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Assessing the Efficacy of Physical Prehabilitation on a Total Knee Arthroplasty

Zen S. Miyashiro
Portland State University

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by

Zen S. Miyashiro

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Dr. William York

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One of the most common orthopedic surgeries performed are knee replacements whether that be a full replacement or partial knee replacement. According to the *New England Journal of Medicine*, approximately 25% of individuals over the age of 55 have knee pain for most of the days in a month (Felson, 2006). The culprit for most knee pain is osteoarthritis. Osteoarthritis is an umbrella diagnosis that can be found throughout the joints of the body and is not limited to the knee. Some signs that point in the direction of osteoarthritis are cartilage degeneration, the replacement of the cartilage padding with bone, and the weakness of the muscles that surround a specific joint, in this case, the knee (Felson, 2006). You may ask if osteoarthritis of the knee is so common, why haven't doctors found a way to combat it? The simple answer is that cartilage degeneration can happen to anyone and occur simply due to the mere use of a joint. Taking this into consideration, telling an individual to walk and function less to reduce their chances of developing osteoarthritis would be setting them up for failure down the road.

When a patient goes through surgery, the homeostasis of their body is disrupted. In simple terms, the knee is first opened, removed, and a new artificial one is inserted. Because our body's homeostasis is disrupted, this opens the door to many different avenues of surgery related complications whether that be at the incision sight or related to the new artificial knee.

Following a knee replacement, patients are likely to enroll in physical therapy for approximately 12 weeks with the hope of returning to work by this point. A meta-analysis on patient satisfaction regarding their total knee arthroplasty reports that patient dissatisfaction ranged from 8-30% (Canovas, 2018). Scott et al. states that 18.6% were dissatisfied with the state of their knee one year after surgery (Scott, 2010). To respond to the alarming rates of dissatisfaction, researchers suggested that prehabilitation could potentially yield better post-surgical outcomes leading to a rise in the literature surrounding the subject.

Though osteoarthritis seems nearly inevitable, there are certain treatments that can reduce pain. I will be focusing on the scholarship surrounding those who are seeking to meet the needs of patients to whom surgery is necessary. This literature review analyzes the surrounding discussion on the implementation of prehabilitation for those who plan to have their knee replaced with the goal of determining the efficacy of such a practice.

Defining Prehabilitation: The Rising Discussion of a Newer Form of Treatment.

Prehabilitation is a relatively new concept so the literature surrounding it is rather limited. First counts of prehabilitation utilization date back to 1946 where the British Army developed a prehabilitation program to address the deficits their soldiers showed upon enlisting. Most of the soldiers that enlisted were subjects of poverty, malnutrition, and were not physically opt to enter the battlefield. Their prehabilitation regiment aimed to address their physical and psychological shortcomings. Of the 12,000 men that enrolled in the program, 85% reported significant improvements both physically and mentally (Lundberg, 2018). After this study, prehabilitation disappeared from popular discussion however, found its way back in the 1980s through discussions surrounding sports medicine. Thanks to Robert Topp and Marcia Ditmyer, authors of *Prehabilitation in Preparation for Orthopedic Surgery*, the concept of prehabilitation was reintroduced. They both argued that "presurgical exercise aiming to improve functional capacity before a surgical procedure leads to more rapid postoperative recovery compared with patients who remain physically inactive through the preoperative period (Lundberg, 2018).

The time frame before an individual undergoes a procedure is arguably just as important as the time frame following surgery. Physical prehabilitation is a patient centered approach that aims to alleviate potential risks and to improve post-operative outcomes. A huge portion of

prehabilitation is centered around patient psychology as well (Shaughness, 2017). Many individuals are afraid of the impact a surgery will have on their lifestyle and the lifestyles of their families. Ultimately, patients are more likely to have a successful treatment if they go into it with the best mindset possible; one that is positive and optimistic. Prehabilitation takes the time before the procedure to reduce patient anxiety and prepare patients for major procedures.

As more research is being conducted and more individuals are undergoing pre-rehabilitation treatments, studies are showing that post-surgical complications are decreasing. The term "prehab" refers to any kind of rehab that is centered around reducing pain, length of stay, and complications following surgery that are done before the surgical procedure (Banugo,, 2017). There are numerous kinds of prehab including, nutrition, lifestyle improvement, as well as psychological prehabilitation.

In this context regarding the prehabilitative process associated with total knee replacements, addressing knee range of motion and quad strength are both essential for a smoother recovery process. However, the educational aspect of prehabilitation is often overlooked. Educational preabilitation ensures that patients are fully aware of the procedure, their limitations following surgery, and can enter the procedure in the best mindset possible.

Elements of Prehabilitation for a Total Knee Arthroplasty

Prehabilitation can be broken down into three categories. These categories must be addressed to increase outcomes following surgery. These categories are as follows: lower extremity strength and quad activation, knee range of motion, and education.

According to numerous studies, prehabilitation before a total knee arthroplasty improves pre-operative leg strength as well as function. Researchers hypothesize that improving lower

extremity strength and the performance of tasks results in improved post-surgical recovery. Because the function and strength of a knee is so reliant on quadricep activation and strength, most pre-rehabilitation practices for total knee replacements point toward improving overall strength and flexibility of the lower extremity from the hip down.

This literature review explicitly aims to answer the following questions:
How are researchers measuring the success of their physical prehabilitation programs?
What are the different approaches to a physical prehabilitation regimen? What do these regimens look like?

Defining Prehabilitative Success on Postoperative Outcomes

To enter the discussion about patient improvement, we need to address and define what exactly is "improvement" in the context of full knee replacements. One way that physical prehabilitation has been evaluated questions how to measure it's success. Throughout the recovery process, multiple things are evaluated including strength, range of motion, functional ability, and proprioception. In this context, improvement can be defined by addressing the four topics mentioned above. The patient has increased strength in knee flexion and extension. The patient has increased knee range of motion in both flexion and extension in comparison to measures before their surgery. The patient shows improvement in specific functional tasks and improved proprioception. The literature reviewed mentions potential indicators of improvement as: lower extremity strength, range of motion, pain, and functional ability. Physical prehab is deemed successful if improvements are shown in the categories mentioned above.

Lower Extremity Strength as a Means of Defining Improvement

The following section on lower extremity strength views it as a key indicator of improvement for post-operative recovery from prehabilitative methods.

Many of the studies included in this literature review indicate that physical prehabilitation does increase lower extremity strength after a total knee replacement however, the results of the research do vary. We will define success as increased strength or a quicker return to baseline levels (measurement taken before surgery) of strength previously evaluated.

In a case study conducted by the University of Louisville, researchers carefully analyzed the progression of a patient who underwent two total knee replacements, 3 months apart. The right total knee replacement was performed first without the use of physical prehab and the left knee shortly after with physical prehabilitation introduced 4 weeks before the left total knee arthroplasty. The researchers gathered the patients' standard strength baselines (strength measurements taken at initial evaluation) 4 weeks before the procedure, 1 week before the procedure, one month after the procedure, and three months after the total knee replacement. From the study on this particular individual, researchers saw a drastic increase in strength 1 week before the procedure with a 54% strength improvement with knee extension and a 34% strength improvement with knee flexion when compared to her standard baseline taken 4 week prior (Brown, 2010). Their results indicated that the patient went into the procedure significantly stronger after the implementation of physical prehabilitative practices. When evaluated 1 month after the procedure on her left knee, the results showed that the patient was able to maintain extension strength when compared to her standard baseline values. However, when her left knee was re-evaluated 3 months after the knee surgery, the patient was unable to maintain the strength gained through her prehab program (Brown, 2010).

Researchers at the University of Valencia took a different approach to their study and had their research subjects perform high-intensity exercises as opposed to the standard, less intense, geriatric approach to prehab. In this blind randomized controlled trial, researchers observed 44 individuals, all over 60 years old, and their progression both before and after a full knee replacement. Individuals were randomly assigned to either a control group (not using prehabilitation) and an experimental group (using intensive physical prehabilitative measures) and researchers were unaware of each subject's placement in respective groups. Those who were part of the experimental group were given an exercise program and were instructed to perform the allotted exercises 3 times per week for 8 weeks (Calatayud, 2016). Isometric strength was measured using a portable handheld dynamometer mounted in positions perpendicular to the patient's tibia. The patients were instructed to extend their knee and curl their leg into the dynamometer. Each member of the study was tested 8 weeks before surgery (T1), within one week of surgery (T2), one month after their TKA (T3), and 3 months after their TKA (T4) (Calatayud, 2016).

The results of the study were astonishing. For both isometric knee extension, flexion, and hip abduction individuals of the experimental group on average showed significantly higher strength values in comparison to those of the control group before surgery, 1 month following surgery, and 3 months post operation. For isometric knee extension, those who were part of the experimental group on average pushed 37.8 kg right before surgery in comparison to the control's measurement of 22.0 kg. When measured one month after surgery, prehab patients could push 8.9 kg while the control group could only push 7.7kg. Their last evaluation took place 3 months post operation and the experimental group on average could push 22.8kg while those who did not participate in prehabilitation, on average, could push 14.3 kg. All values collected

for the experimental group were higher than those of the control group for both knee flexion and hip abduction as well (Calatayud, 2016).

The research conducted at the University of Valencia remains as one of the few studies showing a positive correlation between prehabilitative exercise and postoperative strength. They were able to effectively display the benefits of prehab implementation.

Lower extremity strength is a key factor in a patients post operative success. For an individual to return to a prior level of function, a good foundation of strength is necessary. Researchers involved in the study at the University of Louisville highlight the need for a longer duration, physically intensive, prehab regimen and hypothesize that this may "help realize a faster return to baseline measures of even higher strength outcomes, leading to better functional capability" (Brown, 2010). Those involved in the study at the University of Valencia reported that patients were able to obtain baseline levels of knee extension after three months and baseline levels of knee flexion after 1 month. Because lower extremity strength and functional capability go hand in hand, addressing strength deficits first is necessary. If patients can obtain preoperative levels of strength within three months of their surgery, they can ultimately work towards addressing their functional deficits before those who are still trying to address their lower extremity weakness. With that being said, lower extremity strength is an appropriate way in determining is physical prehabilitation is useful.

Range of Motion as a Means of Defining Improvement

Another essential factor in determining the success of physical prehabilitation involves a patient's knee range of motion in both flexion and extension. Researchers hypothesize that if a patient can obtain higher ranges of motion pre-surgery, they will be able to achieve higher ranges

of motion quicker than those who do not perform prehabilitatitive stretches (Matassi, 2012). Researchers at the University of Florence claim that this is true to a certain extent.

Members of the University of Florence conducted a randomized controlled trial with 122 patients, 61 of which were given a home exercise program focusing on increasing lower extremity strength and range of motion. Evaluation took place at respective time points: immediately after exercising, right after operation, 3, 6, and 9 months following their TKA. Range of motion was evaluated during both active and passive knee flexion and extension (Matassi, 2012). To measure active flexion, participants were structured to stand against a wall and bend their knee with their foot parallel to their other leg. Passive knee flexion was measured by instructing patients to lie supine on a table with their knee slightly bent. The researcher then applied pressure to the area below the patient's knee forcing them into a flexed position. Based on the studies finding, those who adhered to the pre-operative exercise program were able to reach 90 degrees of flexion in an average time of 5.9 days. The control group who did not receive an exercise program had a mean time of 6.9 days. However, the differences between groups did not last long. By the one-year mark after surgery, those who were given an exercise program had about the same active and passive flexion as those who did not receive an exercise program (Matassi, 2012).

Although the results of physical prehab regarding knee range of motion do not last longer than a year, we cannot disregard use of physical prehab. Knee range of motion is important for patient ambulation and function (Matassi, 2012). Because patients were able to obtain 90 degrees of knee flexion quicker than the control group, patients can be “ahead of the curve” and use their post operative rehab therapy visits as a means to address functional deficits as opposed to range of motion deficits.

Similarly, researchers at the University of Valencia observed range of motion as well; however, instead of evaluating patients based on the speed at which they could obtain 90 degrees of flexion, their study observed the average measurement (in degrees) of knee flexion and extension before and after surgery. Their findings show similar results except with knee extension. When measured right before surgery those who were where given an intense "prehab" regimen obtained on average 114.4 degrees of active flexion while the control group averaged 102.8 degrees. Following surgery, the prehab group averaged 6.5 more degrees one month after their procedure and 4.8 more degrees than their counterpart (Calatayud, 2016).

These studies focus on objective measurements regarding knee flexibility. Based on the results, patients who underwent prehab were able to reach 90 degrees of flexion and higher degrees of flexion quicker than those who did not participate.

The studies on knee range of motion and its relation to physical prehabilitation display the short-term benefits. However, that does not make prehab ineffective. Knee range of motion is still a great marker in determining improvement because it plays a substantial role in functional capability as well. Similarly to lower extremity strength, patients must address their range of motion deficits in order to have some hope in returning to their prior levels of function. Though the range of motion results are short term and ultimately put patients ahead of the curve for a few months, it is hard to dictate how this can translate to longer term outcomes. I presume that because patients can obtain more range of motion in quicker time frames, post operative therapy can be used to focus on more functional tasks with the hope of discharging a patient from therapy as soon as possible.

Functional Ability as a Means of Defining Improvement

Most of the studies considered in this literature review analyzed functional ability to some degree. Function was commonly evaluated based on how long it took for an individual to ascend and descend flights of stairs, distance they could walk in a certain amount of time, and their ability to stand from a seated position without the use of their arms for support and balance. In order for prehab to be considered successful, a patient must show improvements in functional outcomes whether it be performing more reps in an allotted time or the ability to perform a functional task in a shorter duration with less limitations.

In the studies conducted by the University of Louisville, patient's functional ability was evaluated based on a walking test, a sit-to-stand chair rise test, and a stair test. Patients were instructed to walk for six minutes around a 36-meter circular track with their distance covered recorded. They were then asked to perform a sit to stand test which had the patient sit on a padded 27-inch bench without a backrest or arms. This would limit the patient's ability to support themselves by any other means than their legs. They were given 30 seconds and asked to perform as many repetitions as possible. The last functional task of these case studies involved ascending and descending two flights of stairs (22 steps total). After ascension, patients were allowed 30 seconds of rest before descending the staircase. Times to complete the task were recorded (Brown, 2010).

Similarly, to the University of Louisville case studies, researchers at the University of Valencia had their patients perform a stair climbing test and a timed up and go (TUG) test. In their test participants were instructed to ascend and descend four flights of stairs and were allowed to use handrails for balance and support. Each participant's time was recorded. As for the TUG, participants were placed seated in a chair and instructed to stand without using their

arms, walk 3 meters, turn around, and sit back in the chair. For these particular tests, faster times indicate higher functional performance (Calatayud, 2012).

The current state of the literature regarding functional ability is rather positive. In fact, a meta-analysis done by the University of Western Ontario looked at 23 studies that specifically observed the effects of physical prehab on post-surgical function. In order to score a patient's functional ability they were assessed using a WOMAC (The Western Ontario and McMaster Universities Osteoarthritis Index). The WOMAC is a widely used method of measuring pain, physical, function, and stiffness. The higher the score, the worse pain, stiffness, or function a patient has (WOMAC, 2013)

The meta-analysis found that with the use of physical prehabilitation, the standard mean difference (SMD) of the results was 0.32. If the SMD is 0 that indicates there was no difference in results between an intervention and control group. A negative SMD shows that the intervention group performed worse. The study showed that there was direct correlation between physical prehabilitation and improved functional scores according to the WOMAC.

Because the WOMAC is based on self-reported interpretations of functional ability, a patient's scores may change based on their expectations following surgery. If a patient feels like they should have less pain and much better function they will more than likely score higher on a WOMAC.

The literature reviewed all used the WOMAC scale to assess function. Because of the self-reported element of the WOMAC, there are mixed results pertaining to functional ability. Perhaps more studies need to be performed simply looking at the difference in performance of functional tasks compared to their baseline levels. With that, direct comparisons can be made regarding their function before and after surgery.

Proprioception

In one of the cases observed, researchers looked at proprioception as a measure of rehabilitative success. Proprioception is like our body's sixth sense. According to John Tuthill of the Department of Physiology and Biophysics at the University of Washington, proprioception is the “sensation of body position and movement, [and] is fundamentally personal and typically absent from conscious perception. Proprioception is used for stability, protection, and locomotion (Tuthill, 2018).

In the context of prehabilitation and total knee replacements, researchers observed proprioception of two individuals. One underwent prehab the other did not. Researchers recorded proprioception based on the patient's ability to detect movement and knee angle recreation (Jaggers, 2007).

The individual who participated in physical prehabilitation showed a 267% improvement in being able to reproduce a desired angle of knee flexion and a 100% improvement on their knee movement detection threshold test. In comparison, the individual who did not partake in physical prehabilitation experienced a 14% decline in their angle reproduction test and a 20% decline in their movement detection threshold test (Jaggers, 2007).

Proprioception is essential for patient function, ambulation, and stability. Knee stability is achieved through direct feedback between proprioceptors and motor neurons. Take for example in basic walking. If the quadricep Is stretched, la afferents (nerve fibers) carry information to the brain telling it to inhibit the activation of the hamstring (Tuthill, 2018). This is called reciprocal inhibition. This inhibition pattern protects the muscle from being pulled with too much force

while also “ensuring stable extensions of the knee.” The same proprioceptive feedback is required for basic rhythmic movements such as walking and running (Tuthill, 2018).

The literature on proprioception and its correlation to physical prehabilitation is limited. More studies need to be conducted observing the relationship between the two as proprioception plays a substantial role in restoring normal gait (walking) patterns.

Variations in treatment

The method of prehab varies from patient to patient and from provider to provider. From personal experience and the studies referenced throughout this review, each therapist or everyone conducting a test approaches therapeutic exercise a little differently. There simply is not a standardized way to do things. Firstly, a lot of variation comes from the patient themself. A fifty-five-year-old Hispanic female with severe osteoarthritis in her knee is going to respond differently than a 50 year old white male with severe osteoarthritis as well. This is where many factors regarding treatment come into play. A patient's pain tolerance, age, occupation, health history, etc. are all factors that will dictate how they respond to treatment. Variation can also occur provider to provider. Based on experience in a clinical setting, each therapist will for the most part address the same issues (in this case quadricep weakness following a total knee replacement) but do so using their own personalized approach. Though there are so many sources of variation that will dictate how prehab is conducted, some underlying themes of prehab with respect to a total knee replacement can be identified. These themes are range of motion, lower extremity strength, functional ability, and education.

Prehab Procedures

According to the different studies observed, there are two methods of prehab regimens. For some patients, physical therapists were only present during testing days where strength, range of motion, function, etc., were measured. Patients were then given a home exercise program with written descriptions and photographs on how to perform the specific exercises and ask to log their progress to ensure compliance to the program. Researchers at the University of Florence explicitly stated that they wanted their patients performing the exercise without the help of a physical therapist. (Matassi, 2012). At home programs make it convenient for patients to perform their exercises. It eliminates the in clinic setting and allows the patients to perform their exercises on their schedule however, leaves room for error while performing exercises as well as relies on personal integrity when reporting compliance to the physical prehabilitation program.

Another approach to a prehab regimen involves having the patients attend in person physical prehab with the supervision of an experienced physical therapist. Although in person sessions require a patient to commute to a clinic, the presence of physical therapist ensures that exercises are performed correctly (Calatayud, 2016).

Each study states how their physical prehab program was performed but did not state why the method was selected that being through a home exercise program or in person setting. I suggest that further research be conducted on the methods in which physical prehabilitation is presented to determine if home exercises programs are sufficient or if prehab must be performed within a clinic with the supervision of a therapist.

Physical Prehabilitation through a Home Exercise Program (HEP)

Every exercise program looked to address similar deficits, that being, strength, flexibility, and functional ability. In both studies out of the University of Louisville, patients focused on resistance training, step training, and step training. Their home exercise program contained the following exercises (Jaggers, 2007) (Brown, 2010):

- 10 minutes of warm up (static stretching and walking)
- 30 minutes of resistance training (9 exercises with a minimum of 1 set of 10 repetitions per exercise)
- 10 minutes of step training (1 set of 8 repetitions stepping in various directions)
- 5 minutes cool down (static stretching)

This prehab style is much more casual than some others. It allows patients to do as many sets as they want if they are able to complete the minimum number of sets and repetitions. Patients increased their step height as their program progressed. Patients participating in physical prehab performed slightly better on their sit to stand test averaging 3 more reps in a 30 second time frame and overall scored better (better as is less reported pain, stiffness, and higher function) on their WOMAC. The patient however, was not able to maintain strength gains made during prehab when evaluated 3 months after surgery.

Researchers at the University of Sarajevo also gave their patients a home exercise program (HEP) encompassing: quadricep strengthening, flexibility, and resistance training. They were instructed to perform the allotted exercises at home for 6 weeks, 3 times per week. To ensure that individuals were performing the exercises correctly, researchers cued patients during their initial evaluation (Jahic, 2018). Their exercise program was not included in their study however their results indicate that the treatment group had an average functional score of 32.5, with 100 meaning they are fully functional according to the Knee Society Scoring System

established in 1989. The control group had an average score of 29.5 during their initial evaluation. When re-evaluated right before surgery, the prehab group scored a 40.5 while the control group scored the same 29.5 they started with. Based on this, the prehab group entered surgery at a higher functional level than the group without prehab. These results, however, did not last very long. Once the surgery was complete, functional levels 3 months after the procedure were merely the same. The experimental group scored 68 and the control scored 67.5 (Jahic, 2012). As previously mentioned, physical prehabilitation yields short term benefits and perhaps evaluating patient 3 months after surgery was too late to see statistically significant results (Calatayud, 2016).

The study at the University of Florence focused mainly on range of motion. The patients' home exercise program consisted of stretching, strengthening, and finished focusing on functional activities. Patients started by stretching their quadriceps and hamstring while sitting in a chair. Patients were instructed to bend their knee and grab onto their ankle and maintain that position for 30 seconds, four times. To stretch their hamstrings, patients extended their knees until it was straight as possible with their heel on the floor. They then leaned forward, bringing their torso as close to the knee as possible. To address strength, patients were given 4 exercises that being: isometric quadricep contractions, isotonic hamstring contractions, isotonic quadricep contractions, and dynamic stepping. Each exercise consisted of 20 repetitions (Matassi, 2012).

- Isometric Quadricep contraction: patient lies supine on a table with their knee fully extended. A towel is placed under the knee and the patient is cued to press into the towel by extending their knee.
- Isotonic hamstring contraction: the patient lies prone while bringing the foot towards the body.

- Isotonic quadricep contraction: patient sits in a chair while and is instructed to maintain a contraction help partially in flexion for 5 seconds.
- Dynamic stepping: patient must step up onto a singular step and then step down.

The patients that participated in the regimen listen above were able to achieve 90 degrees of knee flexion quicker than the control group. There was no prolonged effect on knee motion and function after 6 weeks and 1 year following surgery. This reinforces the idea of physical prehab as a means to address short term deficits (Matassi, 2012).

Though exercises were performed at home without the supervision of a therapist, we can see that with a prehabilitation program, patients were able to show minor levels of improvement in knee range of motion and functional ability. Though exercise programs intended to address strength deficits as well, findings show that strength gained up until surgery, quickly dropped off when evaluated 1- and 3-months post-op.

Physical Prehabilitation in a Clinical Setting

Researchers at the University of Valencia took a much more intense approach to their in-person physical prehabilitation program. The program started with 15 minutes of warm up exercises consisting of step ups, calf raises, and ergometry cycling performed without additional weight (Calatayud, 2016) :

- Step ups: 2 sets of 20 reps
- Calf raises: 2 sets of 20 reps
- Ergometry cycling: 10 min

The main work out set contains exercises as follows with sixty seconds of rest in between each set:

- Leg press: 5 sets of 10 reps
- Knee extension: 5 sets of 10 reps
- Hamstring curl: 5 sets of 10 reps
- Hip abduction: 5 sets of 10 reps

For each exercise, the weight varied from patient to patient. The selected weight was determined on the patient ten rep maximum.

Following the main exercise program, patients worked on balance through another series of exercises. All exercises were performed on an unstable surface known as a Bosu Ball and performed using both affected and non-affected knee:

- Double leg balance with a narrow base of support: 4 sets of 30 seconds
- Single leg balance: 4 sets of 15 seconds

The program concluded with 5 minutes of stretching of the hip flexors, abductors, and extensors of the knee.

The program mentioned in the last study was the most intense but yielded the best results for patients after surgery. They reported that isometric knee flexion, isometric hip abduction, WOMAC scores (looks at pain, physical function, and stiffness) and range of motion in both flexion and extension were higher than the control group right before surgery, one month after surgery, and three months following their procedure. All these studies were conducted using a pool of patients that were over 55 years old (Calatayud, 2016).

Physical Prehabilitation with a Supplemental Education Program

Pain neuroscience education has been implemented into educational programs during the preoperative process. According to Dr Adriaan Louw, a pain specialist, pain neuroscience

education is an educational strategy that takes a biopsychosocial approach to pain related conditions. He states that the:

> "Traditional biomedical education for pain-related musculoskeletal conditions focuses on a structural pathological model as a means of explaining why someone is going through a pain experience. There is evidence to show that biomedical education, which often produces potential negative expectations through verbal suggestions, may influence pain perception in a negative way (Louw, 2016)."

Dr. Adriaan Louw specializes in pain related disorders of the spine however, his research has been utilized in numerous studies concerning other pain-related disorders.

In a study conducted by the Center for Health Activity and Rehabilitation Research in Wellington, New Zealand, researchers had patients partake in a physical prehabilitation program consisting of forty-five minutes worth of exercises as well as 15 minutes of classroom based prehabilitation education as opposed to the other studies reviewed which only contained an exercise regimen. In these classes, patients were taught important concepts pertaining to their total knee arthroplasty. Concepts included: early mobilization, discharge planning, dietary education, the benefits of exercise on arthritis, and postoperative rehabilitation. Physical therapy was performed in a group setting 52 individuals partaking in the prehab program. The studies' quantitative results were not substantial. Those who participated in the prehabilitation program averaged 2.09 seconds quicker on their timed-up-and-go test and scored 3.99% better on their WOMAC test. According to the researchers, these results were not statistically significant (Clode, 2018). The studies qualitative results were far more significant (Clode, 2018). When asked if prehabilitation prepared the patients for surgery, they reported that many of their participants said, "*it made a big difference"* (Clode, 2018).

Members of the experimental group who underwent prehabilitation coupled with an educational program reported having less anxiety entering their procedure. In fact, patients were more optimistic about their surgery and recovery process as well. Researchers reported that the educational program helped improve adherence to exercise programs and created a more positive attitude about exercise sessions. Something important to note is that these educational and exercise sessions took place in a group environment and researchers theorize that "social support is an important component in maintaining adherence with the exercise portion of prehabilitation." They conclude that through the prehabilitation education program, patients had more realistic expectations regarding their level of function following their surgery. However, when these expectations were not met, participants were less satisfied (Clode, 2018) .

In a controlled clinical trial of pain neuroscience education for patients about to undergo a TKA, one hundred twenty individuals agreed to participate in the study but 103 of them were delegated to either the experimental group or the control group. The study found that adding pain neuroscience education to a pre-operative education regiment did not yield significant improvements regarding pain, function, pain catastrophization, and hospital opioid use. It did however, cause patients to have a change in their mentality despite experiencing the same levels of pain. 6 months following their procedure, these patients reported being more satisfied compared to the controls (Huysmans, 2021).

Although prehab education does not explicitly determine improvements in patient function, pain, pain catastrophization, etc., it remains an essential part of prehab to address psychological factors that may affect a patient's ability to recover. Education has also proven to produce more realistic expectations for those coming out of surgery so that patient satisfaction is generally higher (Huysmans, 2021). In the long term, this can potentially lead to decreased

health care cost as patients have the potentiality of reduced range of motion and the presence of pain.

The Validity of Prehab for Improving Postoperative Outcomes

In the literature analyzed prehabilitation does not yield consistent results on post-operative success for patients with total knee replacements. The surrounding literature consistently states the need for further research regarding the intervention (Clode, 2018). Many researchers hypothesize that the concept of prehabilitation sounds promising. The idea of building a stronger foundation for a patient should yield better results. The results were not consistent. Some individuals had better range of motion quicker than others, some the same level of strength as the control group, etc. Generally, the objective measurements (ROM, strength) who participated in a prehabilitation program eventually plateaued a year following surgery at similar levels of those who did not participate. Without significant long-term improvements in strength and function, physical prehabilitation remains difficult to justify for not only patients but also insurance purposes as well.

Required Further Research

I propose that studies need to take a different approach. Based on the study out of the University of Valencia and the research conducted by the Center for Health Activity and Rehabilitation Research in Wellington, New Zealand, prehabilitation programs need to include intense exercise to address range of motion deficits and muscle atrophy while also educating patients on their pain and expectations (Clode, 2018).

The surrounding literature on prehabilitation and total knee replacements focus on improving objective measurements such as range of motion or strength. These two categories lie at the forefront of the discussion, while pain, patient satisfaction, opioid use, etc., are secondary. Because prehab has not produced statistically significant results in those two avenues (range of motion and strength), perhaps studies need to shift gears and take a more macro approach to their research. I believe more research should be done looking at the impact of prehab on health care spending. In a study by Adriaan Louw, he found that pain neuroscience education for those scheduled for surgery to address their lumbar radiculopathy spent 37% on health care expenses following surgery. This includes visits to their primary care physician, physical therapy, and diagnostic imaging (Louw, 2016).

The current scholarly discourse pertaining to prehabilitation and total knee replacements are very limited. Some of the limitations these studies reviewed face are their smaller sample sizes, diverse patient demographic, and varying approaches to prehabilitation. As mentioned before, it is difficult to approach physical therapy interventions with a formula. One size does not fit all in this situation. It is extremely difficult to conclude whether prehabilitation works. Sometimes it does, sometimes it does not. The implementation of prehab is divided into two groups. Some feel it is necessary while other providers feel that it is a waste of visits that could be used post-operatively. The discourse will continue to remain that way until we find more concluding evidence about prehabilitation and knee replacements which is why I propose the redirection of research, addressing more “macro” issues like health care spending.

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