Every athlete has a unique trajectory: Knee-related quality of life in young athletes following anterior cruciate ligament reconstruction

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Research article

Keywords: Adolescent, Kinesiophobia, Physical Activity, Symptoms

Posted Date: December 18th, 2019

DOI: https://doi.org/10.21203/rs.2.19151/v1

Abstract

Background

Although the physical, psychological, and social consequences of sustaining an anterior cruciate ligament (ACL) tear in young athletes are well documented, little is known about how ACL tears influence health-related quality of life (QOL). This case series describes changes in knee-related QOL over the first 12 months following an ACL reconstruction (ACLR) in young athletes and explores the association between 6-month knee symptoms, moderate-to-vigorous-intensity physical activity (MVPA), kinesiophobia, and 12-month knee-related QOL.

Methods

Twenty young athletes (15-20 years old, 70% female) who underwent primary ACLR were evaluated pre-ACLR (baseline) and post-ACLR at 3, 6, 9, and 12 months. Knee-related QOL was assessed with the Knee injury and Osteoarthritis Outcome Score (KOOS) QOL subscale. Knee symptoms (KOOS symptoms subscale), average daily minutes of MVPA (tri-axial accelerometer), and kinesiophobia (Tampa Scale for Kinesiophobia; TSK) were also tracked. Descriptive statistics (median with range, mean with standard deviation, or proportion with 95%CI) were calculated for demographic and outcome variables. Individual changes in KOOS QOL scores over the 12-month study period were compared to minimal clinically important difference, patient acceptable symptoms state, treatment failure, and normative reference values. Associations between 6-month KOOS symptoms, MVPA, TSK, and 12-month KOOS QOL were explored using Spearman's rank correlation coefficient (ρ).

Results

Considerable individual variability in the trajectory of KOOS QOL scores was observed over the study period with 13 (65%) participants achieving clinically important improvements. At 12 months, the median KOOS QOL score was 53 (range 6-100) and only 7 (35%) participants reported acceptable QOL and 4 (20%) exceeded normative reference values. A moderate association was detected between 6-month KOOS symptoms and 12-month KOOS QOL scores ($\rho=0.53$, $p=0.02$).

Conclusions

This case series reveals that young athletes experience unique knee-related QOL trajectories in the first 12 months following an ACLR and that deficits in knee-related QOL still exist at 12 months. These findings highlight the individual and dynamic nature of QOL and the importance of considering QOL as an indicator of recovery in injured young athletes.

Background

Sport participation boasts numerous physical and psychological benefits for children and adolescents.[1] However, sport participation is also associated with increased risk of injury[2, 3] and accounts for 30% of

youth injuries requiring medical attention in Canada annually.[4] Notably, the incidence of sport-related anterior cruciate ligament (ACL) injuries in youth populations is on the rise.[5] An ACL injury is particularly concerning for young athletes with a systematic review concluding that only 62% (95%CI 51, 72) of individuals return to pre-injury sport and only 38% (95%CI 28, 50) return to competitive sport two years following ACL reconstruction (ACLR).[6] Beyond the short-term, young athletes who suffer traumatic knee injuries such as an ACL tear are at increased risk of long-term mobility impairment, physical inactivity, obesity, osteoarthritis, and poor health-related quality of life (QOL).[7, 8] These unfavourable outcomes have substantial long-term health implications and represent significant individual and societal burdens.

Assessing health-related QOL may provide important insight into the ACLR recovery process from the patient perspective. Health-related QOL describes an individual's perception of the physical, psychological, and social domains of their overall health.[9] Similarly, knee-related QOL pertains to these same domains but in the context of knee health and function. Both health- and knee-related QOL may represent more comprehensive indicators of successful recovery following a sport-related ACL injury than the more commonly cited return to sport (RTS),[6, 10, 11] given that not everyone chooses or is able to return to their preferred sport. With previous evidence demonstrating a reduction in health- and knee-related QOL up to 20 years following an ACL injury,[12–14] there is a need to understand when and why changes in QOL occur. A better understanding of modifiable factors that may be negatively influence the physical, psychological, and social domains of health could inform treatment strategies aimed at optimizing recovery and QOL after an ACL injury.

To date, preliminary evidence has suggested that knee symptoms and physical activity (physical domain), fear of re-injury and kinesiophobia (psychological domain), and RTS (social domain) may be important considerations for health-related QOL after a sport-related ACLR. Specifically, there is evidence that persistent knee symptoms are negatively associated with knee-related QOL after traumatic knee injury.[8, 15, 16] Youth and young adults with a previous knee injury exhibited more self-reported symptoms and poorer knee-related QOL compared to uninjured age-, sex-, and sport-matched controls.[15] Conversely, it is hypothesized that regular moderate-to-vigorous-intensity physical activity (MVPA) has a positive influence on health-related QOL through its extensive physical and psychological health benefits.[1, 17–21] Specific to children and adolescents, MVPA is positively associated with self-esteem, mental health, and cognitive functioning.[22]

Although the measurement of psychological and social outcomes following ACL injury has gained increasing traction in recent years,[23–26] there is limited knowledge about their association with health- or knee-related QOL in young athletes that suffer an ACL injury. A recent qualitative study, highlights that young athletes perceive more psychological than physical barriers to RTS following ACLR, including fear of re-injury, lack of motivation, and restlessness due to inactivity.[27] Fear of re-injury and kinesiophobia (an excessive, irrational, and debilitating fear of physical movement and activity resulting from a feeling of vulnerability to painful injury or re-injury[28]) are the most commonly cited reasons for ceasing sport participation after ACLR.[24, 25] There is preliminary evidence that self-reported kinesiophobia is negatively associated with knee-related QOL.[24] Similar to physical activity, RTS has been shown to be

positively associated with knee-related QOL,[29] despite evidence that not all individuals with satisfactory QOL actually RTS.[30, 31] Similar to knee symptoms, physical activity, and kinesiophobia, the relationship between RTS and health- and knee-related QOL is complex and not well understood.

The objective of this case series is to describe changes in knee-related QOL over the first 12 months following ACLR in young athletes. Secondary objectives are to describe changes in self-reported knee symptoms, average daily MVPA, self-reported kinesiophobia, and RTS over this same time period and explore associations between these factors at 6-months post-ACLR with self-reported knee-related QOL at 12 months post-ACLR.

Methods

This case series consists of 20 participants aged 15–20 years who were prospectively followed every three months from baseline (pre-ACLR) to 12 months after ACLR. Participants were assessed at the multidisciplinary (physical therapist, sports and exercise medicine physician, and orthopedic surgeon) acute knee injury clinic at a university-based sports medicine clinic between August 2015 and November 2016. Participants were eligible for study inclusion if they sustained a first-time, full-thickness ACL rupture (arthroscopic confirmation) while playing sport (Cincinnati Sports Activity Scale Level I or II[32]); elected to undergo ACLR; and expressed a desire to RTS. Exclusion criteria included: previous ipsilateral or contralateral ACLR, concomitant knee ligament damage requiring surgery, complications requiring further surgery within 3-months of ACLR, and inability to speak or read English. Ethics approval was granted by the University of Alberta Health Research Ethics Board, Health Panel, Edmonton, Canada (Ethics ID Pro00044385_AME3) and written consent and assent (when applicable) was obtained for all participants prior to testing.

Data Collection

Data were collected at baseline (after orthopedic surgeon consultation and before ACLR) and at 3, 6, 9, and 12 months following ACLR. At each data collection visit, participants underwent anthropometric measurements [height to the nearest 0.1 cm without shoes and weight to the nearest 0.1 kg using a medical scale and stadiometer (Model 402KL, Pelstar, USA)]; completed a series of questionnaires; and were provided with an activity monitor (ActiGraph GT3X, Pensacola, Florida, USA).

A self-designed study questionnaire was used to collect participant characteristics including demographic information (e.g., age, sex) and knee injury details (e.g., type of injury, mechanism of injury, injury date, surgery date; see Additional File 1).

The Knee injury and Osteoarthritis Outcome Score (KOOS) was used to evaluate self-reported knee symptoms and function.[33] The KOOS consists of five subscales: symptoms, pain, function in daily living (ADL), function in sport and recreation (SR), and knee-related QOL. Subscale scores range from 0 to 100 where higher scores indicate better outcomes. The KOOS demonstrates acceptable internal consistency (pooled Cronbach's alpha 0.72–0.93) and test-retest reliability (pooled intraclass correlation

coefficient 0.84–0.89) in ACL injured populations.[16, 33, 34] Ingelsrud et al (2018)[35] estimated a minimal clinically important difference (MCID) in a sample of persons undergoing an ACLR at -1.2, 2.5, 2.4, 12.1, and 18.3 for the symptoms, pain, ADL, SR, and knee-related QOL subscales, respectively.

Physical activity was measured with the ActiGraph GT3X, a tri-axial accelerometer. Participants were instructed to wear the ActiGraph on the right side of their waist for eight days, only removing it for bathing or water activities (e.g., swimming). Non-wear time was recorded on a monitor log and ActiGraph data were cross-referenced with the log to ensure it was worn properly. Non-wear period algorithms were determined by Choi et al (2011).[36] Evenson Children (2008)[37] and Troiano Adult (2008)[38] cut points were used to analyze physical activity for participants < 18 years and participants ≥18 years at baseline, respectively. Data was considered acceptable if it contained a minimum of five days with at least 10 hours of wear-time per day.[38, 39] Participants who did not have acceptable ActiGraph data were removed from the analysis. The ActiGraph is a valid measure of physical activity in youth populations.[40]

The Tampa Scale for Kinesiophobia (TSK) was used to assess self-reported kinesiophobia.[41] TSK scores range from 17 to 68 where lower scores indicate less fear of movement. The TSK is commonly used after ACL injury to evaluate kinesiophobia.[24, 42, 43]

The Return to Sport following ACLR: Sports Participation Questionnaire captures pre-injury sport information, including main sport, participation level, and RTS status.[44] For this study, RTS was defined as return to pre-injury main sport training or competition. Sport participation level was categorized into six classifications: recreational (done for enjoyment with minimal organization and training), club (competitive with organized training and competition schedule), school (selected to represent a junior high or high school), varsity (selected to represent a university or college), provincial (selected to represent a province), and national (selected to represent a nation). This questionnaire has acceptable known-groups validity.[44]

Data Analysis

All statistical analyses were performed using STATA (v14.2, College Station, Texas, United States of America). Descriptive statistics [mean or proportion (95% CI) and median (range) as appropriate] were calculated for all participant characteristics and outcomes at every time point. Outcomes were assessed at 3, 6, 9, and 12 months as these time points corresponded with orthopaedic surgeon follow-up visits. Furthermore, we compared 12-month KOOS QOL scores to the clinically relevant references because this time point often marks the completion of ACLR rehabilitation and RTS.[45] These comparisons include the KOOS QOL subscale MCID,[35] patient acceptable symptoms state,[46] treatment failure,[46] and normative values[47] (see Additional File 2) Specifically, exceeding the patient acceptable symptoms state cut-off of 72 points on the KOOS QOL indicates that an individual perceives their knee-related QOL as acceptable whereas falling below the treatment failure cut-off of 24 points indicates that an individual considers their treatment to have failed.[46]

Spearman's rank correlation coefficient (ρ) was used to explore the associations between KOOS symptom subscale score, average daily MVPA, and TSK score at 6-months, and KOOS QOL subscale score at 12 months post-ACLR (α = 0.05). We chose to explore these relationships at 6-months given that this typically marks the halfway point of ACLR rehabilitation. A better understanding of these factors at this time point and how they may be associated with knee-related QOL at 12-months would provide an opportunity to proactively modify treatment if required. Return to sport was only examined descriptively as a factor that may be related to knee-related QOL at the 12-month mark as few individuals are expected to resume sport participation prior to this time. The strength of association was interpreted as no relationship (0.00-0.25), fair (0.26–0.50), moderate (0.51–0.75), and excellent (0.76-1.00).[48] If participants did not contribute data at a specific follow-up their data were removed from analyses for that time point (Fig. 1).

Results

The mean baseline age of participants was 18.1 years (95%CI 15.1, 20.5), 70% (n = 14) were female, and the median body mass index was 23.3 kg/m^2 (range 19.1–32.4; Table 1). Thirteen participants (65%) reported a non-contact mechanism of injury and 17 (85%) sustained concomitant meniscal injuries (arthroscopic confirmation). Soccer was the most common pre-injury sport (n = 8) followed by basketball (n = 3), ice hockey (n = 3), wrestling (n = 2), handball (n = 1), rugby (n = 1), skiing (n = 1), and swimming (n = 1). Two participants classified their sport participation as recreational, three as school, five as club, four as varsity, five as provincial, and one as national. The median number of days from injury to baseline was 167 (range 78-1178).

Table 1. Participant Characteristics at Baseline

Characteristic	Description (n=20)
Sex (% female)	70 (45, 87)
Age (years; mean±SD, 95%CI)	18.1±1.8 (15.1, 20.5)
BMI (kg/m^2; median, range)	23.3 (19.1-32.4)
Injury mechanism (% non-contact)	65 (40, 84)
Concomitant meniscus injury (% yes)	85 (60, 96)
Main sport (% soccer)	40 (20, 64)
Main sport participation level (% club)	25 (10, 50)
Days from injury to baseline (median, range)	167 (78-1178)

Values represent proportion and exact 95%CI unless otherwise noted.

ACLR = anterior cruciate ligament reconstruction; BMI = body mass index; kg = kilogram; m = metre; SD = standard deviation; 95%CI = 95% confidence interval

Across KOOS subscales, the KOOS QOL subscale was consistently scored the lowest at every follow-up (Table 2). There was considerable individual variability in KOOS QOL subscale scores throughout the study period with two participants recording a maximum score of 100 and one participant recording a score of 6 at the 12-month follow-up (Figure 2). Despite the group median KOOS QOL score improving from baseline to 12 months post-ACLR, not all participants reported improvements over the study period. Thirteen participants (65%) demonstrated clinically relevant KOOS QOL improvements from baseline to 12-month follow-up that exceeded the MCID. Of the remaining seven participants (35%), one reported no change in KOOS QOL score and two reported worsening scores. When comparing 12-month KOOS QOL scores to the acceptable symptoms state and treatment failure cut-offs, seven (35%) participants were considered to have acceptable knee-related QOL whereas one participant (5%) was considered to have failed treatment (Figure 3). Three females and one male participant exceeded sex-specific normative values.

Table 2. KOOS, MVPA, TSK, and RTS Values for Each Testing Time Point.

	Baseline	3-month	6-month	9-month	12-month
KOOS Symptoms	71 (39-100)	64 (14-100)	75 (50-96)	71 (29-100)	80 (36-100)
KOOS Pain	81 (61-100)	81 (67-100)	89 (67-100)	89 (64-100)	93 (67-100)
KOOS ADL	95 (68-100)	94 (82-100)	99 (84-100)	96 (87-100)	100 (93-100)
KOOS Sport	60 (20-100)	60 (20-90)	75 (15-100)	75 (40-100)	90 (30-100)
KOOS QOL	31 (13-63)	34 (0-81)	50 (0-81)	44 (0-100)	53 (6-100)
MVPA (minutes)	48 (27-137)	40 (20-135)	51 (25-135)	53 (34-102)	53 (19-131)
TSK	41 (33-48)	42 (33-49)	37 (30-46)	37 (26-45)	38 (30-47)
RTS (% yes; 95%CI)	10 (2, 36)	11 (2, 39)	32 (14, 57)	58 (34, 79)	70 (45, 87)

Values represent median (range) unless otherwise noted.

ADL = activities of daily living function; KOOS = Knee injury and Osteoarthritis Outcome Score; MVPA = average daily moderate-to-vigorous physical activity; QOL = knee-related quality of life; RTS = return to sport; TSK = Tampa Scale of Kinesiophobia; 95%CI = 95% confidence interval

Similar to the KOOS QOL subscale, there was a large individual variability in KOOS symptoms scores observed over the study period (Table 2). Eighteen participants (90%) demonstrated improvements in KOOS symptoms from baseline to 12 months that exceeded the MCID (see Additional File 3). When examining MVPA over the study period, median minutes of average daily MVPA were greater at 12 months than baseline (Table 2). Eight participants (40%) recorded more minutes of MVPA and six participants (30%) recorded less MVPA at the 12-month mark when compared to baseline (see Additional File 4). Six participants (30%) were excluded from the individual physical activity trends for incomplete or missing data at baseline (n=2) or 12 months (n=4). The median TSK score showed little change from baseline to 12-month post-ACLR (Table 2). Thirteen participants (65%) indicated having less kinesiophobia at 12 months compared to baseline, one (5%) reported no change, and six (30%) reported greater kinesiophobia (see Additional File 5). Fourteen participants (70%) had resumed training or competition 12 months following ACLR in their pre-injury sport, which included soccer (n=5), ice hockey (n=3), basketball (n=2), wrestling (n=2), rugby (n=1), and swimming (n=1). Of those who successfully RTS, six participants exceeded the patient acceptable symptoms state cut-off with their 12-month KOOS QOL scores whereas eight did not. Of those participants who did not RTS, one exceeded the patient acceptable symptoms state cut-off and five did not.

On exploratory analyses, we found no evidence of an association between 6-month average daily minutes of MVPA and 12-month KOOS QOL subscale score (r=-0.09, p=0.73) or 6-month TSK score and 12-month KOOS QOL subscale score (r=-0.40, p=0.10). However, a moderate association[48] between 6-month KOOS symptoms subscale and 12-month KOOS QOL subscale scores (r=0.53, p=0.02) was detected.

Discussion

This case series reveals considerable individual variability in self-reported knee-related QOL in young athletes over the 12 months following ACLR. More interestingly, our findings demonstrate that knee-related QOL of young athletes who undergo a sport-related ACLR does not always reach an acceptable symptoms state or normative values by 12 months. From an exploratory perspective, we provide preliminary evidence that 6-month knee symptoms may be related to 12-month knee-related QOL. These observations highlight the importance of assessing knee-related QOL to understand recovery from the perspective of the patient.

Given the paucity of knowledge in this area, a case series design allowed us to explore and subsequently reveal the unique knee-related QOL trajectory that individual patients experience in response to ACL injury and ACLR. As demonstrated in Fig. 2, the trajectory of knee-related QOL of the participants was highly variable with many experiencing fluctuations over the 12 months following ACLR. This dynamic trajectory emphasizes the complex and multidimensional nature of knee-related QOL. At any given time during rehabilitation, there are many physical (e.g., symptoms, activity, pain), psychological (e.g., fear of movement or re-injury, knee confidence), or social (e.g., isolation from sporting community, frustration

and anxiety with RTS) factors that may result in improvements or deteriorations in the health- and knee-related QOL of young athletes.

Many of the participants in this case series did not consider their knee-related QOL as acceptable at 12 months following ACLR suggesting that young athletes can have deficits in knee-related QOL at what is typically considered the end of the rehabilitation period. This is congruent with the findings of other studies of similar cohorts following ACLR, including young American military students (mean KOOS QOL score 68.00 ± 20.51)[49] and young Swedish patients (mean KOOS QOL score 60.0 ± 23.7).[50] Furthermore, there is evidence to suggest that young female athletes exhibit deficits in health-related QOL after suffering a knee injury.[14, 51] Combined with previous evidence, our findings suggest that clinicians should regularly monitor health- and knee-related QOL throughout rehabilitation and adjust their treatment approach if they detect any deteriorations in QOL.

Previous reports have lead us to believe that individuals who successfully RTS after ACLR would report favourable health- and knee-related QOL whereas those who fail to RTS would report poor QOL.[29] However, this case series provides preliminary evidence of a discrepancy between successful RTS and reporting acceptable knee-related QOL which challenges this assumption. This discrepancy suggests that some participants remained unsatisfied with their knee-related QOL, regardless of returning to their main sport. It is possible that these individuals continue to experience issues with their knee function or have not yet achieved return to performance[52] despite resuming training or competitive play. Lifestyle adjustments and activity modification has been theorized to contribute to improved knee-related QOL in ACLR patients 5–16 years following surgery[12] and could be an option to discuss with individuals who report QOL deficits but wish to participate in sports. This apparent mismatch between successful RTS and acceptable knee-related QOL displayed by some young athletes following ACLR emphasizes the importance of addressing QOL on an individual basis while facilitating safe RTS during rehabilitation.

There is limited research examining factors that are associated with health- or knee-related QOL in young athletes with a sport-related ACL injury beyond RTS. Our exploratory analyses provide preliminary evidence that fewer knee symptoms (e.g., swelling, stiffness, and clicking) at 6 months may be associated with higher knee-related QOL at 12 months. One possible explanation for this finding is that participants who have fewer symptoms at the 6-month mark progress through rehabilitation with fewer setbacks than those with persistent symptoms.

Although previous research has reported a relationship between exercise and health-related QOL,[1, 17, 19–21] our exploratory analyses did not find evidence of an association between 6-month MVPA or kinesiophobia and 12-month knee-related QOL. This is likely due to a lack of statistical power. Despite the lack of association, exercise modification based on recovery stage and patient preference remains important for young athletes to ensure that they meet recommended physical activity levels throughout ACLR rehabilitation. Additionally, there is growing evidence that fear of movement and re-injury hinders physical function and restricts sport participation.[24, 25, 53] Kinesiophobia could be regarded as a negative factor influencing knee-related QOL if individuals with heightened fear of movement progress

slowly through rehabilitation and experience delays in RTS. Future investigations should continue to assess the association between self-reported knee symptoms, physical activity, and self-reported kinesiophobia with health- and knee-related QOL to inform treatment strategies aimed at optimizing QOL following ACLR in young athletes.

Strengths and Limitations

Unlike previous studies which use RTS as the primary outcome of successful recovery after ACLR,[6, 10, 11] this case series provides an intriguing argument for an equally important target: acceptable knee-related QOL. By employing frequent three-month testing, this novel case series demonstrates the unique and dynamic trajectory of knee-related QOL that young athletes may experience over the first year following ACLR. To the best of our knowledge, this case series is one of the first studies to explore physical and psychological factors that may be associated with knee-related QOL in young athletes who have undergone ACLR. It is important to understand the changes in knee-related QOL in order to generate strategies to combat any associated physical, psychological, environmental, and social deficits.

As with any case series, the limited convenience sample is associated with a high possibility of selection bias and type 1 error. Given that all our participants came from one university-based sports medicine clinic in an urban Canadian city, it is unlikely that our findings are generalizable to all young athletes who undergo ACLR. The exploratory analyses of the association between knee symptoms, kinesiophobia, and MPVA at 6-months and knee-related QOL at 12 months was not adequately powered and should be interpreted with caution. Specifically, it is possible that the association identified between 6-months KOOS symptoms and 12 months KOOS QOL subscale scores may be due to a type I error (false positive), another variable (e.g., amount and quality of rehabilitation), or the previous observation that the KOOS symptoms and KOOS QOL subscales are moderately correlated.[15, 16] Lastly, it is important to highlight that the four items contained in the KOOS QOL subscale likely do not capture the breadth and complexity of knee-related QOL. Future investigations should consider including additional instruments to further assess knee-related QOL (e.g., Anterior Cruciate Ligament-Quality of Life questionnaire) and health-related QOL (e.g., Youth Quality of Life instrument) to provide a more complete understanding of QOL in youth populations.[54–56]

Future Directions

There is a paucity of research examining health- and knee-related QOL and its determinants in young athletes in the first 12 months following ACLR. Research should continue to evaluate both health- and knee-related QOL in this population with a more rigorous study design, appropriate sample size and comprehensive measures of health- and knee-related QOL. Additional factors should be examined in attempt to identify determinants of youth QOL (e.g., sex, pre-operative rehabilitation, concomitant injuries, knee confidence, social support). A richer understanding of QOL and what factors might influence it can contribute to tailored interventions that optimize both short- and long-term QOL in young athletes.

Conclusions

This study provides preliminary evidence that each young athlete's self-reported knee-related QOL is highly unique following ACLR. By identifying that some young athletes fail to demonstrate clinically relevant improvements in knee-related QOL or reach patient acceptable symptom states by 12 months, this study highlights the importance of considering QOL as a primary outcome after ACLR in addition to more common indicators of success, such as RTS. Future studies are needed to identify determinants of health- and knee-related QOL in young athletes following ACLR in order to develop strategies to improve short- and long-term QOL.

List Of Abbreviations

ACL: Anterior cruciate ligament

ACLR: Anterior cruciate ligament reconstruction

ADL: Activity of daily living function

KOOS: Knee injury and Osteoarthritis Outcome Score

MCID: Minimal clinically important difference

MVPA: Moderate-to-vigorous physical activity

n: Number of participants

QOL: Quality of life

RTS: Return to sport

TSK: Tampa Scale for Kinesiophobia

95%CI: 95% confidence interval

Declarations

Ethics Approval and Consent to Participate

Ethics approval was granted by the University of Alberta Health Research Ethics Board, Health Panel, Edmonton, Canada (Ethics ID Pro00044385_AME3) and written consent was obtained for all participants prior to testing. For participants under the age of 18 years, we obtained their assent and their parent or legal guardian's consent prior to testing in written form.

Consent for Publication

Not applicable.

Availability of Data and Materials

The dataset used and analysed for the current study are stored in the University of Alberta REDCap online database (https://redcap.med.ualberta.ca) and are available from the corresponding author on reasonable request.

Competing Interests

C.A. Emery holds a Chair in Pediatric Rehabilitation funded by the Alberta Children's Hospital Foundation. All other authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article. The sponsors had no involvement with respect to study design, data collection and analysis, decision to publish, or preparation of the manuscript. The results of the study are presented honestly and without fabrication, falsification, or inappropriate data manipulation.

Funding

Y. Le is partially supported by a Canadian MSK Rehab Research Network (CIHR FRN: CFI-148081) 2017 Trainee Award. This case series is embedded within a larger prospective cohort study funded by an Arthritis Society Young Investigator Operating Grant (Whittaker, YIO-16-379). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Authors' Contributions

CYL developed the research question and statistical analysis plan, scheduled and performed data collection, managed and analyzed data, and prepared and submitted the manuscript. CH developed the study design, obtained ethics, reviewed the statistical analysis plan, and reviewed the manuscript. CAE and PJM helped to develop the statistical analysis plan, oversaw data analysis, and reviewed the manuscript. JLW developed the study design, obtained ethics, developed the statistical analysis plan, oversaw data analysis, and reviewed the manuscript.

Acknowledgements

The authors would like to acknowledge the assistance of research coordinators Hilary Short and Dr. Luciana Macedo who contributed to the initial study set-up and data collection. Numerous Glen Sather Sports Medicine Clinic clinicians and administrative staff also helped with participant recruitment, scheduling, and data collection, including: Dr. Roxanne Chow, Dr. David Otto, Nicholas MacLeod, Declan Norris, Linda Truong, Stephanie Metcalfe, Jennifer Miller, Tiffany Backstrom, Leslie McIntyre, and Monika Viktorova.

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Figures

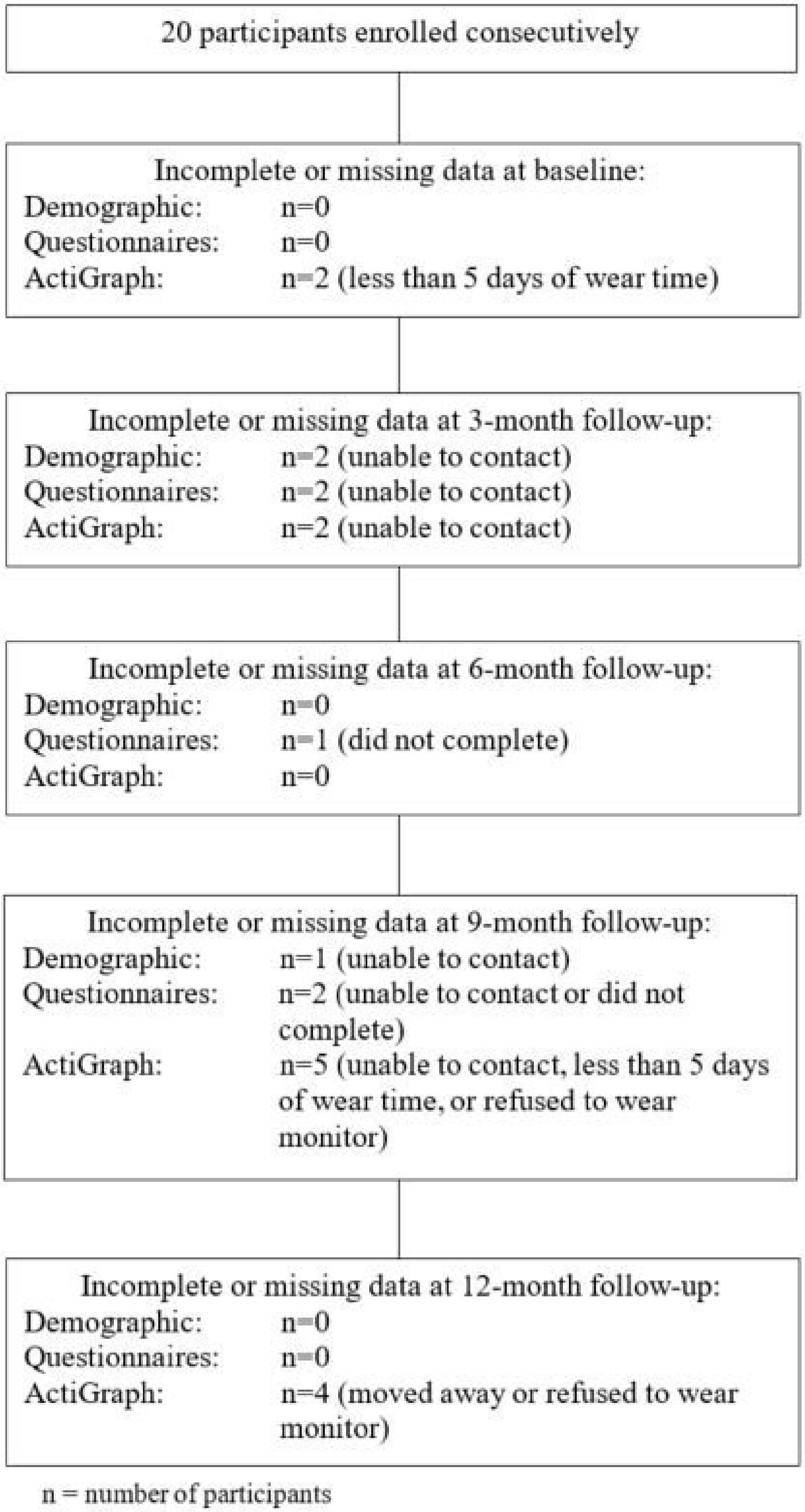

Figure 1

Participant Flow Chart.

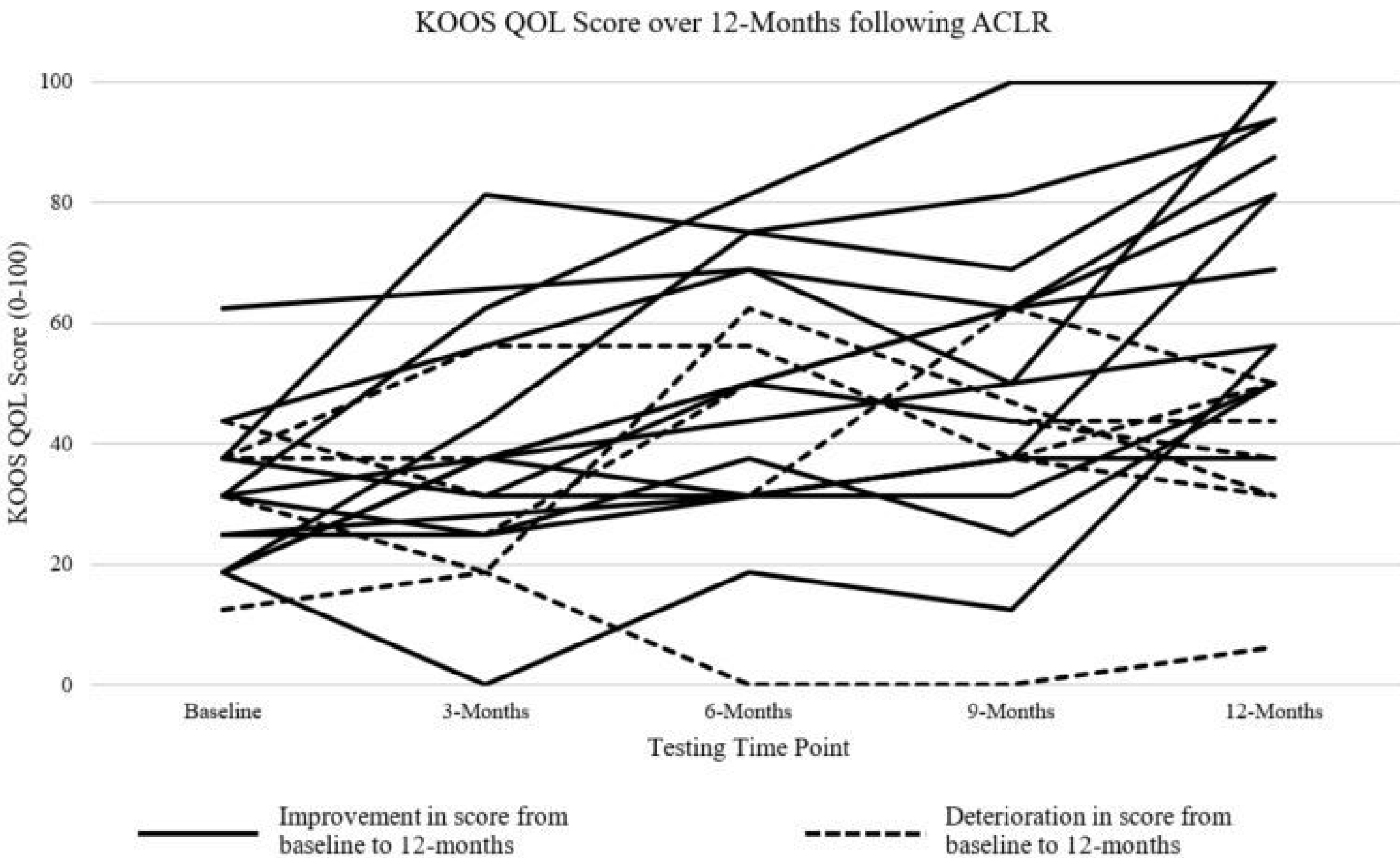

Figure 2

Individual changes in KOOS QOL subscale score. Eighteen participants reported scores that improved from baseline to 12-month follow-up with 15 of these participants exceeding clinically important improvements. Two participants reported scores that deteriorated from baseline to 12-months with none exceeding clinically important deteriorations.

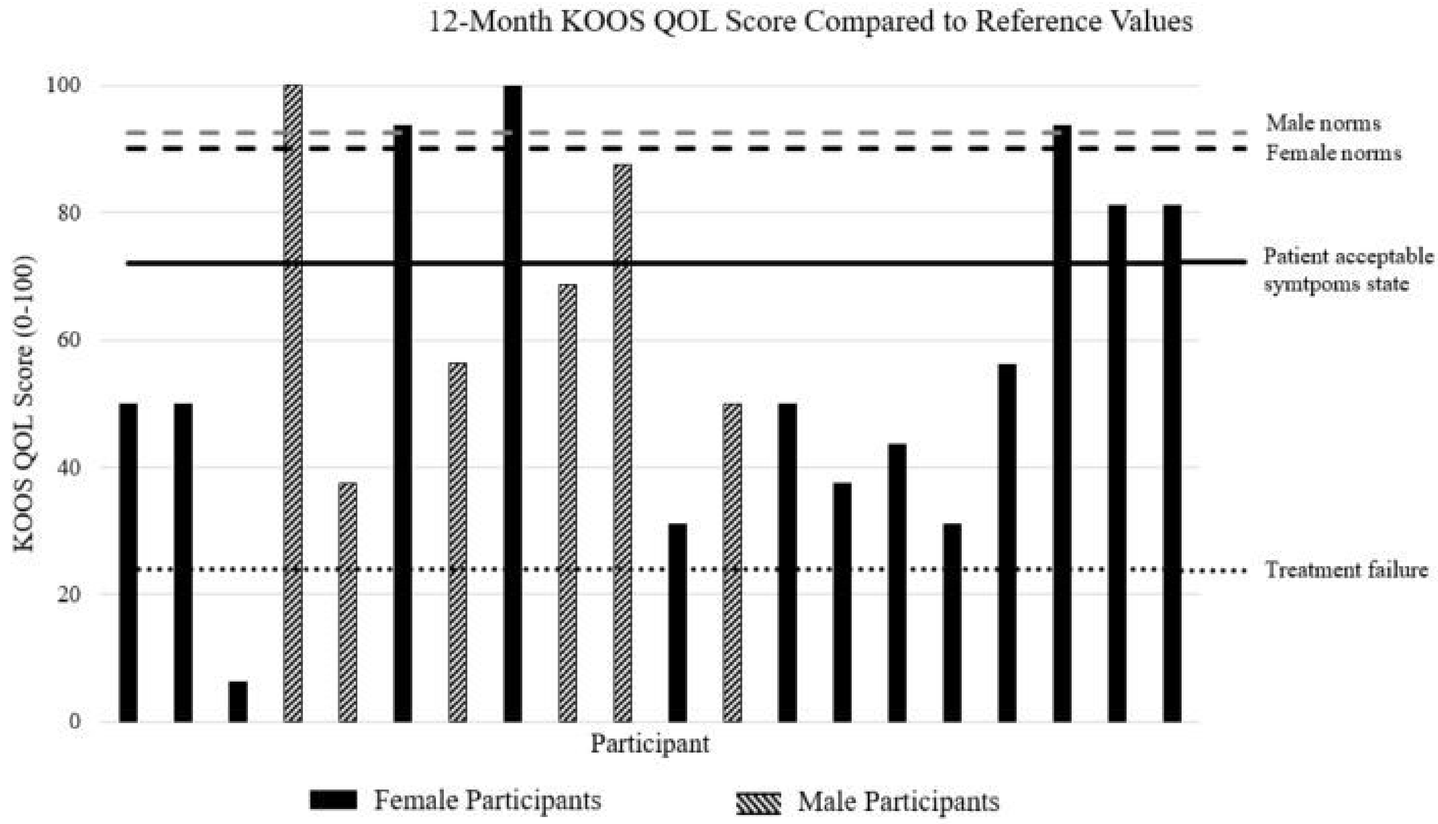

Figure 3

KOOS QOL subscale scores at 12 months following ACLR. Each individual participant score is displayed in comparison to the patient acceptable symptoms state, treatment failure, and sex-specific normative values for the KOOS QOL subscale.

Supplementary Files

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