Original Article

The role of prehabilitation with a telerehabilitation system prior to total knee arthroplasty

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Background: The purpose of the current study was to evaluate the usage of prehabilitation on a telehealth platform prior to total knee arthroplasty (TKA) and its impact on short-term outcomes. Specifically, the study examined whether patients participating in a prehabilitation program impacted length of stay (LOS) and discharge disposition.

Methods: A total of 476 consecutive patients who underwent TKA at three institutions were included. The average age of the 476 patients was 65.1 years (range, 35 and 93 years). There was a total of 114 patients who utilized the novel prehabilitation program that provided exercises, nutritional advice, education regarding home safety and reducing medical risks, and pain management skills prior to surgery. A group of 362 patients who did not utilize the program formed the control cohort. The outcomes evaluated were LOS and discharge disposition to home, home with health aide (HHA), or skilled nursing facility (SNF).

Results: The average LOS in the prehabilitation group was significantly shorter than in the control group (2.0 *vs.* 2.7 days, P<0.001). Additionally, prehabilitation patients had more favorable discharge disposition status in comparison to the control group. In the prehabilitation patients, 77.2% went home without assistance, compared to 42.8% in the control group (P<0.001). Also, significantly fewer patients in the prehabilitation group were discharged to a SNF when compared to the control group (1.8% *vs.* 21.8%, P<0.0001).

Conclusions: Prehabilitation preceding TKA in the current study showed early benefits in LOS and discharge disposition. This study will help expand the current literature and educate orthopaedic surgeons on a novel technology. To truly appreciate the role of telerehabilitation in the setting of TKA, further investigation is needed to investigate long-term outcomes, cost analysis, and patient and clinician satisfaction.

Keywords: Prehabilitation; total knee arthroplasty (TKA); telerehabilitation

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Introduction

Total knee arthroplasty (TKA) has gained wide popularity and has demonstrated clinical success in alleviating pain, restoring joint mobility, and improving quality of life (1-3). Due to its high success rate and long-term failure rate, averaging less than 1% annually (4,5), the yearly number of TKAs performed is projected to increase by 673% by 2030 (6). Importantly, this rise is associated with a dramatic inflation of costs, as annual hospital charges for TKA are estimated to reach upwards of $40.8 billion (7). With an estimated $3.2 billion spent on rehabilitation following arthroplasty (8), in addition to the rising cost associated with the implementation of Medicare bundled care programs (8,9), the concept of prehabilitation, using physical therapy and/or education to enhance joint function before arthroplasty, has emerged as an enticing and cost-effective therapeutic modality (10).

Although the literature conflicted regarding the effectiveness of prehabilitation on functional outcomes following TKA, multiple studies have documented its success and cost-lowering capabilities (11-13). Similarly, telerehabilitation, the use of advancements in information and communication technology to provide high quality rehabilitative services beyond the confines of a traditional healthcare facility (14), has emerged as another cost-effective treatment strategy. Importantly, studies employing telerehabilitation have found that by allowing patients to participate in therapy from the comfort of their own home, patient accessibility and participation increased (15), healthcare costs were lowered (16), patient satisfaction was high (17), and treatment outcomes were unchanged from conventional physiotherapy (18). Yet, despite these findings, there remains a paucity of literature as to the post-operative benefits of telerehabilitation performed preceding surgery.

Therefore, the purpose of the present study was to assess the efficacy of a telerehabilitation program used prior to TKA and its impact on short term outcomes. Specifically, we compared the following between subjects who only received routine postoperative rehabilitation and those who also participated in prehabilitation prior to TKA: (I) lengths of stay (LOS); and (II) discharge disposition. We hypothesized that prehabilitation using a telehealth platform would decrease LOS and positively affect patient discharge disposition following TKA.

Methods

Patient selection

Patients who underwent primary TKA consecutively between December 29th 2015 and May 10th 2017 were prospectively enrolled to utilize the telerehabilitation system of PeerWell™, PreHab (PeerWell, San Francisco, California, USA). Inclusion criteria were: (I) patient agreed to undergo pre-rehabilitation prior to primary TKA in the study arm; or (II) participate in the study in the control arm; and (III) underwent primary TKA for advanced osteoarthritis. In addition, we excluded patients who: (I) underwent TKA for other pathological entities other than osteoarthritis and (II) those who did not complete the pre-rehabilitation program in the study arm. Therefore, a total of 467 patients who met all the inclusion and exclusion criteria were included in the final analysis. Surgeries were performed by four fellowship trained adult reconstruction surgeons at three institutions (contributing 101, 332, and 41 patients respectively).

There were 114 patients who utilized PreHab as a rehabilitation tool prior to surgery, while 362 patients underwent TKA without the utilization of PeerWell™ PreHab program. In the PreHab cohort surgeons all of the four surgeons contributed to the study and performed 35, 36, 25, and 18 surgeries respectively. In the control group, two surgeons contributed patients who served as controls. All patients included in this study received outpatient physical therapy postoperatively. Patients who participated in PreHab but then cancelled their surgery were excluded from the study. Institutional review board approval was obtained at all sites prior to any subject enrollment.

Telerehabilitation tool

The PreHab application/program was utilized in this study. This telerehabilitation platform provided patients with daily activity checklist to be completed prior to their surgery. Patients receive daily exercise instructions, nutritional advice, mindfulness programs to reduce anxiety, education regarding home safety and medical risk reduction, and pain management skills. PreHab allows patients and providers to track their progress as they complete their checklists in the weeks leading up to surgery. Additionally, the platform allows patients to connect with peers undergoing the same surgical procedure and gain support and motivation in tracking their progress in comparison to their peers. The interface is user friendly and is made available on patients' computers and smart phones. Health care providers can also utilize the platform for valuable patient data reports, bundled-payment programs, and year-end reporting (19).

Study demographics

Overall, all patients included in the study had a mean age of 65.1±9.2 years (range, 35–93 years). In the PreHab group, the mean age was 63.5±7.9 years (range, 45–81 years), while the 362 patients in the control group had a mean age of 65.7±9.5 years (range, 35–93 years).

Study endpoints

Hospital LOS, calculated from the first day of the admission to the day of discharge, and discharge disposition [home, home with health aide (HHA), or a skilled nursing facility (SNF)]. Were compared between cohorts.

Data analysis

The data was collected and analyzed in an Excel spreadsheet (Microsoft Corporation, Redmond, Washington, USA). Descriptive statistics were used to describe both cohorts, and data was reported as means and ranges or frequencies and percentages. Student's *t*-test was used for continuous variables and Chi-square of Fischer's exact test was used for categorical variables. All statistical analyses were performed with SPSS version 24.0 (IBM Corporation, Armonk, New York, USA).

Results

LOS

The average LOS for the prehabilitation group was 2.0 days (range, 1–5 days), which was significantly lower than that for the control group, which was 2.7 days (range, 1–9 days) (P<0.001).

Discharge dispositions

In the prehabilitation group, a significantly higher number of patients were discharged without home assistance required following surgery when compared to controls (77.2% *vs.* 42.8%, P<0.001). Additionally, a significantly smaller percentage of the prehabilitation cohort required HHA postoperatively in comparison to the control group (21.1% *vs.* 31.8%, P=0.04). Moreover, significantly smaller proportion of prehabilitation patients went to a SNF compared to the control group (1.8% *vs.* 21.8%, P<0.0001).

Discussion

With aging population and an anticipated increase in the utilization for TKA, measures to facilitate a reduction in healthcare spending are paramount. Telerehabilitation has emerged as a novel and economical substitute to the conventional face-to-face therapy. However, as controversy exists within the literature as to the benefit of prehabilitation for total joint arthroplasty procedures, the present study aimed to evaluate the efficacy of prehabilitation, with a telerehabilitation protocol, for reducing costs and improving short term outcomes. The present study demonstrated that prehabilitation, resulted in a reduction in patient LOS and a more favorable discharge disposition.

There are several limitations to the current study. Our study analysis of endpoints was limited to the LOS and discharge disposition assessment and did not include patient reported outcomes. However, this was the main aim of the study and we used these two endpoints are a representative of our patients improved physical function. Another limitation is the lack of cost analysis among those who used the technology *vs.* patients who received the standard of care. In addition, we did not control for baseline characteristics, comorbidities, severity of knee osteoarthritis, and not every surgeon have contributed equal number of patients. However, this was a feasibility study that aimed to evaluate the technology and a future better designed study by the current authors will take these factors into consideration.

The findings of this study are in agreement with previous studies that have reported on the utility of prehabilitation prior to arthroplasty. In a meta-analysis of randomized control trials (RCTs) comparing prehabilitation to conventional preoperative therapy, Chen *et al.* (11) found that patients in the prehabilitation group had shorter LOS, increased knee range of motion, and improved sit-to-stand tests compared to patients in the control group (P<0.05). Likewise, in an RCT comparing patients who received prehabilitation to those receiving the standard of care prior to TKA, Tungtrongjit *et al.* (20) demonstrated that patients in the prehabilitation group reported better pain scores, quadriceps strength, and modified Western Ontario and McMaster (WOMAC) osteoarthritis index (WOMAC) scores (21) three months post-operatively. Furthermore, in an observational cohort comparison study, Snow *et al.* (13) showed that the use of prehabilitation services prior to total joint replacement procedures was associated with a 29% reduction in post-acute

care use and savings of $1,215 per patient, including reductions in payments for home health agencies and SNFs of $572 and $1,093, respectively. In another meta-analysis evaluating the effectiveness of home telerehabilitation following TKA, Shukla *et al.* (22) showed that patients experienced high levels of satisfaction with similar functional outcomes compared to conventional therapy patients.

This study showed the added benefit of prehabilitation and telerehabilitation preceding TKA; however, other studies failed to demonstrate a clear benefit of the technology. In a systemic review of RCTs comparing the clinical impact of prehabilitation before joint replacement, Wang *et al.* (23) found no statistical difference in LOS, total costs, or quality of life, as measured by the short form (SF)-36-item survey. Similarly, in an RCT performed to evaluate short-term functional outcomes in patients receiving prehabilitation before TKA, Mat Eil Ismail *et al.* (24) showed that there was no significant difference in knee range of motion and short-term functional outcomes, as measured by the Knee Injury and Osteoarthritis Outcome Score (25), at three-months postoperatively. Despite previous reports that have illustrated the efficacy of telerehabilitation, Tousignant *et al.* (26) found that patients receiving professional care, either at home or at an outpatient clinic prior to TKA, had better physical functioning (P=0.019) and less pain (P=0.013) compared to patients who received telerehabilitation. Potential reasons for this discrepancy in findings may have been due to differences in prehabilitation and telerehabilitation implementation and therapy protocols, patient baseline pain and functionality, outcomes that were measured, and patient diagnosis.

Conclusions

Amidst the controversy surrounding the use of prehabilitation and telerehabilitation, the present study provides early evidence to support the benefits of prehabilitation with a telehealth platform. The utilization of prehabilitation in the current study showed decreased LOS and improved discharge disposition compared to the standard preoperative protocol. Further studies are warranted to evaluate long-term outcomes, cost-savings, and patient and clinician satisfaction in prehabilitation programs on telehealth platforms for TKA.

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Footnote

Conflicts of Interest: MA Mont: (I) AAOS: Board or committee member; (II) Cymedica: Paid consultant; (III) DJ Orthopaedics: Paid consultant; Research support; (IV) Johnson & Johnson: Paid consultant; Research support; (V) *Journal of Arthroplasty*: Editorial or governing board; (VI) *Journal of Knee Surgery*: Editorial or governing board; (VII) Microport: IP royalties; (VIII) National Institutes of Health (NIAMS & NICHD): Research support; (IX) Ongoing Care Solutions: Paid consultant; Research support; (X) Orthopedics: Editorial or governing board; (XI) Orthosensor: Paid consultant; Research support; (XII)Pacira: Paid consultant; (XIII) Peerwell: Stock or stock Options, Paid Consultant; (XIV) Performance Dynamics Inc.: Paid consultant; (XV) Sage: Paid consultant; (XVI) Stryker: IP royalties; Paid consultant; Research support; (XVII) Surgical Techniques International: Editorial or governing board; (XVIII) TissueGene: Paid consultant; Research support. M Chughtai: Paid consultant for: DJ Orthopaedics, Sage Products, Stryker, Peerwell, Reflexion, Performace Dynamics. JT Moskal: (I) AAOS; American Association of Hip and Knee Surgeons; Corin U.S.A.; DePuy, A Johnson & Johnson Company; Invuity; Stryker; Think Surgical; (II) AAOS: Board or committee member; (III) American Association of Hip and Knee Surgeons: Board or committee member; (IV) Corin U.S.A.: IP royalties; Paid consultant; (V) DePuy, A Johnson & Johnson Company: IP royalties; (VI) Invuity: Stock or stock Options; (VII) Stryker: Paid consultant; Paid presenter or speaker; (VIII) Think Surgical: Stock or stock Options. JV Tiberi: (I) Peerwell: Stock or stock Options; (II) Stryker: Paid consultant; (II) Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support. The other authors have no conflicts of interest to declare.

Ethical Statement: Institutional review board approval was obtained at all sites prior to any subject enrollment. IRB approval was obtained for the study.

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