THE EFFECTIVENESS OF ONLINE PLATFORM METHOD IN DELIVERING PRE-OPERATIVE EXERCISES AMONG ANTERIOR CRUCIATE LIGAMENT TEAR INDIVIDUALS

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UNIVERSITI PENDIDIKAN SULTAN IDRIS

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ABSTRACT

The purpose of this study was to determine and compare the effect of the online platform and face-to-face method in delivering pre-operative exercises on perceived pain level, muscle strength, dynamic balance and adherence level. Thirty individuals with anterior cruciate ligament (ACL) tear were randomly assigned to an online platform group (OPG) and a face-to-face group (FFG). OPG was monitored using internet-based media (Google Meet) while the subjects from the FFG was monitored by the researcher and physiotherapist in standard face-to-face method. Both groups were given the same exercise protocol. The data were measured utilizing the Visual Analog Scale (VAS), hand-held dynamometer, Y-balance test and Exercise Adherence Scale (EXAS). An independent t-test was used to analyse perceived pain level while one-way repeated measure was applied for muscle strength, dynamic balance and adherence level. There was a significant difference of the online platform method in delivering pre-operative exercises with $p<0.001$ for all the variables. Mixed ANOVA also showed significant difference between OPG and FFG group (intervention effect) on the perceived pain level ($p=0.031$), for all muscles except for knee flexor [knee flexor ($p=0.281$), knee extensor ($p=0.025$), hip abductor ($p=0.045$), plantarflexor ($p=<0.001$), dorsiflexor ($p=<0.001$)]. For dynamic balance, it showed significant difference for the posterolateral direction ($p=0.010$) but not to anterior direction ($p=0.929$) and posteromedial direction ($p=0.094$). The study also showed significant difference on the adherence level ($p=0.001$). In conclusion, online platform method in delivering pre-operative exercises showed significant difference on perceived pain level, muscle strength, dynamic balance and adherence level among pre-operative ACL tear individuals. However, more study should be conducted to support the findings.

KEBERKESANAN KAEDAH PLATFORM ATAS TALIAN BAGI MENYAMPAIKAN LATIHAN PRA-OPERASI DALAM KALANGAN INDIVIDU YANG MENGALAMI KOYAKAN LIGAMEN KRUSIATA ANTERIOR

ABSTRAK

Tujuan kajian ini adalah untuk menentukan dan membandingkan kesan platform dalam talian dan kaedah bersemuka dalam menyampaikan latihan pra-operasi terhadap tahap kesakitan yang dirasakan, kekuatan otot, keseimbangan dinamik dan tahap pematuhan. Tiga puluh individu yang mengalami koyakan ligament krusiata anterior (LKA) telah dibahagikan secara rawak kepada kumpulan platform dalam talian (OPG) dan kumpulan bersemuka (FFG). OPG dipantau menggunakan media berasaskan internet (Google Meet) manakala subjek daripada FFG dipantau oleh penyelidik dan ahli fisioterapi dalam kaedah bersemuka standard. Kedua-dua kumpulan diberi protokol senaman yang sama. Data diukur menggunakan *Visual Analog Scale* (VAS), *hand-held dynamometer*, *Y-balance test* dan Skala Kepatuhan Latihan (EXAS). *Independent t-test* digunakan untuk menganalisis tahap kesakitan yang dirasakan manakala ukuran berulang sehala digunakan untuk kekuatan otot, keseimbangan dinamik dan tahap pematuhan. Terdapat perbezaan yang signifikan pada kaedah platform dalam talian dalam menyampaikan latihan pra-operasi dengan p<0.001 untuk semua pembolehubah. ANOVA campuran juga menunjukkan perbezaan yang ketara antara kumpulan OPG dan FFG pada tahap kesakitan yang dirasakan (p=0.031), untuk semua otot kecuali *knee flexor* [*knee flexor* (p=0.281), *knee extensor* (p=0.025), *hip abductor* (p =0.045), *plantarflexor* (p=<0.001), *dorsiflexor* (p=<0.001)]. Bagi imbangan dinamik, ia menunjukkan perbezaan yang signifikan bagi arah *posterolateral* (p=0.010) tetapi tidak kepada arah *anterior* (p=0.929) dan arah *posteromedial* (p=0.094). Kajian ini juga menunjukkan perbezaan yang signifikan pada tahap pematuhan (p=0.001). Kesimpulannya, kaedah platform dalam talian dalam menyampaikan latihan pra-operasi menunjukkan perbezaan yang signifikan pada tahap kesakitan yang dirasakan, kekuatan otot, keseimbangan dinamik dan tahap pematuhan dalam kalangan individu yang mengalami koyakan LKA. Walau bagaimanapun, lebih banyak kajian perlu dijalankan untuk menyokong penemuan kajian ini.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The knee joint has direct connections distally with the lower leg, ankle, and foot and proximally with the pelvis, hip, and upper leg. Standing, sitting, walking, climbing stairs, jogging, and jumping are all basic activities of daily living that require the weight-bearing from the knee joint complex (Bell & Ward, 2015). Excessive force during those activities may leads to the soft tissues injury in the knee especially anterior cruciate ligament (ACL). In fact, ACL tear has been accounted the most prevalent injury with 86.5% occurrence (John et al., 2016). Moreover, the incidence of ACL damage which related to sporting activities was reported over to 50% of all ACL tear prevalence annually (Joseph et al., 2013).

The tear of ACL causes instability on the tibiofemoral joint during anteroposterior direction and the internal-external rotational transition movements (Chaudhari, Briant, Bevill, Koo & Andriacchi, 2008). These setbacks definitely affect the skills delivery and efficiency of performance collectively. To overcome the potential problems, therefore, correctional pattern of biomechanics is essential to restore the functional activity of the individuals (Ardern, Taylor, Feller, Whitehead & Webster, 2013). One of the effective procedures of this restoration is through operative management as known as ACL reconstruction (Deehan & Pinczewski, 2002).

In normal practice, prior to the surgical procedure, individuals with ACL tear are encouraged to participate in pre-operative rehabilitation session as a preparation for successive operative management (Gokeler, Dingenen, Mouton & Seil, 2017). Pre-operative rehabilitation (prehabilitation) should be commenced as soon as possible after the condition is allowed to minimize any complications that potential arise from the delay of ACL reconstruction such as pain and movement impairments (Bandolm, Wainwright & Kehlet, 2018; Chua, Kang, Fook-Chong & Tan, 2021).

Pre-operative rehabilitation is expecting to provide optimal effects which to reverse the unwanted impact on the physical aspects by reducing swelling, regaining normal range of motion (ROM), also strengthening the hamstrings and quadriceps muscle (Johnson, 2004). As a result, the better condition of the knee prior to surgery will promote faster healing after surgery (Johnson, 2004). Thus, it is important that patients have access to prehabilitation so that they can continue to improve their ability to continue their activities of daily living, work, sport specific and learn as much as possible and to maximise their quality of life (QOL) and ability functionally.

Prehabilitation is strictly time constrained, in contrast to rehabilitation (Halliday et al., 2021). As a result, it is important that exercise behaviour be efficiently and successfully integrated into the pre-operative time. For the time being, home-based preoperative rehabilitation is widely used as one of the reasons of this home-based approach is to reduce hospital length of stay (Waite et al., 2017). However, forgetting to do the exercises and not adhere to the exercise given at home could be a barrier (Babatunde, MacDermid & MacIntyre, 2017). In the meantime, the methods of delivering pre-operative management are developing and growing to provide convenience to patients besides to maximize cost-effectiveness.

In this era of globalisation, along with the development of technology, one approach to overcome the barrier is through innovation of technology, such as online platform rehabilitation in monitoring and measuring activities that may assist patients in accessing physiotherapist and rehabilitation practitioners. Online rehabilitation or remote rehabilitation is one method of digitising services, often known as net therapy, telerehabilitation, virtual rehabilitation, or mobile rehabilitation (Esquivel et al., 2018). In this study, telerehabilitation was mostly used as the related term to remote rehabilitation as well as online platform method in delivering prehabilitation.

Telerehabilitation is an alternative method of providing rehabilitation to individuals remotely in their homes or other settings other than the conventional rehabilitation location (Brennan, Mawson & Brownsell, 2009). Using digital technology, telerehabilitation in physiotherapy enables the remote delivery of tailored evaluation and treatment intervention, bringing the benefits of treatment accessibility and cost reduction for patients who live in places far from rehabilitation centres

(Brennan et al., 2009). Along with technological developments, telerehabilitation is increasingly being used, and past research has demonstrated the potential of telerehabilitation as an alternative to hospital-based rehabilitation (An, Ryu, Lyu, Yi & Lee, 2021).

1.2 Problem Statement

Due to the severity of the injury and the extensive rehabilitation process it necessitates, an anterior cruciate ligament (ACL) tear is typically the injury that causes the greatest concern for individuals (Bell & Ward, 2015). To prevent knee joint instability, a reconstruction of an ACL rupture that has completely torn is advised (Kim, Hwang & Park, 2015). Prior to the surgical reconstruction, patients must be advised of the significance of complying with a brief pre-operative rehabilitation regimen in order to ensure adequate surgical preparation (reducing swelling, acquiring a complete range of motion, and improving strength and proprioception) and a satisfactory post-operative outcome (Johnson, 2004).

Despite the importance to adhere a pre-operative exercise before surgery and the positive outcomes after surgery, previous studies of prehabilitation have shown the need of maximising patient adherence to the exercise (Ferreira et al., 2018). In addition to the exercise training specialisation, low adherence rates (only 16% of people fully adhered to the pre-operative exercise programme) can also contribute to the lack of significant improvements in the outcome (Carli et al., 2010). Although the next study reported the increased rates of adherence to prehabilitation as 45% of patients reported

full compliance (Li et al., 2013), there is still a need for improvement as adherence rates are less than 50%.

Therefore, delivering training programs at home was introduced as one of the supportive tools that allows for the continuance of treatment with the aim to resume patients' physiotherapy which also could overcome the limitations and improve adherence (Bade, Thomas, Scott & Silvestri, 2015, Hotta, 2015). Nevertheless, following an injury, many patients are given exercises to complete at home unsupervised to aid their rehabilitation (Argent, Daly & Caufield, 2018). Besides, the adherence issue toward the exercise regimens at home also can be questioned which arise from no supervision by therapists (Meade, Bearne & Godfrey, 2018).

One study has been carried out by researcher to determine patients' adherence level to the exercises prescribed at home, to understand factors that influence the laxity of adherence to the prescribed exercises and to identify the solution to improve patients' motivation and participation (Ayob, Zolkafi, Ashadi, Mohan & Baharam, 2022). From this study, 96% of the participants were partially and totally not adhering to the prescribed exercises at home. The patients' adherence to exercises at home was relatively low. The findings showed the most responses to the factors that influence the laxity of adherence to the prescribed exercises were unable to remember on how to do the prescribed exercises, having lack of time and forget to do the exercises. Besides, the findings found out two most selected solution to improve patients' motivation and adherence which were patients' been monitored by physiotherapist through online platform medium while performing the prescribed exercises and create a reminder with video instruction on the procedure to perform the exercises.

Hence, a method as an alternative to face-to-face method could be implemented to encounter the raised issues such as (1) effectiveness of exercises and (2) adherence to exercise therapy. To fulfil the criteria, one of the ways to address these raised issues is through technological innovation such as telerehabilitation. Telerehabilitation necessitates the patient's involvement and commitment to therapy thus may improve treatment adherence (Tousignant, Boissy, Corriveau & Moffet, 2006; Bettger et al., 2020). Although telerehabilitation has the potential acts as the alternative to hospital-based rehabilitation according to previous study (An et al., 2021), till now, in Malaysia, the area that employ the telerehabilitation is still limited (Jafni, Bahari, Ismail & Hanafi, 2018) especially the explore of pre-operative telerehabilitation specific to ACL tear prior surgery is still lack until today.

The telerehabilitation can be one of the effective methods in supervising the patients especially for their quality of exercise delivery. It may improve treatment adherence of patient by real-time monitoring to exercises through online platform (Bettger et al., 2020). The issues of non-adherence and unsupervised exercise regimens are affecting the quality of pre-operative management especially related to exercises for ACL tear. Therefore, the alternative method to face-to-face method is important to be explored in order to evaluate the effect of telerehabilitation on pre-operative management among ACL tear individuals.

In order to enhance the adherence to the pre-operative exercises using telerehabilitation, researcher also wanted to determine the effectiveness of this implementation of technology in delivering prehabilitation to perceived pain level, muscle strength and dynamic balance. This is because one of the goals of the pre-

operative exercises is to develop quadriceps and hamstring strength prior to surgery, thus, it is important to measure the outcome of those muscle strength before surgery. Moreover, despite the loss of quadriceps and hamstring muscular strength, patients with ACL tear have been reported to have poor dynamic balance (Zult et al., 2017). The dynamic balance of the knee joint is influenced by the strength of the thigh muscles as well as the distribution of those muscles' strength (White, Lee, Cutuk, Hargens & Pedowitz, 2003; Park, Nam, Kim, Kim & Hwang, 2012). Therefore, it is anticipated that dynamic balance will be correlated with the weakening of the quadriceps and hamstring muscles after ACL tear.

Thus, besides the goals during prehabilitation period mentioned, researcher also compared the adherence level between groups (online platform group who underwent pre-operative exercises through online platform medium and face-to-face group who performed pre-operative exercises through standard face-to-face method) and its effects to the reduction of perceived pain level and improvement of muscle strength and dynamic balance at the end of the study.

In conclusion, there is a study of pre-operative telerehabilitation program increased muscle strength, range of motion, and functional results in older female patients with end-stage osteoarthritis prior to total knee arthroplasty (An et al., 2021). In addition, a pilot study suggested that pre-operative telerehabilitation can be practical for patients awaiting complete hip or total knee arthroplasty to use commercially accessible mobile technologies (Doiron-Cadrin et al., 2020). However, the approach of pre-operative telerehabilitation on ACL tear population still vague until today.

Despite that, the popular population that always being investigate to the use of telerehabilitation in delivering prehabilitation or rehabilitation are total knee arthroplasty, total hip arthroplasty, shoulder arthroplasty (Deweer, 2021) and cancer population. However, to researcher's knowledge, there was lack of pre-operative exercises delivered through telerehabilitation for the ACL tear population prior to ACL reconstruction.

Although the effectiveness of telerehabilitation was showed comparable with face-to-face method in total knee arthroplasty population and others, the research was needed to determine the effectiveness of online platform method in delivering pre-operative exercises to ACL tear population in investigating the outcome prior to surgery. In addition, the empirical data from the study may add to the understanding of how prehabilitation is delivered to those who have had an ACL tear using an alternative approach.

1.3 Research Objectives

In this study, the objectives have been outlined as a guideline for the researcher to conduct the study. The objectives that may be deemed necessary were as follows:

1. To determine the effectiveness of online platform method in delivering pre-operative exercises on perceived pain level, muscle strength, dynamic balance and adherence level prior surgery among ACL tear individuals.
2. To compare the effects of online platform and face-to-face method in delivering pre-operative exercises on perceived pain level, muscle strength, dynamic balance and adherence level among ACL tear individuals.

1.4 Research Hypothesis

Generally, this study covers the effects of four weeks of pre-operative exercises delivered through two different methods (online platform and face-to-face method) on perceived pain level, muscle strength, dynamic balance and adherence level. Therefore, this study was conducted specifically to determine the following research hypothesis:

1.4.1 Hypothesis null (H_O)

There will be no differences on the perceived pain level, muscle strength, dynamic balance and adherence level between online platform group (OPG) and face-to-face group (FFG) after four weeks of intervention program.

1.4.2 Hypothesis alternative (H_A)

There will be differences on the perceived pain level, muscle strength, dynamic balance and adherence level between online platform group (OPG) and face-to-face group (FFG) after four weeks of intervention program.

1.5 Significance of Study

Prehabilitation (pre-operative rehabilitation) is a concept that has been used with reported positive outcomes in patient with musculoskeletal diseases. Prior to surgery, medical or behavioural support therapies such as physiotherapy, exercise, and lifestyle changes are carried out (Durrand, Singh & Danjoux, 2019). Pre-operative exercises treatment has been shown to be beneficial in reducing post-operative complication rates and hospital length of stay (Valkenet et al., 2011). On the other hand, four-week of exercise before surgery may have a variety of beneficial consequences after reconstructive surgery, including faster recovery of knee extensor strength (Kim et al., 2015).

However, the results are expected to encourage improvement of knee condition before surgery (Johnson, 2004). Since the reconstructive surgery are not performed for several weeks and months after the injury, pre-operative rehabilitation should start as soon as the injury occurs (Bell & Ward, 2015). Nevertheless, engaging patients in prehabilitation programmes might be difficult to supervise (Piraux, Caty, Reychler, Forget & Deswysen, 2020). Besides, patients who are in poor physical condition may

find it difficult to make additional appointments for exercise sessions (Ferreira et al., 2018).

Thus, using digital technology, the use of telerehabilitation in physiotherapy enable the remote delivery of individualized assessments and treatment interventions, providing patients residing in remote places with treatment accessibility and cost savings (Brennan et al., 2009; Peretti, Amenta, Tayebati, Nittari & Mahdi, 2017). It facilitates access to health-care services and may increase exercise adherence among patients (Piraux et al., 2020). It can also significantly reduce patient and therapist travel time, allowing for a greater number of client consultations each day. Telerehabilitation may act as a plus of economic sustainability to the health and medical system and better clinical support in local communities by reducing the presence in consultations and speeding up waiting list (Schmeler, Schein, McCue & Betz, 2009).

People either patients, practitioner or community having less awareness towards telerehabilitation method in delivering prehabilitation or rehabilitation. The less awareness can cause to the lack of exposure to its advantages. In Malaysia, the result from the case study shows that majority of the clinical professionals are still have lack of awareness of telerehabilitation and other healthcare technologies (Jafni et al., 2018). On the other hand, a study on the level of awareness of rehabilitation professional regarding telerehabilitation showed that 92% of the subjects had poor level, 8% had a moderate level and none had a high level of knowledge and awareness about telerehabilitation technology (Movahedazarhouligh, Vameghi, Hatamizadeh, Bakhsi & Mousavi Khatat, 2015).

Thus, this study was expected to help patients, physiotherapist and community to be more sensitive to every injury and to create awareness about the important of prehabilitation. Also, this study was expected to provide knowledge and information about the alternative method to deliver prehabilitation which is online platform method or best known as telerehabilitation. With these results and information, individuals could continue the prehabilitation session in the period that has been set by orthopaedic surgeon and physiotherapist. At the end of this study, researcher hopes that physiotherapist, patients and community have more concern on the importance of adhering pre-operative exercises before surgery on perceived pain level, muscle strength and dynamic balance. Additionally, researcher also hopes that physiotherapist aware on the importance of alternative method (telerehabilitation) in enhancing adherence level to the exercise protocol besides the standard face-to-face method.

1.6 Limitation of Study

Subjects in this study were individuals between 18 to 35 years of age, with ACL tear injuries and planned to undergo ACL reconstruction; therefore, the outcomes may not be representative of the entire population. Subjects have been constantly encouraged to perform at their best. They have also been told to acknowledge the researcher if there was any symptoms of pain or injuries before, during and after the session. If subjects encountered any injury problems while performing the intervention, researcher followed their physiotherapist suggestion and would do whatever was advised. In addition, if subjects find difficulties in continuing the study, they were free to withdraw

from the study without penalty and without affecting the standard of care during surgery and post-surgery treatment.

This study also involved the usage of Internet as researcher, physiotherapist and subjects were communicate using video-conferencing medium which was Google Meet to deliver pre-operative exercises. Prior to the appointment, it had been confirmed for the researcher and subjects that the internet signal was excellent. Then, the subjects were encouraged to be at the same location where the exercises were conducted to avoid any future issues. When the internet signal was found problematic, researcher and subjects discussed to find solution and there was no restriction on the devices either using smart phone or computer with camera embedded. There is no requirement for a particular resolution as long as physiotherapist and researcher can easily watch the video. If there were any problems during the scheduled session, researcher rescheduled the session on the next day.

1.7 Delimitation of the study

The exercise protocol of four-week pre-operative exercises was conducted in two methods of delivering prehabilitation: face-to-face session and online platform method. The subjects were obtained from a few institutions which have physiotherapy departments; therefore, the intervention was conducted in the respective physiotherapy department for face-to-face session group. On the other hand, the same online platform (Google Meet) for the online platform prehabilitation method group have been conducted with subjects are in their house respectively. Besides, only the researcher,

subject, and physiotherapist were present in the online platform room during the intervention procedures to reduce the risk of an unfamiliar environment. Subjects were given a form of readiness in performing rehabilitation through online platform that included their internet ability coverage, further exposure on telerehabilitation and readiness in performing the intervention. If subject find any hindrance in performing the intervention, subjects free to withdraw from the study without penalty.

1.8 Operational Definition

The following terms were be adopted for the operational use in this study.

a) Anterior Cruciate Ligament Tear

Complete tear of the ligament occurring either isolation or associated with other concomitant injuries to the knee joint and plan to undergo ACL reconstruction. An anterior cruciate ligament (ACL) tear is a tear of the anterior cruciate ligament, one of the strong bands of tissue that connects the femur and the tibia.

b) Pre-operative rehabilitation

A process of improving the functional capability of a patient prior to ACL reconstruction. In this study, pre-operative exercises was experimentally conducted by face-to-face and online platform method. The concept of pre-operative rehabilitation which also known as prehabilitation, incorporating medical or behavioural support therapies such as exercise, physiotherapy, and

lifestyle changes carried out prior to surgery (Durrand, Hacket, Yates & Danjoux, 2016).

c) Perceived Pain Level

Subjects' current symptoms rating of pain in the area of the knee while in motion, and in sitting and standing positions. The subjects in this study described the sense of unpleasant sensory (pain) by marking on a 100-millimetre Visual Analogue Scale (VAS) after performing the Step-down test for one minute. In terms of intensity, perceived pain level explains how an individual perceives the experience (feeling) of unpleasant sensations linked with total or partial tissue damage (Breivik et al., 2008).

d) Muscle strength

Muscles comprising the knee flexor, knee extensor, hip abductor, ankle plantarflexor and ankle dorsiflexor. Researcher also included ankle plantarflexor and ankle dorsiflexor because these muscles are involved in dynamic balance movements (Neptune & Vistamehr, 2019) which is dynamic balance is one of the variables in this study. Plantarflexors provide a stabilizing force, while dorsiflexors are responsible for adjusting the position of the foot to keep the body in balance (Choi, Lee & Baek, 2020). Muscles of the knee related to the ability of knee muscles to generate force is necessary for all types of movement (Thomas, Villwock, Wojtys & Palmieri-Smith, 2013).

e) Dynamic Balance

The ability to remain standing and stable while performing Y-balance test, a distanced-based measurement of dynamic balance in anterior, posteromedial and posterolateral directions. Dynamic balance is required when the body is in motion and importantly is most used in real life situation, such as walking and performing exercises. Dynamic balance is the ability to maintain equilibrium while in motion or to regain equilibrium after shifting postures quickly and repeatedly (Davlin, 2004).

f) Adherence Level

A process by which subjects performing their pre-operative exercises as prescribed either in online platform group or face-to-face group. According to the World Health Organization (WHO), adherence is the extent to which a person's behaviour complies with recommendations from a health professional (WHO, 2003).

g) Telerehabilitation

The delivery of pre-operative exercises to the individuals with ACL tear over video-conferencing medium, Google Meet. Brennan et al. (2009) refer telerehabilitation is specifically to the delivery of rehabilitation services via online platform (ICT) method. Therefore, in this study, from this section, the term of online platform method was used to represent telerehabilitation method in the intervention.

1.9 Summary

This chapter presented the introduction of the information on the benefit of telerehabilitation method as the used for rehabilitation. Telerehabilitation are believed to be beneficial because it can be an alternative medium and adaptation to ensure the continuation delivery of physiotherapy service. As an introduction, the details about the importance of pre-operative exercises performed in telerehabilitation medium are also mentioned in this chapter. It is obvious that good pre-operative exercises rehabilitation process is important to be performing before surgery to reduce the complication occurs during and after the surgery that can lead to other orthopaedic problems. Additionally, pre-operative exercises therapy has been shown to reduce post-operative complications and duration of stay.