there had not been revision surgery. All eligible patients were approached by phone, and if willing to participate the questionnaires were sent by mail accompanied by an explanatory letter. Returning the questionnaires was considered as informed consent. Approval for this study has been obtained from the local medical ethics committee (number of approval: 2016-026).

From a total of 1,128 patient files 55 patients met in- and exclusion criteria. The control group was formed similarly, and consisted of 26 patients (Fig. 1).

2.4. Study outcomes

The primary outcome measure was the Hip disability and Osteoarthritis Outcome Score (HOOS), that patients filled out for each hip separately [16]. The Dutch HOOS is considered to be a

valid and reliable questionnaire and is useful for the evaluation of patient-relevant outcomes in patients after a THA [17]. It is a 40-item questionnaire, which consists of five subscales, being pain, other symptoms, functioning in daily life, functioning in sports and recreation and hip related quality of life. A score of zero indicates extreme hip problems and a score of 100 indicates no hip problems. If a mark is placed outside a box, the closest box is chosen. If two boxes are marked, the box that indicates the more severe problem is chosen. As long as at least 50% of the subscale items are answered for each subscale, a mean score can be calculated [18,16].

Furthermore, the patients were asked to fill out the Short Form health survey (SF-36) once to survey general aspects of their health [19–23].

Lastly, the study group was asked to answer the question: ‘Which approach would you recommend a friend?’ and to give an explanation. Additionally they were asked to state how satisfied they are with the current hip function as a result of the favored approach using a four-point scale with the options ‘very unsatisfied’, ‘unsatisfied’, ‘satisfied’ or ‘very satisfied’.

2.5. Statistical analysis

The average age, height, weight and BMI were similar in the study and the control group and no significant differences in distribution of gender, ASA-score or smoking status were present. A significant difference in time interval between surgeries, the MCS and the PCS was evident between the groups.

To establish a difference in HOOS score at least one year after surgery between the two groups a paired *t*-test was used. First we confirmed normality of the data of both groups, and if the data was not normally distributed a related samples Wilcoxon signed-rank test was used. The differences in HOOS scores between both groups were compared using a Mann-Whitney U test, to check whether the degree of difference in both groups is equal or not. The overall scores of both groups were compared to analyse if there is a difference in the level of postoperative functioning. The number of individuals with substantial differences in HOOS score between the hips was counted for each group, for the purpose of clarification, pragmatically defined as a difference in HOOS score of five points or more.

Finally, using univariate linear regression analysis it was analysed if being in the study or control group is predictive of HOOS outcome. This was also done after adjusting for age, gender and BMI because according to the before mentioned literature these factors might influence the outcome [24–26]. Time interval between the surgeries has been adjusted, since it is significantly longer in the study group than in the control group. Assumptions are that residual terms of the independent variables do not correlate, follow a normal distribution and residual terms should have a constant variance i.e. homoscedasticity.

For the secondary outcome measure subgroups have been formed to give an overview of the explanations patients have given for their preferred approach. The answers to this question were qualitatively analysed and are hypothesis generating.

Tests were performed using SPSS IBM version 20 statistical software (SPSS inc, Chicago, USA), and *p*-values below 0.05 were considered to be statistically significant. Normality of the data was checked with a Q-Q plot, histogram and a Kolmogorov-Smirnov test. Continuous variables were compared using a *t*-test after checking for a normal distribution of the data, in case the data is not normally distributed, a related samples Wilcoxon signed-rank test (WSR) was used for paired data and a Mann-Whitney U test (MWU) for unpaired data. Categorical variables were analysed using a Chi² test, if the values were less than the expected contingent of five, the Fisher’s Exact test was used.

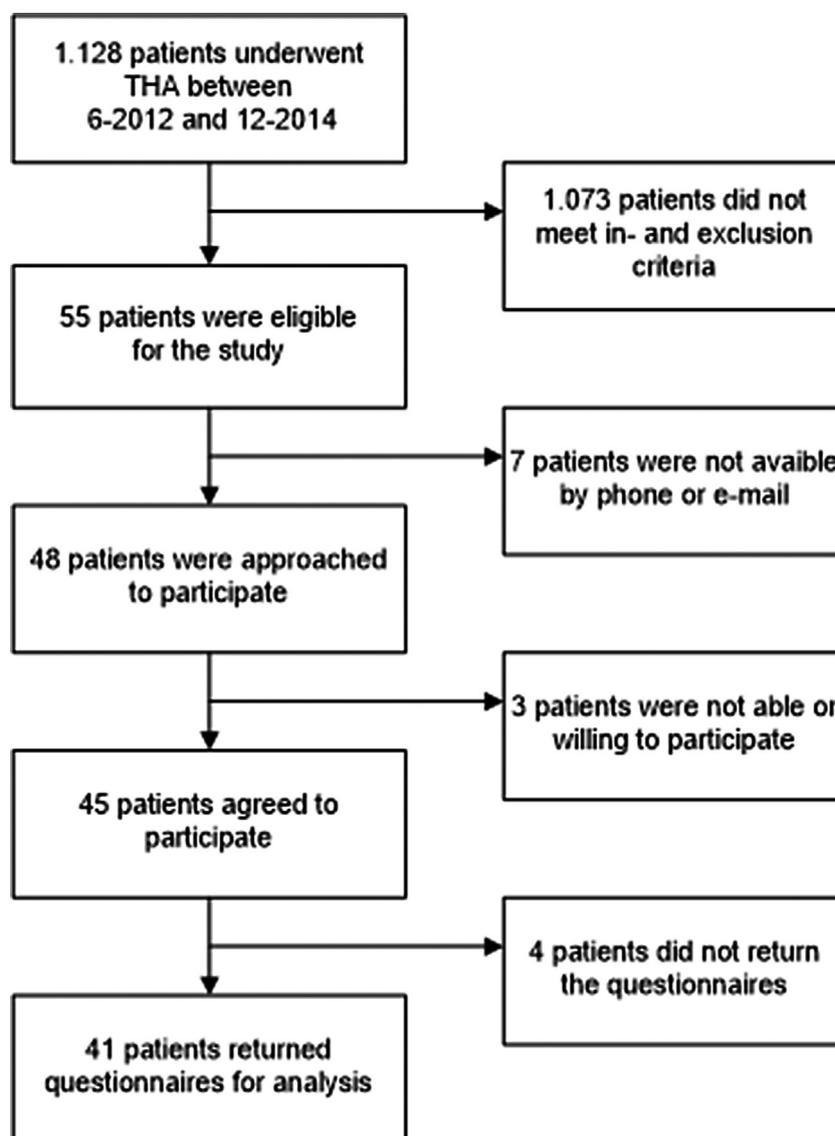


Fig. 1. Flow diagram of inclusion of participants of the study group.

3. Results

Baseline characteristics of the study group are put in [Table 1](#).

3.1. HOOS

For patients who underwent THA through DAA on both sides we found the same score on the primary outcome measure HOOS for the hip after the DAA and the hip after the posterolateral or direct lateral approach (WSR, $p=0.663$). Also the control group, formed by patients who underwent THA on both sides by DAA, showed no difference in HOOS score (WSR, $p=0.326$). The difference between the HOOS scores of the hips in the study group is compared to the difference between the HOOS scores of the hips in the control group, and it showed no difference (MWU, $p=0.964$) ([Table 2](#)).

Furthermore, the overall HOOS scores of both hips were compared between the groups also not indicating significant differences (MWU, $p=0.055$).

In seventeen patients in the study group, a difference between the HOOS scores of five points or more was found, of which eight are in favor of the posterolateral or direct lateral and nine in favor of the DAA. In the control group there were five individuals with

Table 1
Demographic data of study sample.

	Study group (n = 41)	Control group (n = 26)	p-value
Age in years (mean [sd])	74.8 [6.5]	72.1 [8.3]	0.162 ^a
Female (%)	33 (80.5)	22 (84.6)	0.753 ^c
Height in cm (mean [sd])	168.9 [8.2]	165.6 [6.9]	0.095 ^a
Weight in kg (mean [sd])	78.6 [13.9]	76.8 [15.3]	0.613 ^a
ASA score			0.126 ^d
ASA score 1 (%)	16 (39.0)	6 (23.1)	
ASA score 2 (%)	20 (48.8)	18 (69.2)	
ASA score 3 (%)	5 (12.2)	0 (0)	
ASA score 4 (%)	0 (0)	0 (0)	
BMI (mean [sd])	27.6 [4.6]	28.1 [4.7]	0.424 ^b
Smoking (%)	4 (9.8)	3 (12.0)	1.000 ^c
PCS (mean [sd])	41.4 [10.1]	45.0 [11.8]	0.030 ^b
MCS (mean [sd])	52.7 [8.9]	56.1 [13.0]	0.022 ^b
Months between surgeries (mean [sd])	84.2 [58.3]	3.2 [11.3]	0.000 ^a

ASA: American Society of Anaesthesiologists, PCS: Physical component score of SF-36, MCS: Mental component score of SF-36.

^a Independent samples *t*-test.

^b Mann–Whitney U test.

^c Fisher's Exact test.

^d Chi² test.

Table 2
Hip function measured with the HOOS questionnaire.

	Study group			Control group			Study vs. control <i>p</i> -value	Differences within groups		
	DAA, mean [sd]	PL/DL, mean [sd]	<i>p</i> -value	DAA right, mean [sd]	DAA left, mean [sd]	<i>p</i> -value		Study group, median (IQRs)	Control group, median (IQRs)	<i>p</i> -value
HOOS	83.4 [16.8]	82.2 [19.1]	0.663 ^a	87.8 [13.5]	88.0 [14.4]	0.326 ^a	0.055 ^b	0 (-3.4–3.2)	0 (0–2.1)	0.964 ^b

HOOS: Hip disability and Osteoarthritis Outcome Score; DAA: Direct anterior approach; PL: Posterolateral approach; DL: Direct lateral approach.

^a Related samples Wilcoxon signed-rank test.

^b Mann-Whitney U test.

Table 3
Individual difference of five points or more in HOOS scores between the hips.

	Study group		Control group	
	In favor of DAA	In favor of PL/DL	In favor of DAA right hip	In favor of DAA left hip
Difference in HOOS > 5 points, <i>n</i> (% of group total)	9 (22.0)	8 (19.5)	3 (11.5)	2 (7.7)

HOOS= Hip disability and Osteoarthritis Outcome Score, DAA= Direct anterior approach, PL= Posterolateral approach, DL= Direct lateral approach

Table 4
Regression analysis.

	R2	<i>p</i> -value
Study vs. control group	0.004	0.634
Study vs. control group adjusted for age, BMI, gender and time interval between surgeries	0.133	0.642

Table 5
Patients' preferred approach.

	Direct Anterior Approach	(Postero)lateral Approach	No preference
Patients' preference, <i>n</i> (%)	28 (68.3)	8 (19.5)	5 (12.2)
Degree of satisfaction, <i>n</i>			
Very satisfied	15	4	3
Satisfied	6	3	1
Unsatisfied	-	1	-
Very unsatisfied	-	-	-

scores differing five points or more, of which three in favor of the right and two in favor of the left (Table 3).

Univariate regression analysis showed that belonging to the study versus control group was not predictive of HOOS outcome ($p=0.634$). After adjusting for age, BMI, gender and time interval between surgeries the independent variable group, thus the approach, remained non-significant ($p=0.642$). This analysis was executed after determining the normality of the dependent variable (Table 4).

All the residuals of the predicting variables were normally distributed and have normal homogeneity of the variances.

3.2. Patient satisfaction

The secondary outcome measure was patient satisfaction about the approaches. Of the patients in the study group 68.3% recommended the DAA to a friend or relative, with a median of 1 out of 4 on the scale of satisfaction with 1 being very satisfied and 4 being very unsatisfied. 19.5% recommended the posterolateral or direct lateral approach, and 12.2% did not have a preference (Table 5).

In Table 6 an overview is given of the answers patients gave to the question: 'Why would you recommend the favored approach?' No answer options were provided, so unbiased answers were given.

4. Discussion

Current evidence comparing clinical outcome measurements following the DAA versus the posterior approach does not

Table 6
Frequency of the answers given to the question: 'Why do you recommend the favored approach?' for respectively the DAA and PL approach.

	Direct Anterior Approach	(Postero)lateral Approach
Less sleeping discomfort	9	-
Faster healing of scar	8	1
Less pain after surgery	8	-
Faster recovery of function	11	-
Recovery without sequela	3	5
Scar complaints (pain, cosmetics)	1	1
Pain on exertion	3	4
Need of assistance in ADL	-	3
Limited range of motion	1	2
Altered sensibility in leg	1	1

demonstrate clear superiority of either approach, besides a small benefit of the DAA in the first postoperative months regarding function and a slight favor of the posterior approach regarding blood loss [2,20,27].

The strength of our study is that two approaches for THA are compared within one patient leading to solid baseline characteristics, and purely focusing on the subjective outcomes using PROMs. To be able to draw conclusions a reasonable sample size is required, and therefore we expanded the inclusion criteria from the second half of 2012 until 2014 with the previous surgery any time beforehand, hereby introducing a possible bias because the heterogeneity of time intervals between both surgeries of one individual increased. To correct for this baseline inconsistency this variable was included in a regression analysis to rule out possible blurring of the outcome. There are several other factors that may influence the functional outcome according to recent studies [2,28,29]. Therefore age, BMI and gender were added to the regression analysis. However, controversy exists about the relationship between BMI and postoperative pain [30].

A factor that may have limited the study was the subjective nature of the secondary research aim. It complicates the way of surveying the results. It is inherent to research that information is categorized, but the reason for the secondary research question is that it is not possible to strictly separate patients' subjective motives, which makes it paradoxical to try to do so. Additionally, asking how satisfied the patients are with the approach they would recommend a friend is suggestive, but was done to objectify the result to make it more comprehensible. A similar problem of electing the proper outcome measurement exists to represent hip function. The HOOS is considered as best fit for the research question, since it is a validated tool and indicated for measuring

hip function after THA [17]. However, in the overall score, differences derived from the subscales may be lost. Nevertheless, because the separate use of the subscales is not validated, only the overall scores were compared. Also this is a retrospective study, and thus limited by the accuracy of the documenting by the physicians. Baseline characteristics such as smoking, BMI and ASA status were extracted from the same source for each patient as much as possible. A recall bias may exist. In spite of the correction for the time interval between the surgeries, there may be an influence of the fading of detailed memories leading to inaccuracy of the data of the less recent posterolateral or direct lateral approach. And additionally, for the second surgery patients know better what to expect, which may reduce tension and thus influence answers patients have given. Also the MCS of the control group is higher than in the study group but also their PCS of the SF-36, representing physical health, is higher. This is plausible as their average HOOS score, also mainly representing physical function, was higher as well. But again the question remains if the higher HOOS score derives from the higher preoperative PCS, or if it is a consequence of the higher HOOS score, thus postoperative hip function. Since the SF-36 was only administered postoperatively we can not make a statement regarding this matter. Our sample size is small, making the ability to establish subtle but significant differences. No more subjects eligible were in our database unfortunately. Finally, there might be an influence from the marketing that went along with the DAA. As to which extent patients are influenced by this, will not be possible to ascertain.

When using this specific group of patients who underwent two different approaches for THA on both hips consecutively no difference was found in hip function one year or more after the last THA. With high certainty it can be said that the difference in surgical approach does not lead to a different long-term functional outcome, since in our design the approach is the only distinguishing factor between both HOOS scores reported by each individual. Furthermore, introducing a control group of patients who underwent the DAA on both hips provides the opportunity to analyze if there is a difference in hip function regardless of the approach that needs to be corrected for, which appears not to be present. Also results on an individual level are not indicating superiority of one of either approach. This is confirmed by Amlie et al. who reported a similar HOOS for hip function one year postoperatively for the DAA and the PL approach [31]. Poehling et al. state that the impact of muscle damage on patient outcomes in contemporary THA may be less important than previously thought [32]. Although patients in the control group did not report a significantly higher HOOS score in comparison to patients in the study group, the finding might be relevant ($p=0.055$). A larger sample size may result in a significant difference. Andrawis et al. reported that higher preoperative patient activation was associated with more pain relief, decreased symptoms, improved mental health, and greater satisfaction after THA, describing an activated patient as one who is armed with the skills, knowledge, and motivation to be an effective member of the healthcare team [33]. Our control group might have a higher share of 'active' patients causing the outcome. An additional explanatory phenomenon might be the effect of mental health on the functional outcome after THA [30], [21]. Multiple studies have demonstrated that poor mental and emotional health measured with generic PROMs are correlated with poor functional outcomes, less pain relief and patient dissatisfaction after THA [34]. Analysis showed that our control group had a significantly higher MCS on the SF-36, representing mental health, than the study group, which might explain the higher score.

Moreover, when patients were asked which approach they would recommend to a friend, a majority recommended the DAA (68%), suggesting that there is a subjective difference between the approaches. The reasons given are mainly from the first

postoperative months, namely less sleeping disturbances, faster mobilization with less restrictions and less pain. The scar is scarcely being mentioned contrary to our expectations, and when it is being mentioned it is not described as a severe matter. It can be concluded that the first postoperative phase is important for patients, which is relevant information in the process of electing an approach and possibly for future research. However, when interpreting these answers it should be borne in mind that postoperative rehabilitation and analgesia protocols have been improved vastly over the last decades. Besides these reasons regarding faster recovery after the DAA, which have been previously described, it is questionable if this is the full explanation for the found preference. Also recommendations or preference by the surgeon for an approach may lead to a positive attitude towards the approach. This further indicates the idea that the dialogue in the consultation room has an influence on the outcome of the THA in general through a psychological route.

The subjective outcome itself, described as patient satisfaction, is difficult to define. It can be considered as an overall attitude based on perception and meeting of expectations, which could imply a role of explanation by the physician and trust.

5. Conclusion

In conclusion, we found that measuring the present outcomes using PROMs showed no difference between the hips when compared in one patient after receiving a THA with the DAA or the posterolateral or direct lateral approach. Furthermore, no difference in HOOS score between the hips was found for patients who received bilateral THA with the DAA. Patients who underwent both procedures reported a subjective preference for the DAA, which they elucidate by a more comfortable rehabilitation period.

Disclosure of interest

The authors declare that they have no competing interest.

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Authors' contributions

A den Daas: conducting research, data analysis, writing of manuscript.

E Reitsma: conducting research, data analysis, writing of manuscript.

B Knobben: writing of study proposal, correction of manuscript.

B ten Have: writing of manuscript, correction of manuscript.

M Somford: writing study protocol and proposal, writing manuscript, data analysis, correction of manuscript.

References

- [1] Barrett WP, Turner SE, Leopold JP. Prospective randomized study of direct anterior vs postero-lateral approach for total hip arthroplasty. *J Arthroplasty* [Internet] 2013;28(9):1634–8 <http://linkinghub.elsevier.com/retrieve/pii/S0883540313001617>.
- [2] Higgins BT, Barlow DR, Heagerty NE, Lin TJ. Anterior vs Posterior Approach for Total Hip Arthroplasty, a Systematic Review and Meta-analysis. *J Arthroplasty* [Internet] 2015;30(3):419–34 <http://linkinghub.elsevier.com/retrieve/pii/S0883540314007955>.
- [3] Ethgen O, Bruyère O, Richey F, Dardennes C, Reginster J-Y. Health-related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. *J Bone Joint Surg Am* [Internet] 2004;86–A(5):963–74 <http://www.ncbi.nlm.nih.gov/pubmed/15118039>.
- [4] Chechik O, Khashan M, Lador R, Salai M, Amar E. Surgical approach and prosthesis fixation in hip arthroplasty world wide.

- Arch Orthop Trauma Surg [Internet] 2013;133(11):1595–600 <http://link.springer.com/10.1007/s00402-013-1828-0>.
- [5] Spekenbrink-Spooren A, van Steenberghe LN, Denissen GAW, van der Toog CR. Orthopedische implantaten in beeld. LROI-Rapportage [Internet] 2014;2014:13 www.lroi.nl.
- [6] Berend KR, Lombardi AV, Seng BE, Adams JB. Enhanced Early Outcomes with the Anterior Supine Intermuscular Approach in Primary Total Hip Arthroplasty. *J Bone Jt Surgery-American Vol* [Internet] 2009;91(Suppl. 6):107–20 <http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00004623-200911006-00014>.
- [7] Bergin PF, Doppelt JD, Kephart CJ, Benke MT, Graeter JH, Holmes AS, et al. Comparison of Minimally Invasive Direct Anterior Versus Posterior Total Hip Arthroplasty Based on Inflammation and Muscle Damage Markers. *J Bone Jt Surgery-American Vol* [Internet] 2011;93(15):1392–8 <http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00004623-201108030-00003>.
- [8] De Anta-Díaz B, Serralta-Gomis J, Lizaur-Utrilla A, Benavidez E, López-Prats FA. No differences between direct anterior and lateral approach for primary total hip arthroplasty related to muscle damage or functional outcome. *Int Orthop* [Internet] 2016;40(10):2025–30 <http://link.springer.com/10.1007/s00264-015-3108-9>.
- [9] Cohen RG, Katz JA, Skrepnik NV. The relationship between skeletal muscle serum markers and primary THA: a pilot study. *Clin Orthop Relat Res* [Internet] 2009;467(7):1747–52 <http://link.springer.com/10.1007/s00264-015-3108-9>.
- [10] Greidanus NV, Chihab S, Garbuz DS, Masri BA, Tanzer M, Gross AE, et al. Outcomes of Minimally Invasive Anterolateral THA Are Not Superior to Those of Minimally Invasive Direct Lateral and Posterolateral THA. *Clin Orthop Relat Res* [Internet] 2013;471(2):463–71 <http://link.springer.com/10.1007/s11999-012-2603-1>.
- [11] Chiu F-Y, Chen C-M, Chung T-Y, Lo W-H, Tain-Hsiung Chen. The effect of posterior capsulorrhaphy in primary total hip arthroplasty. *J Arthroplasty* [Internet] 2000;15(2):194–9 <http://linkinghub.elsevier.com/retrieve/pii/S0883540300902201>.
- [12] Kiyama T, Naito M, Shinoda T, Maeyama A. Hip Abductor Strengths After Total Hip Arthroplasty Via the Lateral and Posterolateral Approaches. *J Arthroplasty* [Internet] 2010;25(1):76–80 <http://linkinghub.elsevier.com/retrieve/pii/S0883540308008462>.
- [13] Franklin PD, Harrold L, Ayers DC. Incorporating Patient-reported Outcomes in Total Joint Arthroplasty Registries: Challenges and Opportunities. *Clin Orthop Relat Res* [Internet] 2013;471(11):3482–8 <http://link.springer.com/10.1007/s11999-013-3193-2>.
- [14] Homma Y, Baba T, Kobayashi H, Desroches A, Ozaki Y, Ochi H, et al. Safety in early experience with a direct anterior approach using fluoroscopic guidance with manual leg control for primary total hip arthroplasty: a consecutive one hundred and twenty case series. *Int Orthop* [Internet] 2016;40(12):2487–94 <http://link.springer.com/10.1007/s00264-016-3159-6>.
- [15] De Geest T, Fennema P, Lenaerts G, De Loore G. Adverse effects associated with the direct anterior approach for total hip arthroplasty: a Bayesian meta-analysis. *Arch Orthop Trauma Surg* [Internet] 2015;135(8):1183–92 <http://link.springer.com/10.1007/s00402-015-2258-y>.
- [16] Klässbo M, Larsson E, Mannevik E. Hip disability and osteoarthritis outcome score. An extension of the Western Ontario and McMaster Universities Osteoarthritis Index. *Scand J Rheumatol* 2003;32(1):46–51.
- [17] Nilsson AK, Lohmander LS, Klässbo M, Roos EM. Hip disability and osteoarthritis outcome score (HOOS)—validity and responsiveness in total hip replacement. *BMC Musculoskelet Disord* [Internet] 2003;4(1):10 <http://bmcmusculoskeletdisord.biomedcentral.com/articles/10.1186/1471-2474-4-10>.
- [18] Instructions HS. HOOS Scoring 2013. 2013:2–4.
- [19] Laucis NC, Hays RD, Bhattacharyya T. Scoring the SF-36 in orthopaedics: a brief guide. *J Bone Jt Surgery-American Vol* [Internet] 2015;97(19):1628–34 <http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00004623-201510070-00010>.
- [20] Graves SC, Dropkin BM, Keeney BJ, Lurie JD, Tomek IM. Does surgical approach affect patient-reported function after primary THA? *Clin Orthop Relat Res* [Internet] 2016;474(4):971–81 <http://link.springer.com/10.1007/s11999-015-4639-5>.
- [21] Rolison O, Dahlberg LE, Nilsson J-A, Malchau H, Garellick G. Variables determining outcome in total hip replacement surgery. *J Bone Jt Surg - Br Vol* [Internet] 2009;91-B(2):157–61 <http://www.bj.boneandjoint.org.uk/cgi/doi/10.1302/0301-620X.91B2.20765>.
- [22] Aaronson NK, Muller M, Cohen PDA, Essink-Bot M-L, Fekkes M, Sanderman R, et al. Translation, validation, and norming of the dutch language version of the sf-36 health survey in community and chronic disease populations. *J Clin Epidemiol* [Internet] 1998;51(11):1055–68 <http://linkinghub.elsevier.com/retrieve/pii/S0895435698000973>.
- [23] N.O.V. Patient Reported Outcome Measures 2012:1–13.
- [24] Moore AT. Metal hip joint; a new self-locking vitallium prosthesis. *South Med J* [Internet] 1952;45(11):1015–9 <https://www.orthopeden.org/downloads/32/advies-proms-orthopedie.pdf>.
- [25] Petis S, Howard J, Lanting B, Vasarhelyi E. Surgical approach in primary total hip arthroplasty: anatomy, technique and clinical outcomes. *Can J Surg* [Internet] 2015;58(2):128–39 <http://canjsurg.ca/vol58-issue2/58-2-128/>.
- [26] Kennon RE, Keggi JM, Wetmore RS, Zatorski LE, Huo MH, Keggi KJ. Total hip arthroplasty through a minimally invasive anterior surgical approach. *J Bone Joint Surg Am* [Internet] 2003;85(A Suppl.):39–48 <http://www.ncbi.nlm.nih.gov/pubmed/14652392>.
- [27] Martin CT, Pugely AJ, Gao Y, Clark CR. A comparison of hospital length of stay and short-term morbidity between the anterior and the posterior approaches to total hip arthroplasty. *J Arthroplasty* [Internet] 2013;28(5):849–54 <http://linkinghub.elsevier.com/retrieve/pii/S0883540313000880>.
- [28] Preininger B, Schmorl K, von Roth P, Winkler T, Matziolis G, Perka C, et al. The sex specificity of hip-joint muscles offers an explanation for better results in men after total hip arthroplasty. *Int Orthop* [Internet] 2012;36(6):1143–8 <http://link.springer.com/10.1007/s00264-011-1411-7>.
- [29] Müller M, Tohtz S, Dewey M, Springer I, Perka C. Age-related appearance of muscle trauma in primary total hip arthroplasty and the benefit of a minimally invasive approach for patients older than 70 years. *Int Orthop* [Internet] 2011;35(2):165–71 <http://link.springer.com/10.1007/s00264-010-1166-6>.
- [30] Hernández C, Díaz-Heredia J, Berraquero ML, Crespo P, Loza E, Ruiz Ibán MÁ. Pre-operative predictive factors of post-operative pain in patients with hip or knee arthroplasty: a systematic review. *Reumatol Clínica (English Ed)* [Internet] 2015;11(6):361–80 <http://linkinghub.elsevier.com/retrieve/pii/S2173574315001070>.
- [31] Amli E, Havelin LI, Furnes O, Baste V, Nordsetten L, Hovik O, et al. Worse patient-reported outcome after lateral approach than after anterior and posterolateral approach in primary hip arthroplasty. *Acta Orthop* [Internet] 2014;85(5):463–9 <http://www.tandfonline.com/doi/full/10.3109/17453674.2014.934183>.
- [32] Poehling-Monaghan KL, Taunton MJ, Kamath AF, Trousdale RT, Sierra RJ, Pagnano MW. No Correlation Between Serum Markers and Early Functional Outcome After Contemporary THA. *Clin Orthop Relat Res* [Internet] 2017;475(2):452–62 <http://link.springer.com/10.1007/s11999-016-4904-2>.
- [33] Andrawis J, Akhavan S, Chan V, Lehlil M, Pong D, Bozic KJ. Higher Preoperative Patient Activation Associated With Better Patient-reported Outcomes After Total Joint Arthroplasty. *Clin Orthop Relat Res* [Internet] 2015;473(8):2688–97 <http://link.springer.com/10.1007/s11999-015-4247-4>.
- [34] Berliner JL, Brodke DJ, Chan V, SooHoo NF, Bozic KJ. John Charnley Award: Preoperative Patient-reported Outcome Measures Predict Clinically Meaningful Improvement in Function After THA. *Clin Orthop Relat Res* [Internet] 2016;474(2):321–9 <http://link.springer.com/10.1007/s11999-015-4350-6>.