

Association of COVID-19 Lockdown With Increased Rate of Cyclops Syndrome in Patients With Unexpected Home-Based Self-Guided Rehabilitation After ACL Reconstruction

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Background: The risk of cyclops syndrome increases significantly after anterior cruciate ligament (ACL) reconstruction (ACLR) if complete extension is not recovered before the sixth postoperative week. The lockdown in France due to the COVID-19 pandemic led to an absence of supervised rehabilitation, requiring unexpected self-rehabilitation in patients who underwent ACLR just before lockdown.

Purpose: To determine the rate of cyclops syndrome after ACLR in patients who underwent self-rehabilitation during lockdown.

Study Design: Cohort study; Level of evidence, 3.

Methods: A total of 75 patients receiving a hamstring graft for ACLR during the COVID-19 pandemic between February 10, 2022, and March 16, 2020, carried out self-rehabilitation during part of their first 6 postoperative weeks using exercise videos on a dedicated website. Clinical examination was performed at a minimum 1-year follow-up with International Knee Documentation Committee (IKDC), Lysholm, Tegner, and ACL-Return to Sport after Injury (ACL-RSI) scores. This group was compared with a matched-pair control group of 72 patients who underwent surgery in 2019 and completed postoperative supervised rehabilitation with a physical therapist. Rates and reasons for second surgery (arthrolysis, meniscal procedure) were also recorded.

Results: In the COVID group ($n = 72$; 3 patients were lost to follow-up), the mean follow-up was 14.5 ± 2.1 months (range, 13-21) and rate of reoperation for clinical cyclops syndrome was 11.1% ($n = 8$). The rate of cyclops syndrome was significantly lower (1.4%) in the control group ($P = .01$). In the COVID group, 8 patients underwent anterior arthrolysis at a mean of 8.6 months after the primary surgery, and 4 patients underwent another surgical intervention (meniscal procedure [$n = 3$], device removal [$n = 1$]). In the COVID group, mean Lysholm was 86.6 ± 14.1 (range, 38-100), Tegner was 5.6 ± 2.3 (range, 1-10), subjective IKDC was 80.3 ± 14.7 (range, 32-100) and ACL-RSI score was 77.3 ± 19.7 (range, 33-100).

Conclusion: The rate of cyclops syndrome after ACLR was significantly greater in the COVID group versus the matched controls. The dedicated website was not effective at supporting self-guided rehabilitation and could benefit from interactive improvements so it is at least as effective as supervised rehabilitation.

Keywords: ACL; COVID-19; cyclops syndrome; physical therapy; self-guided rehabilitation

Successful outcomes do not depend exclusively on the surgical procedure but also on a combination of preoperative and postoperative factors,¹³ including rehabilitation and personal involvement of the patients to allow full recovery of range of motion, muscle strength, and confidence before a return to sport.¹⁹ Physical therapy, with goals and exercises, is adapted to these different steps after anterior

cruciate ligament (ACL) reconstruction (ACLR) and can be performed by the patient alone (unsupervised home-based or self-guided rehabilitation) or with a physical therapist (physical therapy-supervised rehabilitation). The 2 approaches have been compared by studying range of motion, muscle strength, jump tests, and functional scores, but no difference was reported in the literature.^{4,15,16,18,24,28} If supervised rehabilitation is chosen, the number and frequency of visits is not strictly determined, but better outcomes may be correlated with a higher number of visits.⁵ There is also a debate about the need for

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patients to undertake self-guided or supervised rehabilitation due to the economic consequences.

As a supplementary tool to improve the results of rehabilitation and increase the autonomy of patients, websites have been developed by some surgeons outlining rehabilitation protocols. Mobile applications have also been developed.^{2,11}

In 2020, the world was confronted with the COVID-19 pandemic, which affected all aspects of life. Interpersonal, mobility, and working restrictions were put in place, leading to containment measures and lockdowns in many countries. These restrictions and increasing numbers of COVID-19 cases severely affected health care delivery to orthopaedic and trauma patients.³¹ Patients who underwent ACLR during 2020 could not receive the usual multidisciplinary postoperative protocol (ie, they had no supervised rehabilitation, no opportunity to access rehabilitation facilities, no postoperative in-person examinations); therefore, patients and surgeons had to adapt to the situation implemented by the government in France on March 16, 2020. This was especially true for patients who had undergone surgery just before lockdown.

The purpose of this study was to determine whether the COVID-19 pandemic situation with mandated lockdown measures and an unexpected switch to self-guided rehabilitation increased the rate of complications related to ACLR, in particular stiffness with flexion contracture. Our hypothesis was that the rate of lack of extension and cyclops syndrome would be higher in patients undergoing ACLR just before lockdown measures (COVID group) compared with patients who had ACLR outside the COVID-19 pandemic with supervised rehabilitation (control group).

METHODS

The study protocol was approved by an institutional review board, and each patient gave informed consent. This was a single-center, case-control study with a retrospective analysis of prospectively collected data with propensity matching at a ratio of 1:1. For the COVID group, the inclusion criteria were: primary reconstruction of the ACL using the hamstrings, between February 10, 2020, and March 16, 2020 (beginning of lockdown in France). Antero Lateral Ligament reconstruction was also performed depending on the patient's age, pivot shift, sport, and level of sport.^{10,29} Patients were operated on by 1 of the 2 surgeons involved in the study (N.B., N.G.) using the same surgical technique and for the same indications. All patients were included and followed prospectively. The exclusion criteria included a refusal to participate and multiligament knee injury.

For the control group, 72 patients were matched from a cohort of patients operated on for the same indications and using the same technique in 2019.

Matching Process

Patients who underwent surgery for primary ACLR between February 10, 2020, and March 16, 2020 (COVID group), were matched with a control group of patients who underwent the same surgery between February 10, 2019, and April 15, 2019 (control group). The patients were matched for sex, age ± 5 years, body mass index (BMI) ± 5 kg/m², and additional procedures (ALL and meniscal lesion during surgery). As 3 patients were lost to follow-up in the COVID group, a total of 72 patients in each group satisfied the inclusion criteria and were included in the analysis.

Surgical Technique

ACLR was performed using the hamstring (semitendinosus 4-strand autograft or gracilis plus semitendinosus technique) with a classic out-in technique for tibial tunnel and in-out technique through the anteromedial portal for the femoral tunnel. Fixation was performed using adjustable cortical devices on the femoral and tibial sides. Meniscal repair or meniscectomy was performed depending on the meniscal lesion on magnetic resonance imaging (MRI) and arthroscopic assessment. ALL was performed when necessary using the gracilis 2-strand technique with femoral fixation using a screw and tibial fixation using adjustable cortical fixation. The technique was the same in the 2 groups in 2019 and 2020.

Postoperative Care

Most patients in both groups (>95%) were treated as outpatients (patients living alone stayed in hospital for 1 night) and postoperative care consisted of full weightbearing depending on pain, ice, no brace, and anticoagulation treatment for 10 days. The rehabilitation program was scheduled to begin 4 to 5 days after surgery with the aim of full extension and bending the knee at 90° of flexion at 4 weeks. The rehabilitation program was not modified by meniscal or additional procedure with ACL reconstruction. There was a difference between the 2 groups in terms of rehabilitation. For the control group, rehabilitation with a physical therapist was planned preoperatively, rehabilitation exercises were explained by the surgeon just after surgery before the patient left the center, and the patient received a paper document outlining the rehabilitation exercises to perform. Patients were also asked

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TABLE 1
Demographic Characteristics and Additional Procedures for the COVID and Matched Control Groups^a

	COVID Group (n = 72)	Control Group (n = 72)	P
Age	28.1 ± 11 (13-59)	27.9 ± 11 (16-58)	.93
Male sex	43 (60)	43(60)	>.99
BMI	23.8 ± 3.7 (14-32)	23.3 ± 3.5 (18-38)	.98
Additional procedures			
Anterolateral ligament	30 (42)	28 (38)	.73
Meniscal lesion	43 (60)	49 (68)	.29

^aData are reported as mean ± SD (range) or n (%). BMI, body mass index.

preoperatively to visit a dedicated website with goals for each step before and after surgery, a video description of the different exercises, and number of repetitions to perform. The website was created in 2019 before the COVID pandemic and was used in our center in addition to classic physical therapist care. The rehabilitation program with a physical therapist was performed 2 or 3 times a week beginning in the home if necessary and continued in the physical therapist's clinic. Follow-up was performed in the clinic at 4 to 6 weeks, 3 months, 6 months, and 1 year by the referring surgeon.

For the COVID group, information was given by the surgeon on the day of the surgery about exercises and goals of rehabilitation but, as physical therapist care was not possible for a part of the first 6 weeks due to the lockdown, patients were contacted by phone during the first few days after lockdown, on March 17, 2020, to remind them about other tools available for their rehabilitation—namely, the website and paper documents. It was proposed to organize a teleconsultation via a video application if necessary to talk about the exercises and answer any questions. Follow-up was performed in a conference call between 4 and 6 weeks postsurgery to assess clinical symptoms, the ability to perform the exercises, and range of motion. The consultations at 3, 6, and 12 months postoperatively were performed at the clinic, as the lockdown had ended. Scores were measured at the final follow-up (International Knee Documentation Committee [IKDC], Lysholm, ACL–Return to Sport after Injury [ACL-RSI]). All patients had a minimum follow-up of 1 year. Functional scores were recorded only in the COVID group.

In the 2 groups, and according to our protocol, in the case of an uncomfortable lack of extension at 6 months, an MRI analysis was performed to look for evidence of cyclops syndrome, and anterior arthrolysis (excision of the cyclops lesion) was proposed to the patient. This was the main evaluation criterion in the study. Secondary evaluation criteria were functional scores.

Statistical Analysis

The data were summarized using descriptive statistics. Continuous variables were reported as means and standard deviations, and categorical variables were reported as total number and percentage. The chi-square and Fisher exact

tests were used to analyze differences between categorical variables, and the Mann-Whitney *U* test and Student *t* test were used for continuous variables. A Shapiro-Wilk test was performed to ensure continuous variables were normally distributed ($P > .05$). The fragility index and Cohen effect size were calculated for the primary outcome measure (cyclops lesion). All analyses were performed using IBM SPSS software for Windows 10 (Version 27).

RESULTS

In the COVID group (40% female, 60% male patients), the mean follow-up was 14.5 ± 2.1 months (range, 13-21), mean age at surgery was 28.1 ± 11 years (range, 13-59), mean BMI was 23.8 ± 4 kg/m² (range, 14-32), and mean time between injury and surgery was 6.1 months (Table 1). For the medial meniscus, there were 28 repairs and 6 meniscectomies. For the lateral meniscus, there were 11 repairs and 8 meniscectomies.

At the end of follow-up, mean subjective IKDC was 80.3 ± 14.7 (range, 32-100), mean Lysholm was 86.6 ± 14.1 (range, 38-100), mean Tegner score was 5.6 ± 2.3 (range, 1-10), and mean ACL-RSI was 77.3 ± 19.7 (range, 33-100).

The rate of anterior arthrolysis due to the lack of extension was 11.1% (95% CI, 4% to 19%) (8 of 72 patients) in the COVID group versus 1.4% (95% CI, -1% to 4%) (1 of 72) in the control group ($P = .01$). The fragility index was calculated at 1, and the Cohen effect size was 0.43. For the 8 patients who had a second surgery for anterior arthrolysis in the COVID group, the mean time between primary surgery and anterior arthrolysis was 8.6 ± 2.6 months. There were 3 women and 5 men, mean age was 31.4 ± 13 years (range, 15-47), and mean BMI was 23.9 ± 4 kg/m² (range, 20-32). Of the 8 patients, 2 had combined ACL-ALL reconstruction and 5 had a meniscal procedure (medial meniscal repair [n = 2], medial and lateral meniscal repair [n = 2], and medial meniscal repair and lateral meniscectomy [n = 1]). The mean time between injury and surgery was 5.2 ± 9.7 months (range, 0-50) in the COVID group and 5.7 ± 9.8 months (range, 0-52) with no difference between groups ($P = .79$). At 3 months after anterior arthrolysis, all 8 patients had achieved full recovery and comfortable extension. In the COVID group, 4 patients underwent another surgical intervention (meniscal procedure [n = 3], device removal [n = 1]).

DISCUSSION

The results of this study showed that cyclops syndrome was more frequent in patients who underwent ACLR just before the COVID-19 lockdown in 2020 and performed self-guided rehabilitation than in patients operated on in 2019 who underwent supervised rehabilitation (11.1% vs 1.4%, respectively; $P = .01$). This corroborates our hypothesis that stiffness complications with lack of extension would be higher during the COVID-19 lockdown, requiring significantly more surgical reinterventions.

Although the functional results are generally good, allowing patients to return to sport, ACLR is not free from complications. In 38% of patients, complications relate to a loss of motion.³⁵ One of the possible causes of loss of motion is cyclops syndrome. Its name comes from the Greek “*kyklops*,” meaning “round-eyed,” describing its appearance on MRI scans, and its pathogenesis remains unclear. Cyclops syndrome consists of symptomatic nodular fibrovascular tissue interposed in the intercondylar notch. Patients experience a loss of extension with snapping and catching while walking.³⁰ A loss of $<5^\circ$ of knee extension can contribute to ongoing patellofemoral pain and quadriceps weakness. Knee extension loss of motion can also result in an abnormal bent-knee gait, which can affect running and alter gait mechanics.⁸ The incidence of cyclops syndrome has been reported to range from 1% to 10% of all ACLRs, whereas MRI studies have reported an incidence of 25% to 47% for asymptomatic cyclops lesions.²⁰ The diagnosis is based on clinical examination, symptoms, and MRI findings. Some risk factors for the development of this syndrome have been identified: female sex, because of the presence of a narrow notch; increased graft volume in relation to notch size; bony avulsion of the ACL; anterior placement of the tibial tunnel; double-bundle ACLR because of high graft volume; and hamstring contracture.²⁰

The period to include patients in the COVID group was chosen so that they had at least 1 day within the 6 weeks before lockdown, which started on March 17, 2020 (lockdown lasted 7 weeks after March 17, 2020). The first 6 weeks postsurgery are the most important to recover full extension to prevent cyclops syndrome.²⁶ Delaloye et al⁶ reported that the risk of cyclops syndrome was increased 8-fold in the case of an extension deficit at 6 weeks. Stiffness during the first weeks postoperatively was confirmed by Noailles et al.²³ Pinto et al²⁶ also reported that hamstring spasm 3 to 6 weeks after surgery was a risk factor for cyclops syndrome. Hamstring spasm was present in 58% of the 45 patients who required revision surgery for cyclops syndrome compared with only 24% of the controls. Delaloye et al⁶ studied the risk factors for reoperation due to cyclops syndrome in a group of 3633 patients. A total of 1.8% of patients underwent reoperation for cyclops syndrome, which was close to the rate reoperation in our control group that underwent surgery in 2019 (1.4%). At the final postoperative follow-up, clinical evaluation was important as some patients were uncomfortable with cyclops syndrome and required a second operation for recovery of full extension. The gold standard treatment remains arthroscopic anterior arthrolysis.^{20,23} Before this, however, other

etiologies of stiffness should be eliminated, especially infection and complex regional pain syndrome.^{23,33} In our daily practice, it is proposed to offer patients anterior arthrolysis if there is a lack of extension at 6 months postsurgery, and this was the protocol used in this study.

Except for the inclusion period, our inclusion and exclusion criteria and functional scores were classic and in alignment with those in the literature.^{1,25} A matched-pair analysis was performed to have comparable populations and the groups were paired for demographic data (age, sex, and BMI) and for additional procedures (meniscal lesion, combined ACL-ALL procedure) to decrease the influence of other parameters.

Our COVID group was matched with a population of patients operated on in 2019, before the COVID-19 pandemic, and at a time when rehabilitation was performed according to a classic physical therapist-supervised program. The benefits of physical therapy after ACLR have been widely reported.^{9,17,32} In France, due to availability and social habits, rehabilitation after ACLR is usually performed via a supervised protocol with 1 to 3 physical therapy sessions per week during the first 6 months. At 6 months, care is adapted after a composite and global evaluation.¹² Ebert et al⁷ investigated the practices of Australian physical therapists on rehabilitation and return to sport after ACLR and observed that 82.1% of physical therapists preferred patient visits 1 to 2 times per week during the first 6 weeks. Between 3 and 6 months postoperatively, most physical therapists recommended less frequent visits, with a focus on home- (or gym-) based exercises with periodic review (40.4%), although 25.5% of physical therapists still recommended supervised visits once or twice per week. However, it remains unclear whether the results of home-based therapy versus supervised rehabilitation are comparable.³⁴

Some studies have demonstrated no significant differences in outcomes such as knee range of motion, strength, laxity, and functional scores between home-based and supervised rehabilitation after ACLR.^{15,24} All studies mentioned had well-established home-based programs that were explained to the patients before surgery. This situation differs from that during the COVID-19 pandemic, and particularly during lockdown, where all health professionals had to quickly change their practices to assist and develop new protocols and programs for rehabilitation. In our COVID group without any supervised rehabilitation during the first weeks postoperatively, the rate of cyclops syndrome was higher, but this could also have been due to the difficulties in adapting to the new and unexpected situation.

The COVID-19 pandemic also had a dramatic effect on the health care of patients, especially after functional orthopaedic surgery,¹⁴ and other ways of follow-up, communication, and rehabilitation had to be found or developed. Just after the government's decision to impose lockdown, we had to adapt and use our website, which had existed since 2019, containing videos of exercises at each stage, the number of repetitions recommended, and explanations. The patients in the COVID group also used telemedicine to guide them and to answer any questions. According to

recent research, approximately 84% of patients using virtual care in March 2020 were doing so for the first time. In addition, mobile applications that were developed recently also exist.^{2,11} This interactive tool could be interesting, but should be evaluated to determine its efficiency. Our study did not use a mobile application, as the website was available, and it was not necessary to have multiple methods of support.

Lee et al²¹ showed no differences in patient satisfaction with IKDC and Lysholm scores at 1-year follow-up after ACLR during the pandemic. Conversely, Bartek et al³ examined the influence of the COVID-19 pandemic on medical and physical therapy follow-up care after ACLR. At 3 months postsurgery, patients who had undergone surgery in 2020 showed a clear trend toward a higher frequency of extension deficits of $\geq 5^\circ$ (18.8% vs 4.3%, respectively; $P = .097$) or an inability to bend the knee $\geq 120^\circ$ (23.3% vs 10%, respectively; $P = .197$) compared with those who had undergone surgery in 2019. Alternative treatment options due to the pandemic were offered by 13.3% of physical therapists and 12.2% of physicians.

For the patients in our COVID group, the results for functional scores at a mean follow-up of 14 months (Lysholm, subjective IKDC, and Tegner) corresponded to those in the literature published before COVID-19, and we did not observe worse results, although 1 year is a short follow-up time to evaluate the results of ACLR.^{22,27}

Limitations

This study has some limitations. First, we did not have functional scores for the control group. Then, due to the fact that the COVID-19 pandemic and the lockdown in 2020 were abnormal situations, this was only a case-control study, as in other recent papers,^{3,21} to compare the impact of COVID-19 on patient care. The follow-up was <2 years, but as lack of extension is a complication that appears during the first few months postsurgery, this does not alter the conclusions of the study. We compared unexpected home-based rehabilitation and supervised rehabilitation but other factors could be associated that have not been studied: lack of motivation, general cessation of all physical activity, and decrease of mobility during lockdown. Groups were matched for meniscal lesions but types of lesions were not analyzed in each group, and this could have affected results. The inclusion period could be a bias as it corresponds to a determined and selected period due to COVID-19.

This study has some strengths, such as the inclusions of a large number of patients who were operated on by the same 2 surgeons, using the same surgical technique, and for the same indications. Moreover, it concerns a hot topic, as the COVID-19 pandemic has not yet ended, and it is possible that similar conditions could be reimposed in the future.

CONCLUSION

The COVID-19 pandemic and lockdown period increased the rate of cyclops syndrome after ACLR due to changes in rehabilitation treatment, with the imposition of

unexpected home-based self-rehabilitation. Better home-based, self-guided rehabilitation methods should be developed in case of pandemic situations.

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