Predicting Short Stay Total Hip Arthroplasty by use the Timed Up and Go-test

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Abstract

Background

Establishing patient criteria is one of the most important steps before implementing short stay total hip arthroplasty (THA). Most existing risk models are mainly based on medical condition, but as physical functioning is associated with outcome after THA, we assume a measure of physical functioning might be of added value to predict short-stay THA.

Methods

We used retrospective data of 1559 patients who had anterior THA. Logistic regression analyses were done to study the predictive value of preoperative physical functioning by use of the Timed Up and Go test (TUG), in a basic model with age, and the American Society of Anesthesiologists (ASA)-score for short stay THA (<36 hours). The receiver operating characteristic (ROC) curve was used to define a cut off point for TUG associated with LOS.

Results

TUG was significantly associated with LOS (OR 0.84, 95%CI 0.82-0.87) in univariate regression analysis. In multivariate regression, a model with the TUG had a better performance with an AUC of 0.77 (95%CI 0.74-0.79) and R^2 of 0.27 then the basic model (AUC 0.75, 95% CI 0.73-0.77, R^2 0.24). Patients with a preoperative TUG less than 10 seconds had an OR of 3.64 (95%CI 2.86-4.62) of being discharged within 36 hours.

Conclusions

Performance based physical functioning, measured by the TUG, is associated with short stay THA. This knowledge will help in the decision-making process for the planning, expectations and needs in outpatient THA protocols with the advantage that the TUG is a simple and fast instrument to be carried out.

Introduction

Total hip arthroplasty (THA) is one of the most common and most successful orthopedic procedures. With the aging population, the demand for THA and its economic burden are expected to grow considerably in the next decade[1, 2]. In the past, the length of stay (LOS) following primary THA has been one week or more; however, advances in surgical techniques and clinical pathways have allowed for faster recovery and shorter LOS. These advances in (minimal invasive) surgical techniques, combined with multimodal analgesia and early rehabilitation have reduced LOS to an average of 2–4 days, even allowing for same-day discharge in selected patients[3]. Same-day THA can be safe and effective in appropriate patients and may result in substantial cost savings[4, 5]. Furthermore, a shorter LOS may also improve patient satisfaction, allowing patients to recover in their private, comfortable home environment

and achieve independence as early as possible[6]. Establishing patient criteria is one of the most important steps before implementing same-day THA. Several studies concluded that patients with specific medical conditions, a low American Society of Anesthesiologists (ASA) classification (< III), undergoing primary arthroplasty, age < 75 and with support at home are eligible candidates for outpatient joint arthroplasty [7–11]. While most studies have focused on demographic and medical factors, preoperative physical functioning has not been reported as a selection criterion. Although Bodrogi et al. defined worse physical functioning (TUG > 10 seconds) as a relative exclusion criterion for same-day discharge after total joint arthroplasty (TJA), this recommendation was not based on an outpatient TJA population [12, 13]. As other studies found that measurements of physical functioning were of relevance to predict recovery of functioning and LOS after total joint arthroplasty [14–16], we assume that preoperative physical functioning might also be an important predictor for short stay THA.

In this study we evaluated the association between preoperative performance based physical functioning (the Timed Up and Go test, TUG), for short stay elective minimal invasive anterior THA (discharge within 36 hours after surgery).

Methods

We used data of a retrospective cohort of patients who had primary THA between 2015 and 2017 in the Gelderse Vallei Hospital in the Netherlands. We used data from all patients who had elective primary total hip arthroplasty by anterior approach. Patient who had THA by posterior approach were excluded as the posterior approach was only used in this hospital for specific cases like revision surgery. Six orthopedic surgeons did anterior THP surgery. Use of clinical data was approved by the local medical ethics committee of Gelderse Vallei Hospital (BCWO 1804-076). This study complied with the principles in the Declaration of Helsinki. Data was extracted from the medical files by a data-specialist and checked, complemented and anonymized by the researcher. The STROBE guideline was used when drafting the manuscript.

In our pathway called “Active Recovery”, all patients had a preoperative screening by an anesthetist, nurse and physical therapist, including a screening of physical functioning. Besides a screening of health conditions and comorbidities, preoperative physical fitness was evaluated by self-reported questionnaires and performance based to determine the risk for delayed recovery or complications. Patients were informed and advised about the importance of staying physically active and fit before surgery by the physical therapist. Expectations, goals, home situation and (necessary) help were discussed. Furthermore, patients were trained to walk with crutches. Patients were informed that a hospital stay of 1 or 2 night was common. All patients had the same perioperative protocol. Both local and general anesthesia were used based on the indication of the anesthetist and preference of the patient.

Postoperatively, patients started to mobilize 4 hours after surgery and were discharged when they were able to ambulate independently (with crutches or other walking aid), had no medical or wound problems

and had sufficient help and care at home. Same day discharge was not possible yet due to logistics and organization of care.

Outcome measures

LOS was the dependent variable and was dichotomized. Short stay THA was defined as a LOS less than 36 hours (1 overnight stay). Hours were counted from time of surgery until discharge.

Preoperative physical functioning was the independent measured by TUG. The TUG test measures the domain of functional mobility and is recommended by OARSI [17]. Participants were asked to rise from a chair, walk three meters, turn, return and sit down, all as fast as possible. A lower score (in seconds) reflects better functional mobility. Use of a walking aid was permitted, only when they also depended on a walking aid at home

Other descriptive variables were:

- Preoperative: sex, Body mass index (BMI, kg/m²), social status (living together, living alone with help from someone nearby or living alone), HOOS-PS (Hip disability and Osteoarthritis Outcome Score - Physical Function Short Form) [18] and the ASA classification [18]. As we had only a few patients with ASA score 4, ASA class 3 and 4 were merged as one category.
- Peroperative: anesthesia (general or spinal)
- Postoperative: discharge destination (home or rehabilitation)

Assuming at least 10 events per variable, the database is large enough for sufficient statistical power [19]. We used complete case analysis and checked for bias by evaluating if the missing data were related to baseline characteristics and ASA score (by Chi-square statistics) and age (by paired t-test).

Standard statistics were used for descriptive data. The variance inflation factor (VIF, cut-off 4.10) and the correlation matrix (cut-off 0.8) were used to test for multicollinearity [19].

First univariate regression was done for age, sex, ASA score and TUG. Thereafter, multivariate logistic regression analysis was used to analyze the association between the TUG and short stay THA, within a basic model based on literature (sex, age and ASA-score). [7–10].

Therefore, we evaluated 2 models: 1. the basic model with age, sex and ASA-score as variables, 2. the basic model + TUG. Goodness of fit was tested with the Hosmer & Lemeshow test and Nagelkerke R² statistics. Receiver operating characteristic (ROC) curves were constructed with the logistic regression model to assess their predictive value using the area under the curve (AUC).

Furthermore, we performed a logistic regression with TUG (< 10 seconds) as a dichotomous variable to be able to compare the results with other studies and to translate them into clinical practice. This cut off

was based on the ROC-curve.

SPSS Statistics 25 (SPSS Inc., Chicago, IL) was used for all statistical analyses.

Results

A total of 1608 patients had a THA in the study period and 49 cases were excluded (revision surgery, posterolateral approach, THA at both sides). All 1559 patients who were included had primary THA by anterior approach. Table 1. shows baseline characteristics. Mean BMI was 27.2 (SD 4.8) kg/m² and 69% of all patients were women (Table 1). Mean TUG was 10.8 seconds (SD 5.8) .

Table 1
Characteristics of the study population

		Total	Fast recovery	Normal recovery
			LOS 1 night	LOS $\geq$ 2 nights
			(< 36 hours)	($\geq$ 36)
		n = 1559	n = 629	n = 926
Preoperative				
Age	mean (SD)	69.8 (9.3)	66.1 (8.3)	72.4 (9.1)
Sex	% women	68.8	56.0	77.5
BMI (kg/m ²)	mean (SD)	27.2 (4.5)	26.9 (4.1)	27.4 (4.7)
Social status				
living together	%	68.5	84.3	57.7
help nearby	%	10.7	7.7	12.7
living alone	%	20.8	7.9	29.5
ASA score				
I	%	25.0	35.8	17.7
II	%	59.8	57.1	61.6
II/IV	%	15.2	7.2	20.7
TUG (sec)	mean (SD)	10.8 (5.8)	8.8 (4.2)	12.1 (6.4)
HOOS-PS	mean (SD)	44.1 (17.3)	40.6 (16.4)	46.5 (17.4)
Peroperative				
Anesthesia				
general	%	53.9	54.5	53.5
spinal	%	46.1	45.5	46.5
Postoperative				
LOS	mean (SD)	2.0 (1.3)		
Discharge location				
home	%	89.0	98.1	82.8
rehabilitation	%	11.0	1.9	17.2

Total	Fast recovery LOS 1 night	Normal recovery LOS $\geq$ 2 nights
LOS = length of hospital stay, BMI = Body mass index, ASA = American Society of Anesthesiologists classification, TUG = Timed up and go test, HOOS-PS = The Hip disability and Osteoarthritis Outcome Score - Physical Function Short Form, SD = standard deviation		

Forty percent (n = 627) of all patients went home one day after surgery (< 36 hours) of which 16% went home within 24 hours. A total of 11% of all patients needed inpatient rehabilitation after discharge.

ASA-score had 2 missing values and TUG had 44 missing values. Missing values of TUG were probably due to patients not attending preoperative physical therapy screening or because it was not possible to perform the test due to physical limitations.

There were no differences in age, sex or ASA-score between the dataset with and the dataset without missing data of TUG.

There was no multicollinearity as the VIF's were all below 2 and all correlation coefficients were below 0.5, so they did not reach the cut-off points.

Univariate regressions confirmed that sex, age, ASA and TUG were all independently associated with short stay LOS (Table 2.).

Table 2
Univariate association between baseline characteristics and short stay (< 36 hours) THA

	OR (95%CI)
Age	0.92 (0.91–0.93) *
Sex	2.72 (2.18–3.39) *
ASA score	
I	reference
II	0.46 (0.36–0.58) *
III/IV	0.17 (0.12–0.25) *
TUG	0.84 (0.82–0.87) *
*p < 0.05, ASA = American Society of Anesthesiologists classification, TUG = Timed up and go test, CI = confidence interval	

Table 3. shows the results of multivariate regression. A basic model with age, sex and ASA-score had an AUC of 0.75 (95% CI 0.73–0.78). TUG (OR 0.92, 95%CI 0.89–0.95) contributed significantly to basic model. The model with the TUG had the best performance with an AUC of 0.77 (95%CI 0.74–0.79) and R² of 0.27.

Table 3
Multivariate association between baseline characteristics and short stay (< 36 hours) THA

	MODEL 1 Basic variables	MODEL 2 Basic variables + TUG
	OR (95%CI)	OR (95%CI)
Age	0.93 (0.92–0.95)*	0.94 (0.93–0.95)*
Sex	2.80 (2.20–3.56)*	2.54 (1.99–3.28)*
ASA score		
I	reference	reference
II	0.56 (0.43–0.72)*	0.62 (0.48–0.81)*
III/IV	0.23 (0.15–0.34)*	0.29 (0.19–0.45)*
TUG	X	0.92 (0.89–0.95)*
Nagelkerke's R ²	0.24	0.27
Hosmer & Lemeshow test, p-value	0.26	0.31
AUC	0.75 (0.73–0.77)	0.77 (0.74–0.79)
*p < 0.05, ASA = American Society of Anesthesiologists classification,, TUG = Timed up and go test,, OR = odds ratio, CI = confidence interval, AUC = Area under the curve		

Based on the ROC curve a cutoff point of 10 seconds for TUG suited our data. Patients with a TUG less than 10 seconds had an OR of 3.64 (95%CI 2.86–4.62) to be discharged within 36 hours.

Discussion

In our retrospective cohort we aimed to evaluate the predictive value of preoperative physical functioning for short stay THA. We found that perioperative performance based physical functioning (TUG) was independently associated with short stay THA. A basic model (age, sex and ASA) with TUG, score had a better predictive value then the basic model without TUG, with an acceptable AUC of 0.77. Patients with a TUG less than 10 seconds had an OR of 3.64 of being discharged within 36 hours.

Several studies already confirmed a performance based measure like TUG or gait speed as an independent determinant of LOS or functional recovery [13, 20, 21] or in most studies more specific prolonged LOS or functional recovery [14–16], but as far as we know no studies have been done on the value of TUG in selection models for short-stay or day treatment. Although Bodrogi et al. stated in a review about management of patients undergoing same-day discharge primary total hip and knee arthroplasty that a Timed Up and Go Test > 10 seconds is a relative exclusion criteria for outpatient TJA[12], this recommendations was based on the study of Poitras et al. in which they found an association between preoperative TUG (cut off point 11.7 seconds) and LOS (cut off point 3 days). Other studies found cut off points of 12.5 seconds [16] or 10.5 seconds [14] for predicting a delayed recovery of

functioning after THA. Our study confirmed that a TUG < 10 seconds is associated with short-stay THA. However, this cut off point should be validated in each local setting based on the context and preferences and should be validated for an outpatient setting (without overnight stay).

Most outpatient protocol primarily focus on ASA-score or other tools assessing medical condition like the recently developed Outpatient Arthroplasty Risk Assessment (OARA)[11]. This screening instrument has 9 medical items to predict safe outpatient TJA and is effective for identifying patients who can safely undergo outpatient total joint arthroplasty. However, this is a one-dimensional approach and does not take into account the functional capabilities of patients. As reported in the study of Gromov et al., lack of safe mobilization might be one of the most common reasons for THA patients not being discharged at the day of surgery[22]. Therefore, it makes sense that better preoperative functional mobility is related to successful outpatient THA. We assume a measure of performance based physical functioning cannot simply be replaced by a questionnaire. Performance-based measures assess what an individual can do rather than what the individual perceives they can do. Furthermore, patients could under- or overestimate their functional ability by use of self-reported measures [23]. In our study both ASA and TUG were associated with short-stay THA, so we propose to take into account both physical functioning and comorbidity, by use of the ASA or the OARA score, in preoperative risk stratification to estimate whether a quick and uncomplicated recovery is likely.

A strength of this study is that we had a large cohort with patients who had surgery in our hospital without selecting candidates for short-stay THA prior to surgery. This provides a good reflection of daily practice without being biased. We assume a large number of patients who were discharged the next postoperative day in our cohort are candidates for outpatient THA when managing expectations, optimizing the mindset of patient and caregivers within a multidisciplinary approach and evidence based fast track protocols[3, 4, 12]. Another strength is that we used TUG as measures for physical functioning as TUG is widely used and simple to perform. TUG can be measured during preoperative physical therapy, which is part of most outpatient protocols [4] or even at the patients' home. Furthermore, TUG is not only useful in predicting LOS after THA but may also be useful to predict long term outcome and other postoperative risks as TUG is also found to be associated with functional independence and risk of falling and frailty in elderly [24, 25] and with deep venous thrombosis after THA [26]. In addition, including preoperative measurement of physical functioning like TUG may be an important starting point to a more function tailored pathway. Van der Sluis et al. studied a function tailored approach and were able to reduce LOS by use of measurements of physical functioning, reduction of inactivity and stimulation of self-efficacy of the patients[27]. Functional mobility, measured by TUG, is a modifiable risk factor and could be a target in preoperative preparation of patients.

This study had several limitations. First, it was a single-center retrospective study without external validation. Second, although we took into account confounding factors like age, sex and ASA score, there are more preoperative factors related to short-stay THA, which may result in some residual bias. Thirdly, we only evaluated one single test of physical functioning. Further studies are necessary to validate the

use of TUG or other measures of physical functioning in preoperative risk stratification for short-stay or outpatient THA and their added value to other existing risk assessment instruments like the OARA score.

Conclusions

Performance based physical functioning, measured by the TUG, is associated with short stay THA and has added value in a prediction model with ASA-score, age and sex. This knowledge will help in the decision-making process for the planning, expectations and needs after THA with the advantage that the TUG is a simple and fast instrument to be carried out. Further studies are necessary to validate the use of the TUG in preoperative prediction models for outpatient THA.

List Of Abbreviations

THA Total Hip Arthroplasty

ASA American Society of Anesthesiologists

HOOS-PS Hip disability and Osteoarthritis Outcome Score - Physical Function Short Form

LOS Length of Stay

OARSI Osteoarthritis Research Society International

BMI Body Mass Index

VIF Variance Inflation Factor

OR Odds Ratio

CI Confidence Interval

ROC Receiver Operating Characteristic

SD Standard Deviation

AUC Area Under the Curve

Declarations

Ethics approval and consent to participate

Use of clinical data was approved by the local medical ethics committee of Gelderse Vallei Hospital (BCWO 1804-076). As this was a retrospective study, informed consent to participate was waived by the

ethics committee (the local medical ethics committee of Gelderse Vallei Hospital (BeoordelingsCommissie Wetenschappelijk Onderzoek, BCWO 1804-076)).

All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

EO contributed to the conception and design of the design, the acquisition, analysis and interpretation of data and drafted the manuscript. SV contributed to the conception of the design, the acquisition of data and substantively revised the manuscript. EB contributed to the acquisition and interpretation of data and substantively revised the manuscript. PK contributed to the conception of the work and substantively revised the manuscript.

All authors have approved the submitted version and have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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