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Outcome of osteoarthritis and arthroplasty from patient perspective to molecular profiling.

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Association of hand grip strength with patient reported outcome measures after total hip and knee arthroplasty

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Submitted

Abstract

Background**:** About 33% of the osteoarthritis patients undergoing total hip/knee arthroplasty are not satisfied with the outcome, warranting the need to improve patient selection and to improve management of patient expectations. Previous research has found that quadriceps strength is related to outcome of arthroplasty and handgrip strength has been suggested as a proxy for overall muscle strength. This study aims to assess whether preoperative handgrip strength is associated with gain in hip/knee function and quality of life in arthroplasty patients.

Materials & Methods: 226 hip and 246 knee arthroplasty-patients were selected from a prospective cohort study, including patients from October 2010 to September 2012. Preoperative handgrip strength was assessed with a dynamometer and the HOOS/KOOS and SF-36 questionnaires were collected before arthroplasty and one year thereafter. The association of handgrip strength with the outcome change was assessed by linear regression models, including age, sex, body mass index and baseline score.

Results: Handgrip strength was strongly associated with change score on "sport & recreation"-domain in hip and moderately to "sport & recreation"-domain in knee and "symptoms"-domain in hip.

Conclusions*:* Handgrip strength can be used as a tool to provide patients with information about gains to be expected on certain aspects of life after arthroplasty.

Introduction

Total Hip Arthroplasty (THA) and Total Knee Arthroplasty (TKA) are effective procedures to improve pain and functioning in osteoarthritis (OA) patients.[1,2] Despite high success rates, up to one-third of persons undergoing arthroplasty are not satisfied with the outcome of surgery, warranting the need to improve the selection of patients who may and may not benefit and manage expectations in this patient group. [3-5]

Besides age, gender, physical and mental status, poor quadriceps strength was associated with worse outcomes of knee arthroplasty.[6-8] Handgrip strength (HGS) is a proxy for overall muscular strength, with only a small number of measurements with a handgrip dynamometer considered necessary to characterize an individual's overall strength status.[9-11]

HGS has been demonstrated to associate with worse general health in the elderly as well as being a predictor for all-cause mortality in elderly.[12-18] In various patient groups, HGS has been shown to be predictor for disability, malnutrition and surgery complications.[19-29] To our knowledge, only one study focused on HGS in hip and knee arthroplasty patients, showing that a lower HGS is associated with increased length of hospital stay after hip or knee replacement while correcting for age.[30] Hence, the value of HGS as a predictor for long-term outcomes after lower limb arthroplasty surgery is currently unknown.

The purpose of this study is to assess the association of preoperative HGS with postoperative changes of hip and knee function and quality of life one year after total hip or knee arthroplasty as measured on the various subscales of the Hip disability and Osteoarthritis Outcome Score (HOOS) and Knee Injury and Osteoarthritis Outcome Score (KOOS) and Short Form-36 Health Survey (SF-36) questionnaires.

Materials & Methods

This study on HGS as an indicator for THA and TKA outcome was part of a prospective observational cohort study on the outcomes of THA and TKA performed at the Department of Orthopedics of the Alrijne Hospital, Leiderdorp, the Netherlands, from October 2010 to September 2013 (inclusion of patients until September 2012).

The study protocol was in concordance with the Declaration of Helsinki[31] and was reviewed and approved by the local hospital Review Board of the Alrijne Hospital (registration number 11/02), which is supervised by the Medical Ethics Committee of the Leiden University Medical Center, Leiden, the Netherlands.

This prospective cohort study aimed to include all consecutive patients undergoing a primary THA or TKA because of OA, aged 18 years or older, able to read and understand Dutch and being mentally and physically able to complete questionnaires.

Excluded were patients with revision of a THA or TKA, undergoing a hemi-arthroplasty of the hip and undergoing a THA or TKA because of a tumor or rheumatoid arthritis. All assessments were done preoperatively and 12 months thereafter and consisted of HGS measurement at the hospital and the collection of questionnaires, administered personally (preoperative assessment) and by regular mail (follow-up).

One day preoperatively, before being admitted to the hospital, information about the study was provided to all eligible patients. Patients received a response form as well as a set of questionnaires. The response form comprised statements for both patients who wished to participate (including signature) and those who did not want to participate. Each patient was asked to return the questionnaires and informed consent form and perform the HGS-test on the day of surgery, when admitted to the hospital.

Socio-demographic characteristics were recorded preoperative and included: age (years); gender and length (cm) and weight (kg) to calculate the Body Mass Index (BMI). Age was categorized into three groups; <60 years, 60-70 years and aged >70.

Isometric HGS was measured before arthroplasty using the JAMAR® hydraulic hand dynamometer (Patterson medical, Mississauga, Canada).[32] Results were expressed in kilograms. Patients were shown the correct operation of the dynamometer prior to measurements. They were instructed to keep their shoulders adducted and neutrally rotated, their forearm in a vertical position, and wrist in a neutral position and to squeeze the grip with maximal strength. The highest result of two grip strength trials with the dominant hand in a seated or semi-seated position was used.

Patient reported outcome scores were collected before arthroplasty surgery and at one year follow-up. The SF-36 questionnaire was used to assess overall quality of life and the HOOS/KOOS for joint specific PROMS measurements. The SF-36 is composed of 36 questions and standardized response choices. Summary component scores for physical health (PCS) and mental health (MCS) can be calculated from this questionnaire. In this study, scores of the Dutch general population were used to standardize our scores in order to apply norm-based scoring.[33]

In patients undergoing THA, the HOOS was used to assess functioning. This questionnaire consists of 40 items divided over 5 dimensions: pain (P); symptoms (S); activity limitations-daily living (ADL); function in sport and recreation (SP) and hip related quality of life (QoL). Persons with end stage knee OA received the similar KOOS questionnaire which comprises 42 items and uses the same 5 subscales as the HOOS. For the present study, validated Dutch versions of the HOOS and KOOS were used.[34,35]

Statistical Analyses:

Patients' socio-demographic characteristics were compared between those who did and did not complete the one year follow-up assessment by using unpaired Student's t-test (for continue variables) or Chi Square test (for categorical variables).

The SF-36 PCS and MCS subscales were included as outcome score as well as the five subscales from the HOOS/KOOS questionnaire: pain (P), symptoms (S), activity limitations of daily living (ADL), function in sport and recreation (SP) and quality of life (QoL). For each of these subscales a change score was calculated by subtracting the pre-surgery scores from the 1-year follow-up score.

Normality of the change scores was assessed by means of histograms, Q-Q-plot and Kolmogorov-Smirnov test. Multiple regression models for hip and knee patients were used to study the association between HGS and change scores adjusted for age group, gender, BMI and preoperative values of outcome measures. An interaction term between gender and age group was incorporated in the model to investigate possible additional different effects between males and females. These analyses were performed for THA and TKA separately.

The strength of the association of HGS to the outcome change score was quantified by assigning the unstandardized effect sizes to one of the categories: 0-0.19 very weak, 0.2-0.39 weak, 0.4-0.59 moderate, 0.6-0.79 strong, 0.8-1.00 very strong.[36]

All data was analyzed using the SPSS statistical package (version 20.0, SPSS, Chicago, Illinois). The level of statistical significance was set at $P \leq 0.05$ for all analyses.

Results

341 persons undergoing THA surgery completed the preoperative assessment of which 226 (66.3%) persons completed the one year follow-up. Among the 315 TKA patients, 246 (78.1%) completed the one year follow-up.

Demographic characteristics of patients with end stage OA, scheduled for either total hip or total knee arthroplasty are shown in Table 1. There were no statistically significant differences in age, gender and BMI between those who did and did not complete follow-up. Among those who completed the questionnaire, TKA patients were significantly more often female than those who underwent THA (P=0.001) and had a higher BMI (P<0.001), there was no significant difference in age between THA or TKA patients (P=0.605).

Table 1 - Demographic characteristics of patients with end stage OA, scheduled for either total hip or total knee arthroplasty.

	Total Hip Arthroplasty			**Total Knee Arthroplasty**		
	Completed N=226	Incomplete N=115	P*	Completed N=246	Incomplete N=69	P*
Sex %Female	127 (56.1%)	75 (65.2%)	0.109	176 (71.5%)	52 (75.3%)	0.531
Age (Years)	66.4 (9.5)	67.8 (10.8)	0.243	66.9 (9.2)	68.1 (11.5)	0.359
BMI	26.9 (4.4)	27.8 (4.8)	0.082	29.4 (4.5)	29.7 (4.7)	0.675

* P-value for differences between patients with end stage hip or knee OA who did and did not complete follow-up. Difference was calculated by means of Chi-Square or unpaired Student's T-test, where was appropriate.

Mean HGS was 26 kg for end stage hip OA and 24 kg (SD=10) in end stage knee OA patients, with males having higher scores than females in both hip (mean (SD) HGS males: 34(10) kg, females: 21(6) kg) and knee (mean(SD) HGS males: 34(10) kg, females 19(7) kg).

As can be seen in Table 2, for each outcome score except MCS a significant difference in pre- and post-surgery outcome score was found. In both hip and knee the change in outcome for PCS was higher than the minimal clinically important difference (MCID) of 10 points. However, for MCS the change scores were not significant, neither clinically relevant.[37,38] The smallest change score on the HOOS/KOOS subscales was 10.8, (KOOS-S) which is just above the MCID cut-off of 10.[39,40] Interestingly, the final scores on the “Function in sport and recreation” and “Symptoms” subscales of the HOOS/KOOS were significantly (both P<0.001) higher in the THA groups than the TKA group.

Table 2 – Outcome score at baseline and one year follow-up.

		Total Hip Arthroplasty N= 226			**Total Knee Arthroplasty N=246**		
		Baseline Mean (SD)	1 year FU Mean (SD)	P*	Baseline Mean (SD)	1 year FU Mean (SD)	P*
SF-36[a]	PCS [b]	40.2 (7.5)	53.3 (7.7)	<0,001	40.6 (7.3)	52.1 (8.9)	<0,001
	MCS [c]	52.1 (10.5)	53.4 (8.4)	0,096	52.8 (10.1)	52.0 (9.35)	0,115
HOOS KOOS [d]	ADL[e]	45.2 (17.8)	84.8 (16.9)	<0,001	50.1 (18.1)	84.2 (16.4)	<0,001
	Pain	43.2 (18.5)	88.2 (14.7)	<0,001	43.0 (16.5)	85.0 (17.0)	<0,001
	QoL[f]	35.7 (10.3)	54.8 (17.1)	<0,001	35.2 (9.9)	54.2 (17.1)	<0,001
	SP[g]	21.6 (19.3)	63.8 (26.6)	<0,001	14.0 (16.0)	47.1 (28.8)	<0,001
	Symptoms	38.2 (18.9)	80.5 (19.8)	<0,001	45.0 (13.5)	55.8 (12.0)	<0,001

* P-value for Wilcoxon test assessing outcome score at baseline and one year follow-up.
a SF-36: Short Form 36 Questionnaire.
b PCS: Physical Component Score of the SF-36 questionnaire
c MCS: Mental Component Score of the SF-36 questionnaire
d HOOS/KOOS: Hip disability / Knee injury Osteoarthritis Outcome Score.
e ADL: Activities of Daily Life – domain of the HOOS/KOOS Questionnaire
f QoL: Quality of Life – domain of the HOOS/KOOS Questionnaire
g SP – Function in sport and recreation – domain of the HOOS/KOOS Questionnaire

The unstandardized adjusted coefficients, showing the effect of preoperative HGS and the change on the postoperative PROMS outcome-variable, are shown in table 3 where the effect is quantified by the coefficient (coef). In both arthroplasty groups a significant effect of HGS on “function in sport and recreation”-scale of the HOOS/KOOS (THA: coef=0.68, P=0.005; TKA coef =0.52, P=0.049) was found. Some evidence for an effect of HGS on the “symptoms” subscale was seen in THA (coef=0.56, P=0.001), but not in the TKA group (coef=0.16, P=0.146). A small effect of HGS to “quality of life” as measured by HOOS/KOOS was seen on THA (coef=0.32, P=0.047) and TKA (coef=0.33, P=0.033). A significant effect of HGS was found on PCS for TKA (coef=0.31, P=0.001) but not in THA (coef=0.14, P=0.052). No evidence of effect of HGS on the MCS of the SF-36 on both THA and TKA group was found.

All observed statistically significant effects were positive, indicating that with increasing handgrip strength a positive change in the outcome measures occurs after arthroplasty surgery.

Table 3 – Outcome of multiple regression models for HGS and change score.

		Total Hip Arthroplasty N= 226			**Total Knee Arthroplasty** N=246		
		Coef (SE)	95% CI	P*	Coef (SE)	95% CI	P*
SF-36[a]	PCS [b]	0,136 (0,07)	[-0,001 - 0,273]	0,052	0,305 (0,09)	[0,135-0,476]	0,001
	MCS[c]	0,074 (0,07)	[-0,054 - 0,202]	0,257	-0,022(0,09)	[-0,192-0,148]	0,802
HOOS KOOS [d]	ADL[e]	0,253 (0,15)	[-0,037 - 0,543]	0,087	0,308 (0,15)	[0,012-0,604]	0,042
	Pain	0,270 (0,13)	[0,015 - 0,524]	0,038	0,188 (0,16)	[-0,119-0,496]	0,229
	QoL[f]	0,317 (0,16)	[0,005-0,630]	0,047	0,327 (0,15)	[0,026-0,628]	0,033
	SP[g]	0,681 (0,24)	[0,209-1,153]	0,005	0,520 (0,26)	[0,001-1,039]	0,049
	Sym[h]	0,564 (0,17)	[0,228-0,900]	0,001	0,159 (0,11)	[-0,056-0,373]	0,146

* P-value; potential confounder age group, sex, BMI and baseline-outcome.
a SF-36: Short Form 36 Questionnaire
b PCS: Physical Component Score of the SF-36 questionnaire
c MCS: Mental Component Score of the SF-36 questionnaire
d HOOS/KOOS: Hip disability / Knee injury Osteoarthritis Outcome Score
e ADL: Activities of Daily Life domain of the HOOS/KOOS
f QoL: Quality of Life domain of the HOOS/KOOS
g SP: Function in sport and recreation domain of the HOOS/KOOS
h Sym: Symptoms domain of the HOOS/KOOS

Discussion

This study shows that preoperative hand grip strength of total hip or knee arthroplasty patients is strongly associated to the change in outcome on the "*function in sport & recreation*"-subscale of the HOOS/KOOS in both the THA and TKA groups, a strong positive association was also found on the "*symptoms*"-subscale and some evidence for a smaller effect on "quality of life" of the HOOS in THA patients.

Our findings are in agreement with current research where low HGS before surgery is associated to adverse outcome scores. The associations of HGS with the increase in score for physical measures (reflected in "function in sports and recreation", "symptoms" and PCS) post-surgery is also discussed in Savino et al., the authors show that HGS is associated to walking recovery after hip fracture surgery.[41] In the same type of patients, Visser *et al*[42] have shown that a decline in HGS post-surgery is associated to less recovery of mobility and Beloosesky[43] has demonstrated that HGS can be used to predict motor functioning at 6 months post-surgery. Although we measure a more generic outcome measure in a different patient group with a longer follow-up, these findings are in line with published literature.

The association of HGS with "*function in sport and recreation*" was more pronounced in THA patients than TKA patients and the "*symptoms*"-subscale was only associated with HGS in THA patients, not in TKA patients. A systematic review by Skoffer *et al*[44] found that muscle strength training in THA is effective to improve QoL after surgery, whereas for TKA this is not demonstrated.

These outcomes, together with the present study, suggest that the association of muscle strength with surgery outcome is dependent on the joint site, however, the mechanism has yet to be elucidated. TKA patients were, at baseline, more overweight than THA patients, which may play a role. Indeed, it has been reported that obesity is negatively associated with functional score and quality of life after TKA but not in THA.[45] However, our results were corrected for BMI, nevertheless, we do find different results for both joints.

The mean HGS values found in our study (THA: males: 34, females: 21; TKA: males: 34, females 19) were lower than the reference values as reported by Leong *et al*[46] for males (HGS=42) and females (HGS=26) aged 61-70 from North America and Europe. These lower values are explained by the fact that our patients all have end-stage osteoarthritis, while the reference values were obtained in healthy adults.

This study suffers from a high rate of loss to follow-up (THA: 33.7% and TKA: 21.9%), although we did not find any statistically significant differences in age, sex or BMI distribution, those who did not complete follow-up tend to be older and have a higher BMI. As increased age and BMI are associated with worse outcomes, this is a major limitation to our study.

Since the guidelines on indication for hip and knee arthroplasty are based on limited evidence, the application of HGS as a tool to identify patients who may experience lower outcome changes may contribute to optimize patient specific care.[47,48] HGS could be applied to manage patients expectations and include patients in the shared decision making process.

In conclusion, a rather easily applicable clinical measurement such as HGS could contribute to the assessment of the postoperative outcome of THA and TKA, providing the orthopedic surgeon as well as patients an easy preoperative tool on certain aspects of the postoperative outcome of THA and TKA.

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