Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Apunts Sports Medicine 57 (xxxx) 100392

apunts SPORTS MEDICINE

apunts
SPORTS MEDICINE
www.apunts/org

ORIGINAL ARTICLE

Treatment of ACL injury in a professional soccer player during COVID-19 lockdown

I. Molina[a,*], A. Muñoz[a], X. Linde[a,b,c]

[a] *Invisible Training S.L., Sant Cugat del Vallés, Spain*
[b] *Medical Services of Football Club Barcelona, Barcelona, Spain*
[c] *Faculty of Psychology, Education and Sport Sciences Blanquerna, Ramon Llull University, Barcelona, Spain*

Received 1 May 2022; accepted 13 July 2022
Available online 19 July 2022

KEYWORDS
Anterior cruciate ligament;
Treatment;
Physiotherapy;
Soccer;
COVID-19

Abstract Anterior Cruciate Ligament (ACL) injuries stand out as the most severe in sports such as soccer. This study presents the rehabilitation process of a professional soccer player who suffered a total ACL tear. It details the treatment performed after the surgical intervention and all the adaptations that had to be applied in the rehabilitation process due to the lockdown period established at the beginning of the COVID-19 pandemic. During the period comprised between weeks 9 and 21 post-surgery, the rehabilitation treatment was carried out virtually, adapting the actions, work environment and equipment used. Despite the limitations it entailed, the virtual format and the adaptations in the treatment allowed the rehabilitation process to continue, fulfilling all the pre-established objectives and deadlines with a consequent satisfactory and safe return to competitive sport. After carrying out a bibliographic research, no clinical cases have been found regarding the adaptation of the rehabilitation process of an ACL reconstruction in a professional soccer player during the COVID-19 lockdown.

Introduction

Anterior Cruciate Ligament (ACL) injuries are considered one of the most severe injuries in soccer, [1] causing in many cases a long period of sport inactivity.[2,3] The incidence is higher in people who practices sports such as soccer, that include actions classified as non-contact,[2,4] such as the changes of direction or pivoting manoeuvres.[5,6] Numerous studies have focused the investigation on ACL injuries in professional soccer players, the rehabilitation process and the Return to Sport (RTS).[6]

Due to the COVID-19 (SARS-CoV-2) pandemic, on March 14th 2020 the state of alarm was declared in Spain and lockdown measures were applied to the population.[7]

This paper describes the case of a professional soccer player of the Greece Super League 1 and details the process of rehabilitation after suffering a total tear and reconstruction of the ACL. Due to the lockdown, between March 14th and June 21st,2020, the treatment was established in a virtual format, which led to the adaptation of the workout, the work environment and the material used.

* Corresponding author.
E-mail address: imolina@invisible-training.com (I. Molina).

https://doi.org/10.1016/j.apunsm.2022.100392

Table 1 Treatment carried out according to the week post-surgery and the adaptations to lockdown.

Postoperative Weeks / Categories	Treatment	Observations
9th & 10th week (face-to-face format)		
ROM	*PT. Man. Ther.:* PROM Knee FLEX. (PRO. and SIT.), PROM Knee EXT. (SUP.) and PROM Tibial Rot. (SIT.). PT. Man. Ther. of the hip, knee and ankle. DF (Mobs. patella, patellar and quadricipital tendon).	Knee FLEX. 120°. Knee EXT. 0°. Tibial Rot. and patella Mo. preserved.
Strength	*Quadriceps.* (60-90°): CKC with TRX. *Hamstrings:* MR ex. to CKC (SUP.). *Adductors and gluteus medius:* MR ex. to OKC (elastic-resistance). *Gluteus:* MR ex. (PRO.) to CKC (SUP.) *CORE: Supine*.	Quadriceps muscle recruitment and activation. Co-contraction of quadriceps and hamstrings.
Swelling, oedema y scars	*Swelling/oedema: PT. Man. Ther.* manual drainage. Pressotherapy. Cryotherapy (10 min. post-treatment and 3-4 times/day). *Scars: PT. Man. Ther*, cupping and DF. PT. Man. Ther (inhibition of the popliteus muscle).	Absence of pain. Signs of joint effusion. No adhesions on the scars.
Proprioception	Ex. on stable surface.	
Aerobic capacity	Stationary bicycling	
11th & 12th week (face-to-face format)		
ROM	*PT. Man. Ther.:* PROM Knee FLEX. (PRO. and SIT.), PROM Knee EXT. (SUP.) and PROM Tibial Rot. (SIT.). PT. Man. Ther. of the hip, knee and ankle. DF (Mobs. patella, patellar and quadricipital tendon).	Knee Flex. 135°. Knee Ext. -3°. Tibial Rot. and patella Mo. preserved.
Strength	Quadriceps: CKC B. ex. CONC. and ECC. (Progression from FWB to external load). Hamstrings: CKC ex. (ISOM., CONC. y ECC. with external load). Adductors: OKC ex. (ISOM., CONC. y ECC). Gluteus: CKC and OKC ex. (functionals, with WB and elastic-resistance). CORE: SUP. and ST.	Quadriceps muscle recruitment and activation. Co-contraction of quadriceps and hamstrings. Endurance strength (2-3 sets 12-25 reps.)
Swelling, oedema y scars	*Swelling/oedema: PT. Man. Ther.* manual drainage. Pressotherapy. Cryotherapy (10 min. post-treatment and 3-4 times/day). *Scars:* PT. Man. Ther, cupping, and DF. PT. Man. Ther. (Inhibition of the popliteus muscle).	Absence of pain. Signs of joint effusion. No adhesions on the scars.
Proprioception	Ex. on stable and unstable surface, with perturbations.	
Aerobic capacity	Stationary bicycling.	
13th & 15th week (virtual format)		
ROM	Active Mobs. ex. for knee and hip. Auto passive Mobs. of the patella. Auto DF with a spoon (Mob. patella, patellar and quadricipital tendon). Active-assisted Mobs. ex. for knee FLEX.	Complete and symmetric knee FLEX. and EXT. Tibial Rot. and patella Mo. preserved.
Strength	Quadriceps: CKC ex. from B. to UNI. OKC ex. (0° a 45°) with elastic-resistance. Functional patterns. Hamstrings: OKC and CKC (ISOM., CONC. and ECC.). Adductors: CKC and OKC (ISOM., CONC. and ECC.) increasing external load. Gluteus: CKC and OKC ex. (functionals, with WB and elastic-resistance). CORE: SUP. and ST. with perturbations.	Quadriceps muscle recruitment and activation. Co-contraction of quadriceps and hamstrings. Endurance strength (2-4 sets 8-10 reps.)
Swelling, oedema y scars	*Swelling/oedema:* Pressotherapy. Cryotherapy (10 min. post-treatment). *Scars:* Auto DF with a spoon. Inhibition of the popliteus muscle with a tennis ball and auto passive Mobs. of the fibular head.	Absence of pain. Mild joint effusion. No adhesions on the scars.
Proprioception	Ex. on stable and unstable surface, with perturbations.	
Aerobic capacity	Initialization of coordination workout, running technique drills and plyometric ex. (week 14). 2 sessions/week of workout focused on the aerobic capacity.	
16th & 17th week (virtual format)		
ROM	Active Mobs. ex. for knee and hip. Auto passive Mobs. of the patella. Auto DF with a spoon (Mob. patella, patellar and quadricipital tendon). Active-assisted Mobs. ex. For knee FLEX.	Complete and symmetric knee FLEX. and EXT. Tibial Rot. and patella Mo. preserved.
Strength	Quadriceps: CKC ex. B. and UNI. OKC ex. (0° a 45° and increase to full knee AROM ex.) with elastic-resistance. Functional patterns. Hamstrings: OKC and CKC (ISOM., CONC. and ECC.).	Quadriceps muscle recruitment and activation. Co-contraction of quadriceps

Table 1 (*Continued*)

Postoperative Weeks / Categories	Treatment	Observations
	Adductors: CKC and OKC (ISOM., CONC. and ECC.). Gluteus: CKC and OKC ex. (functionals, with WB and elastic-resistance). CORE: SUP. and ST. with perturbations.	and hamstrings. Endurance strength (2-4 sets 8-10 reps.)
Swelling, oedema y scars	*Swelling/oedema:* Pressotherapy. Cryotherapy (10 min. post-treatment). *Scars:* Auto DF with a spoon. Inhibition of the popliteus muscle with a tennis ball and auto passive Mobs. of the fibular head.	Absence of pain. Mild joint effusion. No adhesions on the scars.
Proprioception	Ex. on stable and unstable surface, with perturbations.	
Aerobic capacity	Coordination workout, running technique drills, plyometric ex. and initialization of running.	
18th & 19th week (virtual format)		
ROM	Active Mobs. ex. for knee and hip. Auto passive Mobs. of the patella. Auto DF with a spoon (Mob. patella, patellar and quadricipital tendon). Active-assisted Mobs. ex. For knee FLEX.	Complete and symmetric knee FLEX. and EXT. Tibial Rot. and patella Mo. preserved.
Strength	Quadriceps: CKC ex. B. and UNI. OKC ex. (0° a 45° and full knee AROM ex.) with elastic-resistance. Functional patterns. Hamstrings: OKC and CKC (ISOM., CONC. and ECC.). Adductors: CKC and OKC (ISOM., CONC. and ECC.). Gluteus: CKC and OKC ex. (functionals, with WB and elastic-resistance). CORE: SUP. and ST. with perturbations.	Quadriceps muscle recruitment and activation. Co-contraction of quadriceps and hamstrings. Endurance strength (2-4 sets 8-10 reps.)
Swelling, oedema y scars	*Swelling/oedema:* Pressotherapy. Cryotherapy (10 min. post-treatment). *Scars:* Auto DF with a spoon. Inhibition of the popliteus muscle with a tennis ball and auto passive Mobs. of the fibular head.	Absence of pain. Mild joint effusion. No adhesions on the scars.
Proprioception	Ex. on stable and unstable surface, with perturbations.	
On-field workout	Coordination workout, running technique drills, plyometric ex. and running workout. On-field circuits including slaloms, acceleration and deceleration actions, lateral displacement, and initialization on COD drills.	
20th & 21st week (face-to-face format)		
ROM	*PT. Man. Ther.:* PROM Knee Flex. (Prone and SIT.), PROM Knee Ext. (SUP.) and PROM Tibial Rot. (SIT.). PT. Man. Ther. of the hip, knee and ankle. DF (Mob. patella, patellar and quadricipital tendon).	Complete and symmetric knee FLEX. And EXT. Tibial Rot. and patella Mo. preserved.
Strength	Quadriceps: CKC ex. B. and UNI. OKC ex. (0° a 45° and full knee AROM ex.) with elastic-resistance. Functional patterns. Hamstrings: OKC and CKC (ISOM., CONC. and ECC.). Adductors: CKC and OKC (ISOM., CONC. and ECC.). Gluteus: CKC and OKC ex. (functionals, with WB and elastic-resistance). CORE: SUP. and ST. with perturbations.	Quadriceps muscle recruitment and activation. Co-contraction of quadriceps and hamstrings. Maximal strength and hypertrophy (5 series 3-5 reps.).
Swelling, oedema y scars	*Swelling/oedema:* Pressotherapy. Cryotherapy (10 min. post-treatment).	Absence of pain and joint effusion. No adhesions on the scars.
Proprioception	Ex. on stable and unstable surface, with perturbations. Tasks with ball.	
On-field workout	Coordination workout, running technique drills, plyometric ex. and running workout. On-field circuits including slaloms, acceleration and deceleration actions, lateral displacement, COD's (variability of angulation), front and back displacement and pivoting actions. Introduction of soccer ball and decision-making tasks.	

AROM (Active Range of Motion), B. (Bilateral), COD (Change of Direction), CONC. (Concentric), CKC (Closed Kinetic Chain), DF (Diacutaneous Fibrolisis), ECC (Eccentric), Ex. (Exercises), EXT. (Extension), FLEX. (Flexion), *FWB (Full Weight Bearing),* ISOM. (Isometric), Man. Ther. (Manual Therapy). min. (minutes), Mo. (Mobility), Mobs. (Mobilization), MR (Manual Resistance), OKC (Open Kinetic Chain), PRO (Pronation), PROM (Passive Range of Motion), PT (Physical Therapist), Reps. (Repetitions), ROM (Range of Motion), Rot. (Rotations), SIT (Sitting), ST (Standing), SUP. (Supination), UNI (Unilateral), WB (Weight Bearing).

Case description

Professional soccer player, midfielder (age, 29 years old; height, 1,75m; weight, 70Kg), who suffered a total right knee ACL tear during a soccer match of the Greek Super League 2019-2020 season, in a pivoting action. On December 26th, 2019, was submitted to a surgical reconstruction of the ACL with a patellar tendon self-grafting.

The rehabilitation program started in his club, and on February 17th, 2020, the player travelled to Barcelona in order to start the treatment at Invisible Training. In the initial physical examination, there was evidence of swelling, signs of joint effusion and an increase in the surface temperature. In relation to the Range of Motion (ROM) there was a deficit of the knee flexion (105°). The tibio-femoral rotations and the knee extension ROM values where in normative ranges. Regarding muscular balance, with an assessment by manual resistance it denoted a deficit of strength of the main muscular groups: quadriceps, hamstrings, glutes, adductors, and the triceps surae.

The treatment consisted of three stages, comprised between the 9th and 21st week post-surgery, which were influenced by the social and sanitary circumstances of the moment (Table 1). Until the 12th week, daily physiotherapy treatment was accomplished in the centre.

Due to the confinement, from the 13th to the 19th week, a new therapeutic plan was established aiming to adapt the treatment to a virtual format and the necessary material was provided. From the 19th to the 21st week, the face-to-face treatment was restored. In this last stage, strength, structural and functional tests (Table 2) were added to the treatment in order to objectify possible inter-limb asymmetries and determine objectively if the player was ready for the RTS. From the 21st week onwards, the player returned to his club of origin for the last period of the readaptation and RTS. On June 27th, 2021 (26 weeks post-surgery), he received the sport discharge and played an official competitive game with a satisfactory RTS.

Discussion

The main objectives and interventions performed in the continuum of the rehabilitation process until the RTS in ACL injuries have been detailed by numerous authors.[2,8] Nevertheless, after carrying out a bibliographic research, no similar cases describing the process of rehabilitation and follow-up in a virtual format of an ACL injury in a professional soccer player during the lockdown period have been found.

Strategies to restore the ROM of the patella and knee, and for the control of the post-surgery oedema and inflammation have been previously described.[9,10] During the lockdown, the treatment adaptations allowed the accomplishment of the objectives established for a satisfactory recovery (Fig. 1).

To restore the levels of quadriceps and hamstrings strength with symmetric values in the functional strength assessment is essential for a safe RTS and reduce the risk of re-injury.[8,10,11] The schedule of tasks and the control of loads by the physiotherapists, with the supervision of a correct execution in the daily virtual follow-up, allowed the progression and achievement of strength values in relation to the contralateral leg.

Although the lockdown could have involved in a larger inactivity period, it has been possible to objectify that with the adaptation to the virtual format and the availability of proper material at home, the objectives can be achieved within the pre-established deadlines, allowing a competitive RTS, in a safe manner and similar to other cases described with a face-to-face follow-up.[6,12]

Fig. 1 Passive mobility exercises and stretches.

Table 2 Strength, structural and functional tests.

	Right lower extremity (affected)	Left lower extremity
Strength test		
Maximal isometric strength test (20th week)		
Quadriceps	504,45 N	571,82 N
Hamstrings	243,76 N	312,42 N
Structural test		
Thigh perimeter (20th week)		
5 cm	44 cm	44,2 cm
15 cm	53 cm	53,2 cm
Functional test		
Hop test (21st week)		
Single leg hop test	140 cm	161 cm
Triple hop test	423 cm	444 cm
Side Hop test for 30" (40cm)	12% deficit of the right lower extremity (affected)	

This study demonstrates that satisfactory results can be obtained with inexpensive material, added to the professional's knowledge and skills. Also, it is questioned whether the face-to-face intervention of the physiotherapist is strictly necessary or if, on the other hand, with supervision and an adequate method and approach by the professionals, the objectives can also be successfully achieved.

Conclusion

The virtual format and the treatment adaptations, with a load control, a correct supervision of the execution of the workout and a progressive approach of the tasks by the physiotherapists, demonstrate that all objectives can be accomplished in the pre-established deadlines after an ACL tear and its surgical reconstruction, with the consequent safe and satisfactory RTS.

Funding

This research received no external funding.

Conflicts of interest

The authors declare no conflict of interest.

References

1. Waldén M, Hägglund M, Magnusson H, Ekstrand J. Anterior cruciate ligament injury in elite football: a prospective three-cohort study. Knee Surg Sports Traumatol Arthrosc. 2010;19(1):11—9. 2010 191.
2. van Melick N, van Cingel RE, Brooijmans F, Neeter C, van Tienen T, Hullegie W, et al. Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. Br J Sports Med. 2016;50(24):1506—15.
3. Waldén M, Hägglund M, Magnusson H, Ekstrand J. ACL injuries in men's professional football: a 15-year prospective study on time trends and return-to-play rates reveals only 65% of players still play at the top level 3 years after ACL rupture. Br J Sports Med. 2016;50(12):744—50.
4. Faunø P, Jakobsen BW. Mechanism of anterior cruciate ligament injuries in soccer. Int J Sports Med. 2006;27(1):75—9.
5. Alentorn-Geli E, Myer GD, Silvers HJ, Samitier G, Romero D, Lázaro-Haro C, et al. Prevention of non-contact anterior cruciate ligament injuries in soccer players. Part 1: Mechanisms of injury and underlying risk factors. Knee Surg Sports Traumatol Arthrosc. 2009;17(7):705—29. 2009 177.
6. Forsythe B, Lavoie-Gagne OZ, Forlenza EM, Diaz CC, Mascarenhas R. Return-to-Play times and player performance after ACL reconstruction in elite UEFA professional soccer players: A Matched-Cohort Analysis From 1999 to 2019. Orthop J Sports Med. 2021;9(5):23259671211008892.
7. Real Decreto 463/2020, de 14 de marzo, por el que se declara el estado de alarma para la gestión de la situación de crisis sanitaria ocasionada por el COVID-19. (Boletín Oficial del Estado, número 67, de 14 de marzo de 2020). Disponible en: https://www.boe.es/buscar/doc.php?id=BOE-A-2020-3692
8. Myer GD, Paterno MV, Ford KR, Hewett TE. Neuromuscular training techniques to target deficits before return to sport after anterior cruciate ligament reconstruction. J Strength Cond Res. 2008;22(3):987—1014.
9. Wilk KE, Macrina LC, Cain EL, Dugas JR, Andrews JR. Recent advances in the rehabilitation of anterior cruciate ligament injuries. https://doi.org/102519/jospt20123741. 2012; 42 (3):153-71.
10. Filbay SR, Grindem H. Evidence-based recommendations for the management of anterior cruciate ligament (ACL) rupture. Best Pract Res Clin Rheumatol. 2019;33(1):33—47.
11. Welling W, Benjaminse A, Lemmink K, Dingenen B, Gokeler A. Progressive strength training restores quadriceps and hamstring muscle strength within 7 months after ACL reconstruction in amateur male soccer players. Phys Ther Sport. 2019;40:10—8.
12. Zaffagnini S, Grassi A, Muccioli GMM, Tsapralis K, Ricci M, Bragonzoni L, et al. Return to sport after anterior cruciate ligament reconstruction in professional soccer players. The Knee. 2014;21(3):731—5.