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Association between rehabilitation attendance and physical function following discharge after total knee arthroplasty: prospective cohort study

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SUMMARY

Background: Rehabilitation is widely advocated and provided as a standard of care for patients with total knee arthroplasty (TKA) but its effects on intermediate- to longer-term physical function is unclear. Also unknown is the relationship between the number of rehabilitation sessions attended and functional outcomes.
Methods: We conducted a prospective cohort study of 1540 patients who had undergone TKA and were referred for rehabilitation. Physical function was indexed by the Short-Form 36 (SF-36) physical function score at 6 months post-TKA. We used multivariable linear regression to assess the association between rehabilitation attendance and Month-6 physical function. Among patients who attended rehabilitation, multivariable linear regression was used to examine the dose–response association between the number of sessions attended and Month-6 physical function.
Results: Of the 1540 patients, 68 patients did not attend rehabilitation, 86 patients attended one session, and 1386 patients attended two or more sessions. Adjusted for the propensity to attend rehabilitation, rehabilitation attendance was independently associated with better Month-6 SF-36 physical function (point estimate, 5.0 points; 95% CI, 0.5–9.5; $P = 0.028$ compared with patients with no rehabilitation). Among patients who attended rehabilitation, attending five sessions was associated with a 3.6-point increase in SF-36 scores (95% CI, 0.8–6.5; $P = 0.01$) relative to patients who attended one session.
Conclusions: Rehabilitation attendance post-TKA is associated with an increase in self-report physical function. Among patients who attended rehabilitation, a modest dose–response relationship was observed between the number of sessions and functional outcomes.

Introduction

Following discharge after a total knee arthroplasty (TKA), physical rehabilitation, comprising mainly physical therapy intervention, is widely advocated and provided as a standard of care[1–3]. Although a recent meta-analysis of randomized controlled trials has shown that post-TKA rehabilitation was associated with an improvement in physical function in the short-term (~3 months post-TKA), only four small randomized studies have examined, with conflicting results, its association with intermediate- to longer-term (6 months or longer) self-report physical function[4]. Notably, probably due to ethical considerations, control-group patients from previous randomized studies often received some form of physical therapy intervention[4]; hence, the effectiveness of post-TKA rehabilitation over true non-intervention control patients is not known. Furthermore, among patients who have participated in rehabilitation, the association between the number of sessions attended ("dose") and follow-up functional outcomes is not known. Given the increasing need to control cost in primary TKA[1] and the lack of consensus regarding the appropriate "dose" of rehabilitation[3], a comprehensive evaluation of the effectiveness and dose–response of post-TKA rehabilitation within a real-world context is needed more than ever.

Thus, the present study aims to (1) examine the association between post-TKA rehabilitation attendance and Month-6 self-report physical function in a large cohort of patients who were referred for rehabilitation and to (2) characterize the dose–response association between the number of rehabilitation sessions attended and self-report physical function among patients who attended at least one rehabilitation session.

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Methods

Between July 2013 and November 2015, we identified 2890 patients age ≥50 years who underwent a primary TKA and were discharged home from Singapore General Hospital – the largest tertiary teaching hospital in Singapore which performed half (51.1%) of all knee arthroplasties in the nation[5]. In Singapore, patients co-pay for health services (including rehabilitation) and provisions are made for those who cannot afford the co-payment[6]. Singapore also has a connected and efficient public transportation system[7] which facilitates transportation to rehabilitation. We excluded patients who had a history of rheumatoid arthritis ($n = 39$) and patients with stroke or Parkinson disease ($n = 45$). For patients with consecutive admissions for TKA, only data from their first admission were analyzed if the second operation occurred at least 1 year after the index TKA ($n = 215$). Of the remaining 2591 patients, we selected a cohort of 1540 patients with non-missing follow-up (6 months) Short-Form 36 (SF-36) scores and rehabilitation attendance status (described below). Included patients were similar to those who were excluded because of missing data (Appendix Table I). The institutional review board approved the study with a waiver of informed consent (SingHealth CIRB 2014/2027, Singapore).

Exposure

We considered three groups of patients in the present study: patients who were referred for but did not attend post-TKA rehabilitation at our institution, patients who attended just one rehabilitation session, and patients who attended two or more sessions. To minimize differential misclassification bias within the group of patients who did not attend rehabilitation, as part of routine clinical practice, therapy assistants phone-contacted these patients within 6–10 weeks from the date of referral to ascertain that these patients were indeed disinclined to attend rehabilitation and that they were not receiving rehabilitation elsewhere.

Post-TKA, all patients underwent daily inpatient rehabilitation and at discharge, they were given a booklet with advice on ice therapy, the outpatient rehabilitation process, and home exercises (involving mainly seated exercises). All patients were routinely referred for outpatient physical therapy rehabilitation at our institution within 2 weeks following discharge, and patients who attended rehabilitation would receive exercises, patient education, manual therapy and other modalities that were prescribed and progressed at the physical therapist's discretion. Patients who attended rehabilitation were also prescribed an individualized home exercise program and they were encouraged to exercise on days when not attending rehabilitation. During each one-to-one rehabilitation session, the physical therapist would review the home exercise program, observe the patients performing the exercises, and correct their form and techniques when necessary. Finally, to monitor treatment progress, patients who attended rehabilitation would undergo a physical assessment involving knee range-of-motion, quadriceps strength, and gait speed testing at 4 weeks and 12 weeks after surgery[8]. Appendix Table II details the inpatient and outpatient rehabilitation programs, and all therapists were trained in the rehabilitation protocols.

Outcome

Trained technicians and physical therapists, who were unaware of patients' rehabilitation attendance status, interviewed patients in person at 6 months after TKA using the English and Chinese SF-36 health survey[9], of which we used the physical function subscale as the dependent variable. Notably, the English and Chinese SF-36 scores have previously been shown to be internally consistent and equivalent in a Singapore Chinese sample[9]. The SF-36 subscale ranges from 0 to 100, with higher scores representing better health state.

Covariates

We selected 12 covariates *a priori* based on their potential association with both rehabilitation attendance and functional outcomes. Covariates collected preoperatively included age, sex, body mass index (BMI), contralateral knee pain (present vs absent), and preoperative levels of SF-36 bodily pain, mental health, and physical function. Covariates collected in the early postoperative period in the inpatient setting included the availability of caregiver support post-TKA (yes vs no), length of hospital stay, surgeon specialty (adult reconstruction specialist or not), the type of gait aids used preoperatively and on the day of hospital discharge (coded into four categories: (1) none, (2) walking stick, (3) quadstick, and (4) walking frame). Covariate information was obtained from detailed patient interview, patient physical assessment, and medical record abstraction.

Because it is possible that patients who attended rehabilitation were healthier than patients who did not participate in rehabilitation (the "healthy user effect" or "attendance bias"[10]), we developed the propensity score using an ordinal regression model, with the 3-level rehabilitation attendance status (none, once, two or more sessions) as an ordinal outcome[11,12]. Independent variables included all covariates measured preoperatively and early postoperatively (in the inpatient setting). We also included in the propensity score model additional variables such as knee flexion range-of-motion measured preoperatively and at hospital discharge, comorbid conditions (obtained from medical records) such as hypertension, diabetes, and heart disease, the ability to walk on the first day post-TKA, and the ability to perform an active straight-leg raise (SLR) on the day of hospital discharge (able vs unable). The linear predictor from this logistic regression model was included in subsequent regression models (described later) as a patient's propensity for attending two or more rehabilitation sessions. After generating the propensity score, we examined its distribution across the different groups and excluded patients with propensity scores in the non-overlapping regions, thereby (1) reducing the sample to those within a common range of propensity scores and (2) preventing model extrapolation into the non-overlapping regions where no treatment comparisons can be made[13] (Appendix Fig.).

Statistical analysis

Continuous variables were presented as means with SDs and medians with interquartile ranges (IQRs) whilst categorical variables were presented as frequencies with percentages. As our covariates were missing at very low levels (0.01–0.98% for individual covariates and ~4% of patients had missing covariate data), we used the *transcan* function developed by Harrell[14] to singly impute missing values. We used the Mann–Whitney tests (for continuous variables) and Pearson's χ^2 tests (for categorical variables) to compare the various clinical-demographics variables across rehabilitation status (none, once, two or more sessions).

We used a multivariable linear regression model to evaluate the association of rehabilitation status (none, once, two or more sessions) with SF-36 physical function at follow-up, adjusting for 14 pre-specified covariates - namely, the 12 covariates measured preoperatively and early postoperatively (in the inpatient setting), the propensity score for attending two or more rehabilitation sessions, and the time from TKA surgery to follow-up outcome evaluation.

To examine the dose–response association between the number of rehabilitation sessions attended and SF-36 physical function, we first identified patients who attended at least one rehabilitation session. Next, we used a multivariable linear regression model and included the actual number of sessions attended (log transformed to reduce the influence of extreme values) as the main predictor and all covariates described in the previous regression model.