



QUIT: Quadriceps Inhibition Trends after knee arthroplasty

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Abstract

This study investigates quadriceps inhibition trends after total knee arthroplasty (TKA). Eighteen patients undertook perioperative physiotherapy using Slider[®], a Class I medical device that measures forces and knee motion. Slider[®] monitors and uses gamification to encourage users to do knee exercises at home while displaying the results on their tablet. The results are sent securely to their clinician with exception notification. Perioperative changes in the straight leg raise (SLR), inner range quadriceps (IRQ), and knee flexion lying (KFL) exercises were analyzed. After starting Slider[®] two patients declined surgery because their knee pain had decreased, two moved away, two were cancelled for medical reasons, and twelve had TKA. Two patients developed infections and abnormal trends in the results of the knee exercises were detected by the Slider[®] algorithm before the patients' clinic appointments. The curves of perioperative results of patients who had no infection were J-shaped (concave) postoperatively, while those of the patients with infections were m-shaped (double-convex). These objective findings are consistent with clinical experience of quadriceps inhibition occurring due to fluid accumulation following infection. In the infected patients, Slider[®]'s algorithm enabled timely alerts to the patients' clinics and early intervention. One had a successful washout, the other needed a revision. Larger studies on Slider[®] are needed to provide statistically significant characterization of anomalies to support clinical decisions.

1 Introduction

Knee osteoarthritis (KOA) is a prevalent condition that severely impacts patients' mobility and quality of life, requiring effective and accessible physiotherapy interventions (Tore et al., 2023). The recent shift towards remote rehabilitation solutions, accelerated by decreased staffing levels and the COVID-19 pandemic, has necessitated the development of innovative approaches to patient care (Lebleu et al., 2023).

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Complications following knee arthroplasty are best diagnosed and treated early to optimize the chance of a full recovery. Telemedicine and early discharge necessitate prompt notification to the clinician of complications should they arise after discharge. Slider[®] is a class 1 medical device that monitors without direct contact with the skin of the leg. It addresses the challenges faced by other digital and wearable telemedicine physiotherapy methods by offering a more inclusive and accessible solution for patients.

Quadriceps inhibition occurs when there is fluid and pain in the knee (Fahrer et al., 1988). This is normal after knee arthroplasty, but also occurs after an infection causing pain and reduction in the straight leg raise (SLR) and inner range quadriceps (IRQ) exercises.

This paper describes differences in the SLR between infected and a typical non-infected knee.

1.1 Device Overview

Slider[®] (*Figure 1*) is a remote physiotherapy tool, designed for patients suffering from KOA. Slider[®] employs a force plate and motion sensors to accurately measure muscle forces and the motion of the knee. Algorithms provide assessments of knee flexion angles, muscular strength, and exercise frequency.

Slider[®] connects with its user-friendly tablet App via Bluetooth. The App's interface is designed to enhance patient engagement through gamification, offering an interactive and enjoyable experience for users. It provides detailed visualizations, charts, Patient Reported Outcome Measures (PROMs), and summaries, simplifying the interpretation of complex exercise data. This is particularly important for both patients and healthcare professionals as it allows for effective monitoring of treatment plans and facilitates informed decision-making.



Figure 1 - Slider measures force and tracks movements in all directions. It sends data to the user's tablet and to the clinician.

Slider[®] has been designed for ease of use and accessibility, making it suitable for patients with varying levels of technological proficiency, ensuring that the benefits of Slider[®] are widely accessible, particularly to older populations.

2 Methodology

The primary objectives of the study were to evaluate Slider[®]'s usability and effectiveness in meeting physiotherapy requirements. The study monitored the frequency and duration of Slider[®] usage, as well as the consistency of exercise routines followed by patients (to be reported elsewhere) This report describes Slider[®]'s potential capability in early detection of infections, a critical aspect of post-operative care.

Following ethical approval, questionnaires were mailed to 30 patients on the waiting list for TKA. The first eighteen were selected and after informed consent were enlisted in the study. They used Slider[®] as part of their physiotherapy regimen before and after knee arthroplasty.

3 Results

The study comprised ten females and eight males. After using Slider[®] two patients declined surgery because their knee pain had decreased. Two patients moved away and two were cancelled for medical reasons.

Of the twelve who had TKA, the statistics were as follows:

Mean Age = 70.4 years old, Standard Deviation (Age) = 7.6 years

Mean duration Slider[®] was used = 42.9 weeks, Standard Deviation (Usage) = 18.2 weeks

No significant relationship was found between age and the duration Slider® was used ($p=0.29$)

Two patients developed infections and the abnormal trends in their results for the knee exercises were detected by the Slider® algorithm before their clinic appointments. This allowed the patients to be seen earlier than would have otherwise happened.

The curves in the graphs of results can be described as follows (*Figure 2*):

Normal recovery: J-shaped SLR (concave)

Infection: m-shaped SLR (double convex)

The ability of Slider® to track and analyze physiotherapy data in real-time also played a crucial role in maintaining patient engagement and motivation throughout the study period.

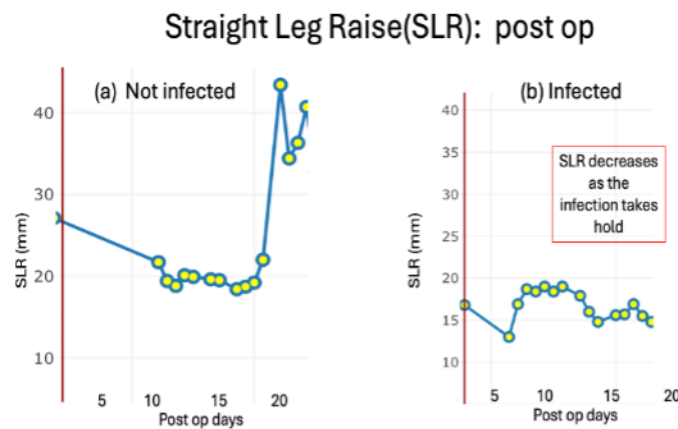


Figure 2 - Difference between the (a) non-infected and (b) an infected knee showing the changes in the SLR after TKA.

4 Discussion

Following TKA, quadriceps inhibition normally initially occurs due to the accumulation of intraarticular fluid, followed by absorption by about day five (Hurley et al., 1994). This results in the J-shaped SLR and IRQ Slider® curves for the non-infected patients.

However, infections typically become manifest 5-10 days post-operatively, producing a secondary accumulation of intraarticular fluid and further quadriceps inhibition. Infected patients presented m-shaped (double-convex) curves. This study demonstrated the ability of Slider® to remotely provide close monitoring of physiotherapy for patients after TKA and Slider®’s potential to provide early warning of an infection post TKA. However, a larger patient group would be required for validation.

5 Conclusion

Slider[®] represents a significant innovation in remote physiotherapy for KOA. Its ease of use, combined with its potential clinical capabilities in early infection detection and predictive analytics, position it as a potential asset in enhancing patient outcomes and optimizing healthcare resources.

References

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