The Role of Fear of Re-Injury On Step-Up-And-Over Performance through Rehabilitation

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ABSTRACT

In all, this study has contributed a promising new method for evaluating progression through rehabilitation with an easy, objective and quick test that is accessible to clinicians. Bailey and Costigan (2015) modified the test with an inexpensive accelerometer and changed the movement speed to a comfortable pace allowing the SUAO test to track an individual’s progression through rehabilitation. This modified SUAO test was then used to assess the performance of ACLR patients through rehabilitation. This discussion then described some of the current issues related to symmetry tests and variables that require further study. As a next step, clinicians should assess whether the SUAO test can track ACLR progression through rehabilitation with a larger population size, whether the test reports similar symmetry measures as the current maximal effort tests such as the single-leg hop at the 4-month mark post-surgery and whether the SUAO test can measure postural sway in ACLR patients.

Keywords: fear of re-injury, Step-up-and-over performance, rehabilitation

INTRODUCTION

The purpose of surgically repairing a torn anterior cruciate ligament (ACL) is to restore normal knee function including the ability to perform pre-injury activities. However, 24% of individuals who have an ACL surgically repaired choose not to return to their pre-injury levels of activity and report their fear of re-injury as the main reason (Kvist et al., 2005; Tripp, Stanish, Ebel-Lam, Brewer, & Birchard, 2007). In some cases, athletes return to the same sport but at a reduced level of competition, whereas others return to a different sport while some leave sport altogether. Fear of movement/re-injury tends to decrease with increasing time from surgery and is inversely related to joint function (Chmielewski et al., 2008); the better you move the less fearful you are of movement. However, the inability to overcome this fear of movement/re-injury delays the ACL-reconstructed (ACLR) patients’ improvement during rehabilitation, increasing their recovery time which in turn can delay their return to activity (Kvist et al., 2005; Mainwaring, 1999).

As with the fear of re-injury, pain-related fear and pain itself are other factors that influence an individual’s choice to return to their pre-injury level of activity (Swinkels-Meewisse, Roelofs, Oostendorp, Verbeek, & Vlaeyen, 2006). Complications from injury or surgery such as anterior knee pain hinder rehabilitation and a delay in rehabilitation could result in a loss of range of motion, increased anterior knee sensitivity to pain and possibly the need for follow-up surgery (Kartus, Magnusson, Stenert, Brandsson, Eriksson, & Karlsson, 1999). Those who focus on pain sensations are unable to effectively use coping strategies which may increase their future disability (Sullivan et al., 1998, 2002). Additionally, the sensation of pain has been shown to decrease the recovery of muscular strength in the affected leg of ACLR patients (Natri et al., 1996). Similar to fear of re-injury, pain can increase the time needed to recover full knee function and if these factors are not considered throughout the rehabilitation process, patients can be cleared to return to full activity without being truly ready.

The current goal of rehabilitation is to return patients to unrestricted sports activities within six months (Keays et al., 2000; Shelbourne & Nitz, 1990). Typically, patients are released after six months of rehabilitation solely based on the time since surgery and in some cases must pass an ‘exit’ test before being cleared to return to unrestricted sports activities. However, after six months fewer than half of the patients pass the selected exit tests (Thomeé et al., 2012), which, in part, may explain the rate of non-return to sport. These tests often include limb symmetry measures using either isokinetic knee strength testing or the single - leg horizontal hop test requiring the affected limb to have a performance of at least 85% compared to the unaffected limb to pass (Myer et al., 2006; Shaw et al., 2004; van Grinsven et al., 2010; Werstine, 2009). These two tests are the most commonly used tests (Myer et al., 2006; Shaw et al., 2004; van Grinsven et al., 2010) and, although valid and reliable, both require a maximal effort from the ACL-reconstructed knee. This level of effort is...
contraindicated early in rehabilitation (Cascio et al., 2004; Lahav & Burks, 2005) and so these tests are not used throughout the rehabilitation program but only as exit tests. The high demands placed on the knee by these tests could result in knee pain or trigger an individual’s fear of re-injury, either of which could limit an individual’s ability to perform the test which may confound the patient’s performance thereby limiting the tests’ ability to determine the patient’s readiness to be released. Thomeé and colleagues (2011) suggested that the current functional tests are either not demanding enough or not sensitive enough to identify differences between injured and non-injured limbs and felt that new criteria were required to evaluate knee function before allowing athletes to safely return to sports after ACLR (Thomeé, Kaplan, Kvist, Myklebust, Risberg, Theisen, Ts epis, Werner, Wondrasch, & Witvrouw, 2011).

If maximal effort tests cannot be performed due to their high demands, sub-maximal effort tests must be used to evaluate knee function in the early stages of rehabilitation to identify any issues in progression that may arise and change the course of treatment accordingly. The step-up-and-over (SUAO) test is a sub-maximal effort test that differentiates between the affected and unaffected legs of patients with ACLR, and between ACL-deficient patients and ACL-intact populations (Chmielewski et al., 2002; Lin et al., 2010; Mattacola et al., 2004). As with many knee function tests, including muscle strength testing and the single-leg hop for distance, the main outcome from the SUAO test is the ratio of performance between the affected and unaffected legs and it is expected that at release the performance of the affected leg be better than 85% of the unaffected leg and in some cases equal to the affected leg (100%) (Thomeé et al., 2011). Bailey and Costigan (2015) investigated the use of the SUAO test performed at a comfortable pace, rather than a maximal pace used in previous research, and found similar results between the variables obtained from a force plate and those obtained from an accelerometer. At a slower pace, this test can be used throughout rehabilitation to assess the limb symmetry performance of ACLR patients, enabling clinicians to track an individual’s progress and allow them to alter a patient’s course of treatment if needed. In this pilot study, we hypothesize that pain will be associated with more asymmetrical (further from 100%, or 1.0 as a ratio) SUAO scores and, since the test asks the participant to step at a comfortable, self-selected pace, fear will not be correlated with SUAO scores.

METHODS

Twelve participants (7 females and 5 males) were recruited from a surgeon’s patient list and all had had an ACL reconstruction. Mean patient age at the time of surgery was 32 (Range: 16-55) years. The mean time from injury until surgery was 14 (Range: 3-52) months. Five participants received a hamstring graft and seven received a bone-to-bone patella tendon graft. Besides their reconstructed ACL, participants were free from any other back or lower body injury at the time of surgery. Prior to beginning the study, each participant completed the Physical Activity Readiness Questionnaire Plus (PAR-Q+) to screen for any underlying health conditions and signed a letter of informed consent.

Once a month after surgery, participants completed a shortened version of the Tampa Scale for Kinesiophobia (TSK-11) administered electronically to subjectively assess their fear of re-injuring their knee. The TSK-11 was completed each month until participants were cleared by their physical therapist to return to unrestricted physical activities. The dates reflect the days in which each participant completed the questionnaire. The 11 items of the TSK-11 have four response options: “strongly disagree”, which scores 1 point, and “strongly agree”, which scores 4 points. The total sum score is calculated and can range from 11 to 44. A high score indicates a strong fear of movement/re-injury. On each testing day, at the completion of the final trial, participants rated the highest pain they felt throughout the test on a Pain Visual Analog Scale, where 0 was no pain and 100 was the worst pain they ever felt. The Pain Visual Analog scale began being administered after the study had begun reducing the sample size for the pain scores (n = 85).

At each physical therapy clinic visit participants performed the Step-Up-and-Over (SUAO) test. Before the test, participants warmed up on a stationary bicycle for 3 minutes and performed dynamic stretching exercises of the hip, knee and ankle. Before beginning the Step-Up-and-Over (SUAO) test, an inertial measurement unit (IMU) (IMUx, x-io Technologies, UK) was secured to a Velcro strap placed at their lower back to approximate the center of mass location. The IMU recorded the 3-dimensional accelerations that later were combined to give the net acceleration. Once the participant was comfortable performing the test, they stood behind a 12-inch box and then stepped on the box with their lead leg, swung their trail leg over the box, landed on the other side of the box and stepped down. Each participant completed the SUAO test 5 times on each leg and the order of the 10 trials was randomized. The test was completed at a self-selected pace.

The SUAO test returns the variables of lift acceleration and impact acceleration for each trial.
The lift acceleration characterizes the concentric control of the lead leg’s knee extensors and the impact acceleration characterizes the eccentric control of the lead leg’s knee extensors. Once the net acceleration was computed, 1g was subtracted to remove the acceleration due to gravity. The lift acceleration is the peak net acceleration during the up-phase of the test and the impact acceleration is the peak net acceleration during the down-phase. The lift and impact indices were then averaged across the trials for both the affected and unaffected leg. After averaging, a symmetry score was calculated by dividing the affected leg’s score by the unaffected leg’s score. Limb symmetries were calculated for both the lift acceleration and the impact acceleration giving two new variables: lift symmetry and impact symmetry. A symmetry score of 1.0 indicates perfect symmetry and scores deviating from 1.0 are increasingly asymmetric.

Separate linear regression models were determined for lift symmetry, impact symmetry, and fear of re-injury all regressed against time since surgery and a power model was determined for the pain scores as it showed an exponential decay in scores occurring in the first 3 months with a plateau thereafter. The beginning of the plateau for each participant was determined by calculating the first point in which the line of progression of the curve became zero. These four models were determined for each participant. Correlations examined the relationship of the lines of progression among the four variables. The influence of pain and fear was examined on each individual’s rehabilitation progress.

In an additional analysis, the residuals from the regression models of all four variables for each participant were calculated to remove the effect of time. The influence of pain and fear on an individual’s performance was examined on each testing day. Correlations examined the relationships among the variables after removing the time trend.

RESULTS

The best fit for the variables was determined by using the smallest residuals. As a result, a linear regression was applied to the lift symmetry, impact symmetry and fear of re-injury variables and a power regression was applied to the pain scores. The curve profiles for all four variables for a select participant’s progression through rehabilitation are displayed in Figure 1.

A negative line of progression for the lift and impact symmetries indicates that the affected leg is becoming increasingly similar to the unaffected leg and a positive line of progression indicates that the affected leg is becoming increasingly dissimilar to the unaffected leg. Two participants had positive lines of progression suggesting their limbs became increasingly asymmetrical with time. A negative line of progression for the pain scores over time indicates a decrease in pain during the rehabilitation process. S02 was the only participant who exhibited no change in their pain score throughout rehabilitation, denoted by a line of progression of zero. All other participants had a negative line of progression seen by an exponential decrease in scores with a plateau (a low point) occurring approximately 96-days post-surgery (SD=36.4). An example of the pain line of progression can be seen in Figure 1. Since the pain scores were fitted with a power curve, more negative lines of progression indicate a faster decrease in pain over time.

Additionally, for fear of movement/re-injury a negative line of progression towards 1.1, the lowest possible score, indicates a decrease in fear. Two participants, S02 and S09 did not experience a change in fear through rehabilitation as denoted by a line of progression of zero. On the other hand, three participants had a positive line of progression suggesting an increase in fear of movement/re-injury as their rehabilitation progressed. As expected, the lift and impact symmetry lines of progression were correlated with each other ($r = 0.603, P < 0.05$) suggesting an improvement in both concentric and eccentric knee function during rehabilitation. The fear of re-injury (TSK-11) line of progression was correlated with the impact symmetry line of progression ($r = .591, P < 0.05$) suggesting that as knee eccentric function improved the fear of injury decreased. The line of progression of the pain scores was negatively correlated with the lift symmetry line of progression ($r = -.582, P < 0.05$) indicating that as pain decreased more rapidly, the impact symmetry line of progression became more positive suggesting a slower progression. After removing the effect of time there was a weak correlation between pain and lift symmetry ($r = .219, P < 0.05$) and between pain and impact symmetry ($r = .333, P < 0.01$) indicating that on each testing day, the higher the pain score the less symmetrical the lift and impact scores were for each individual. There was no relationship between fear of re-injury (TSK-11) and either lift or impact symmetry ($Ps > 0.05$).
Figure 1. An example of a participant’s pain scores, fear or re-injury scores, lift symmetry, and impact symmetry scores according to days from surgery.

Figure 2. Relationship between the lines of progression of the pain scores and the lift symmetry scores
DISCUSSION

The purpose of this study was to examine the relationship between pain and fear of re-injury on the variables obtained from the SUAO test measured throughout rehabilitation. In a positive progression through rehabilitation a change in symmetry score from asymmetric to symmetric (approaching 1.0), a decrease in pain (approach 0.0) and a decrease in fear of re-injury (approach 1.1) would be expected. As mentioned, only two participants became increasingly asymmetrical through rehabilitation denoted as a symmetry score increasing away from 1.0. All participants exhibited a decrease in pain except one who experienced no change in pain through rehabilitation. Those with a decrease in pain experienced a plateau in pain occurring at approximately 96-days post-surgery. Three participants experienced an increase in fear of re-injury through rehabilitation and two experienced no change in fear whereas all other participants experienced a decrease in fear of re-injury as rehabilitation progressed.

As hypothesized, a correlation was found between impact symmetry and pain; however, this correlation is negative suggesting that as an individual’s pain levels drops more quickly (becomes more negative), their eccentric control of their knee measured with the impact symmetry is more asymmetrical over time or progresses more slowly. However, as shown in Figure 2, the participant who experienced the most negative pain line of progression (-5.3) and experienced a decrease in symmetry, as shown by the positive line of progression appears to have skewed the data. As a result, this relationship needs to be further investigated with a larger population.

Since all pain lines of progression with the exception of one participant were negative, Figure 1 demonstrates an example of the general trend that occurs through rehabilitation. A large decrease of pain with time occurred for all participants and suggests that the influence of pain on performance may only be dominant in the early stages of rehabilitation. However, if pain persists beyond the first three months, individuals are more likely to have delays in recovering their pre-injury levels in muscular strength (Kobayashi et al., 2004; Natri et al., 1996) possibly contributing to a decrease in knee function and in turn might increase an individual’s fear of re-injury. On day 122 post-surgery, S13 was still experiencing some pain and their limbs had become increasingly asymmetrical throughout rehabilitation for both the lift and impact symmetries suggesting a delay in recovery. On the other hand, S02 experienced no change in pain throughout their rehabilitation as displayed by a line of progression of zero.

The lines of progression for fear of re-injury were correlated with the lift symmetry line of progression highlighting the importance of targeting fear of re-injury early in rehabilitation to aid in improvements of the concentric control of the individual’s knee’s extensors as measured with the lift symmetry. Despite individuals regaining full knee function, fear of re-injury remains the main reason for approximately 1/4 of patients who chose not to return to their pre-injury levels of physical activities (Kvist et al., 2005). Those who are more fearful of re-injuring their knees are more likely to progress more slowly in regaining their pre-injury level of concentric control of their injured knee’s extensors. The results in this study are in agreement with a study by Lentz and colleagues (2014) who found a relation between increased fear of re-injury and quadriceps weakness at 6 months and 1-year post-surgery indicating a relationship exists between progression and fear. However, S02 did not experience any change in fear and maintained a low level of fear of re-injury throughout their rehabilitation suggesting they may have had adequate coping mechanisms and strategies to maintain these low levels of fear throughout their rehabilitation. This participant’s lift and impact symmetries also improved throughout rehabilitation with a final symmetry score of 1.22 and 0.81 for the lift and impact symmetry respectively. Although this participant’s limbs were not perfectly symmetrical at release, they demonstrated an improvement from 1.46 and 1.15 for the lift and impact symmetries on their first testing day (48-days post-surgery). Physicians and physiotherapists should work with their patients on overcoming this fear throughout rehabilitation to ensure they are not fearful when returning to physical activities post ACLR rehabilitation.

Positive correlations were found between the residual pain scores and the residual lift and impact symmetries indicating that pain may negatively influence an individual’s performance during the SUAO test on any given day since symmetry scores are more asymmetrical with an increase in pain. This relationship has been seen by Sullivan and colleagues (2002) who found that individuals who were unable to cope with their pain experienced negative moods, increased pain and a reduction in the weights they were able to lift, suggesting that pain and the fear of pain influence daily performance. Since residual pain scores are related to the residual impact symmetry scores, the lift symmetry score may be the preferred measure to use to monitor knee performance during rehabilitation as it was not related to pain.
Additionally, fear of re-injury was not related to either SUAO variables on the testing day.

Although the SUAO test was performed at a self-selected pace to reduce the effect of pain and fear of re-injury, pain may still have influenced an individual’s landing strategies. Individuals who report knee pain often report difficulties going down stairs but little to no difficulty going up stairs (Fairbank, Pynsent, van Poortvliet, & Phillips, 1984). Since the SUAO test mimics stair climbing, the landing portion of the test, which results in higher levels of pain, may result in a fear of pain and ultimately a fear of re-injuring the patient’s knee. However, the variables obtained from the SUAO test were not correlated with fear of re-injury, suggesting this test is may be an alternative to more demanding knee function tests such as the single-leg, horizontal hop test in the early stages of rehabilitation to evaluate progression through rehabilitation. A self-selected and comfortable pace was used by each participant and that may have reduced the effect of fear of re-injury. This suggests that the SUAO test may be used as soon as the patient has enough range of motion to step up on the box and then step down. The SUAO test is a quick test of ACLR performance that should be used to evaluate each individual’s progression through rehabilitation.

Further studies should investigate the effect of pain and its influence on an individual’s progression through rehabilitation. In conclusion, this promising pilot study has shown that the mild and moderate correlations between pain and the lift and impact symmetries suggest that when measuring the variables obtained from the SUAO test, pain should also be recorded as there appears to be an influence on the SUAO scores.

CONCLUSION AND FUTURE DIRECTIONS

The results highlighted the importance of tracking an individual’s pain levels throughout rehabilitation as they may influence the variables measured using the SUAO test on a daily basis. The patient’s fear of re-injury was related to the progression of impact symmetry suggesting that as fear of re-injury abated, the individual’s impact symmetry improved. However, fear did not influence the daily performance on the test.

However, these projected times should be used as guidelines to gauge a participant’s progression as opposed to a release criterion since many studies suggest an 85% limb symmetry score as being adequate to return to unrestricted athletics (Myer et al., 2006; Shaw et al., 2004; van Grinsven et al., 2010; Werstine, 2009). The average day the patients were released from physical therapy was 142-days post-surgery and the average projected time to symmetry was 376 days and 222 days after their reconstruction surgery for the lift and impact symmetry respectively. While previous rehabilitation programs began with immobilization of the affected leg to protect the graft, current accelerated programs begin weight bearing and passive range of motion immediately post-surgery (Carol et al., 1992) The accelerated rehabilitation program aims to release patients in 6 months to unrestricted physical activities. However, as seen by the average release date for these participants, it appears that individuals are being released around 4-months post-surgery. All patients who attended supervised physical therapy treatments were released by their physiotherapists suggesting that the release criteria used for these patients indicated they were ready to return to unrestricted athletics. It is however unclear if these individuals are ready to return to unrestricted physical activity at this time since the results from the SUAO test indicate that many do not have symmetrical limbs upon release and up to 30% of individuals with an ACL reconstruction have a repeat injury within the first two years after release (Paterno et al., 2014; Webster et al., 2014). The high number of repeat injuries suggests that future studies investigating the progression of patients with the SUAO test should measure the performance of patients with current exit tests after 3 months to provide more information about a participant’s progress after ACLR.

Objective measures are important for evaluated ACLR patients’ knee function post-surgery as many believe that their knees are healed and highly functional when in fact, this may not be the case (Harter et al., 1988; Kocher et al., 2004; Myer et al., 2008; Risberg et al., 1999; Ross et al., 2002). Participant S02 participated in competitive sports and after 4 months chose to not to attend supervised physical therapy clinic visits. As seen in initial low pain and fear scores and no change in pain or fear of re-injury throughout their rehabilitation. Despite their assessment of their own knee function being near normal with the use of the ACL-QoL at the time they terminated treatment, their projected time to symmetry was 55 days after their last testing day for the lift symmetry suggesting they still required some supervised physical therapy to increase symmetry of their limbs. Asymmetrical limbs are the main causes of individuals sustaining a subsequent ACL tear (De Vita et al., 1998; Kaur et al., 2016; Noehren et al., 2013; Paterno et al., 2010; Salmon et al., 2005; Di Stasi et al., 2013; Wright et al., 2007) highlighting the importance to test different areas of knee function using objective measures such as limb symmetry since subjectively, this participant believed to be fully recovered and may not have been.
However, using only measures of symmetry may be problematic since symmetry scores hide details about how symmetry was achieved. The symmetry score is computed by dividing the lift or impact acceleration for the affected leg by the corresponding acceleration for the unaffected leg. Therefore, the same symmetry score can be achieved by having high scores on both legs or low scores on both legs. When examining the lift and impact acceleration scores that compute the symmetry score, several different cases emerged. The most common case was ACLR patients who had a “high affected” score, where the affected leg lifted or impacted more forcefully than their unaffected leg. Patients who fit this case on any day may have had less control of their ACL-reconstructed knee. However, the lack of control may have gone unnoticed if their unaffected leg also had a “high unaffected” score, leading to a symmetry score close to 1.0 since the two legs performed similarly. On the other hand, participants who had a “low affected” score, lifted or impacted less forcefully than their unaffected leg. These low cases suggest that these patients may have been being cautious. Again, the low scores may have gone unnoticed if they also were cautious with their unaffected leg. For example, on day 118 post-surgery, S10 had a low affected and low unaffected score (0.999 and 0.9686, respectively) resulting in a perfect limb symmetry whereas on day 65 post-surgery, S09 had a score of 4.2892 and 4.9452 also resulting in perfect symmetry. These two cases, although the scores are highly different and may have been exhibiting different strategies to complete the test, the symmetry score is very similar highlighting the importance to use other objective measures to assess knee function.

In addition to variability within individuals resulting in perfect symmetry scores, variability also occurred within the same individual throughout their rehabilitation. For example, on day 45, participant S08 had a “low affected” lift acceleration score but a limb symmetry of 0.97, near perfect symmetry. However, on the next testing day (56-days post-surgery) their lift symmetry score was 2.06 indicating the limbs were not symmetrical. On day 45, this individual exhibited less control of their unaffected leg when lifting up on the box generating this near perfect limb symmetry value and obtaining a “low affected” score. The variability in scores on a daily basis suggests that frequent testing of the SUAO test throughout rehabilitation is important to reduce any outliers which may result in skewing the line of progression.

Variability also occurred between different participants. The results for participant S08 show that some form of supervised rehabilitation is important for proper recovery. S08’s score on the ACL-QoL showed that they felt they improved during the testing period while at the same time their fear of re-injury increased. Also, their predicted dates to limb symmetry were 907 and 261 days after their last testing day (195-days post-surgery). S08 did not have adequate health coverage and did not attend physical therapy. The lack of supervised visits may have accounted for their slow recovery and their increase in fear of re-injury throughout their recovery. This highlights the importance of having clinicians and physiotherapists work with patients throughout rehabilitation to decrease this fear with behavior counseling and improve their knee function both subjectively and objectively to improve the proportion of patients that are able to safely return to their pre-injury levels of physical activity.

S13 was a particularly interesting participant as they had two previous reconstructions, one on each knee. This participant’s limbs became increasingly asymmetrical and their subjective knee function became worse throughout rehabilitation. This decrease in function both subjectively and objectively highlights the importance of using both objective and subjective evaluations to measure an individual’s knee function throughout rehabilitation and before release to unrestricted physical activities. Although this participant exhibited increasingly asymmetrical limbs seen through rehabilitation, they were released from physical therapy treatment 122-days after their surgery suggesting that other measures were used to determine their readiness to return to unrestricted physical activity. As a result, symmetry measures along with other release criteria need to be used in conjunction to evaluate an individual’s knee function and one measure cannot be solely used to evaluate a person’s function without the other.

Although it is important to consider symmetry measures as they are easy to calculate, objective and widely used measures for assessing return to physical activity readiness in patients with an ACL-reconstruction (Gustavsson et al., 2006; Myer et al., 2006; van Grinsven et al., 2010; Werstine, 2009; Wilk et al., 1994), these measures on their own may not provide enough information to release patients to unrestricted physical activities. The SUAO test requires one leg to control the movement through the step up and over portion of the test and problems with postural control could influence the result. The accelerometer used to measure the SUAO test measures accelerations in all 3 directions which could allow future studies to investigate postural stability using accelerations that would provide more
information about knee function, increasing the value of the test. The SUAO test is quick to administer and its ability to be administered with the use of an accelerometer makes it easily portable and applicable in a clinical setting.

The small population used for these studies had varying characteristics. These patients had a wide range in age (32 ± 12 y), mass (68 ± 10 kg), height (1.76 ± 0.14 m), different grafts, their health histories were unknown. The differences in their demographics may have led to different performances and it is unknown if these factors affect the SUAO test performance. Another limitation of these studies was the studies’ designs. Due to time constraint, a small population size was used and many variables that might have affected the SUAO performance could not be tested. For example, pre-operative strength, or the intensity of rehabilitation, or adherence to one’s rehabilitation program may have influenced an individual’s progression through their rehabilitation programs and should be investigated in future research.

In all, this study has contributed a promising new method for evaluating progression through rehabilitation with an easy, objective and quick test that is accessible to clinicians. Bailey and Costigan (2015) modified the test with an inexpensive accelerometer and changed the movement speed to a comfortable pace allowing the SUAO test to track an individual’s progression through rehabilitation. This modified SUAO test was then used to assess the performance of ACLR patients through rehabilitation. This discussion then described some of the current issues related to symmetry tests and variables that require further study. As a next step, clinicians should assess whether the SUAO test can track ACLR progression through rehabilitation with a larger population size, whether the test reports similar symmetry measures as the current maximal effort tests such as the single-leg hop at the 4-month mark post-surgery and whether the SUAO test can measure postural sway in ACLR patients.

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