Early Open Kinetic Chain (OKC) Improves Muscle Strength Recovery after Anterior Cruciate Ligament Reconstruction without Graft Laxity Increasing

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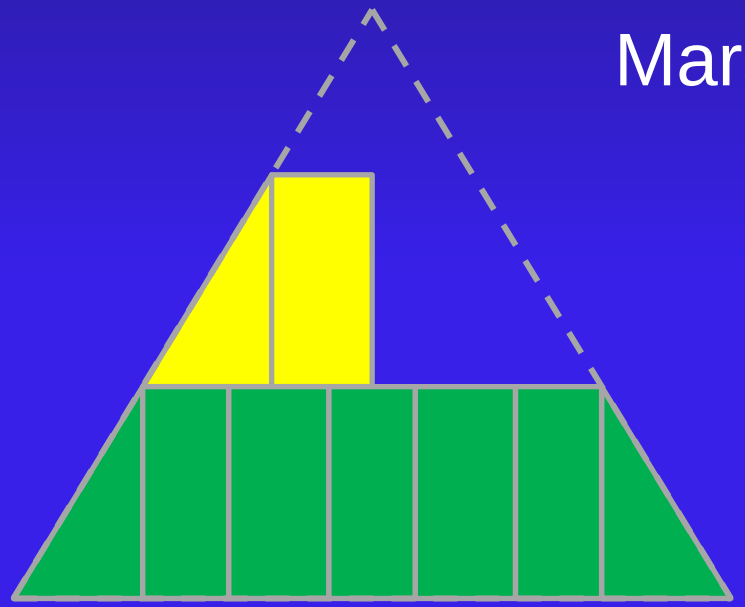
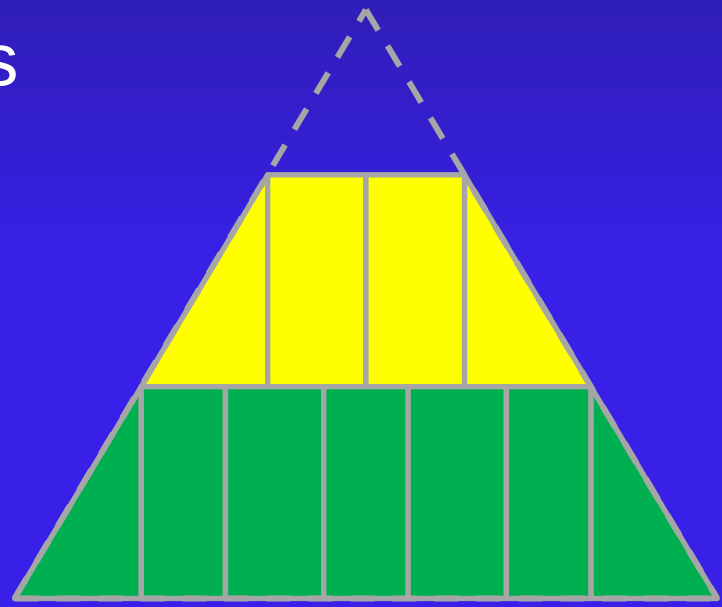


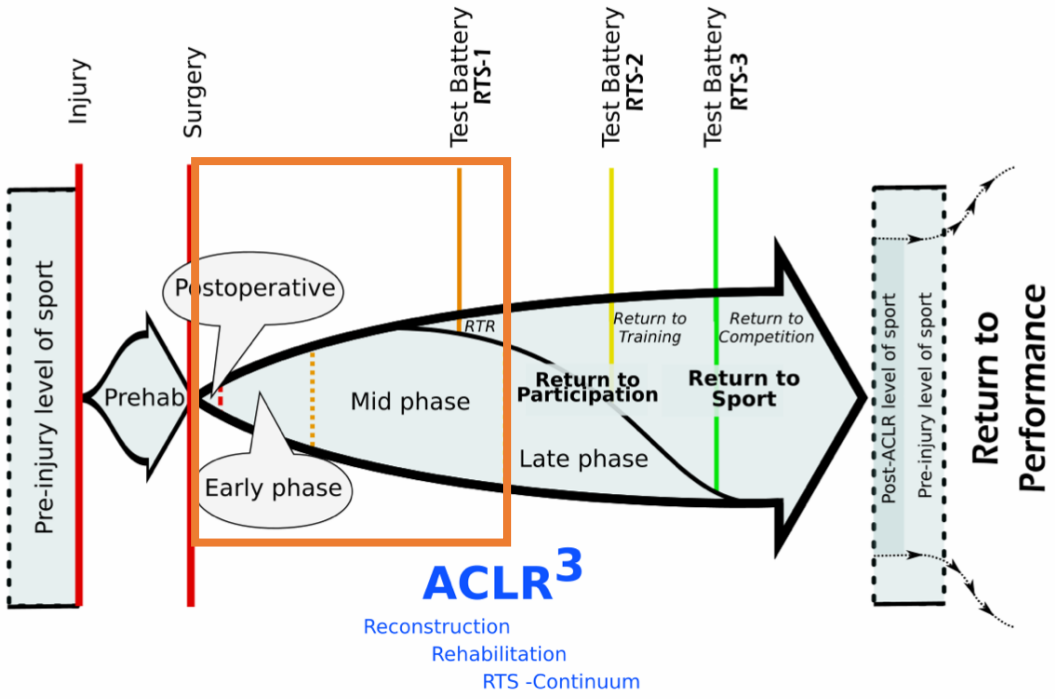


Introduction

Reconstruction, rehabilitation and return-to-sport continuum after anterior cruciate ligament injury (ACLR3 -continuum): Call for optimized programs

Alexandre JM Rambaud PT,PhD[1,2,3] | Thomas Neri MD,PhD[1,4] | Pascal Edouard MD,PhD[1,5]

OKC Starting?



OKC Recommandations

Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus

Nicky van Melick,[1,2] Robert E H van Cingel,[3,4] Frans Brooijmans,[5] Camille Neeter,[6] Tony van Tienen,[7] Wim Hullegie,[8] Maria W G Nijhuis-van der Sanden[1]

4 weeks 45-90° with 10° increase each week

ACL Reconstruction Rehabilitation: Clinical Data, Biologic Healing, and Criterion-Based Milestones to Inform a Return-to-Sport Guideline

Alexander W. Brinlee, PT, DPT, SCS, CSCS,† Scott B. Dickenson, PT, DPT, OCS, ATC,† Airelle Hunter-Giordano, PT, DPT, OCS, SCS,†* and Lynn Snyder-Mackler, PT, ATC, ScD, SCS†

4 weeks between 0-90°

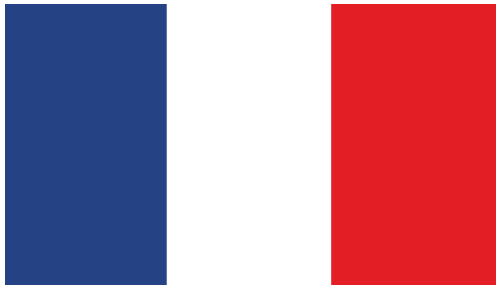
26-240-C-10

EMC

Rééducation postopératoire des greffes du ligament croisé antérieur

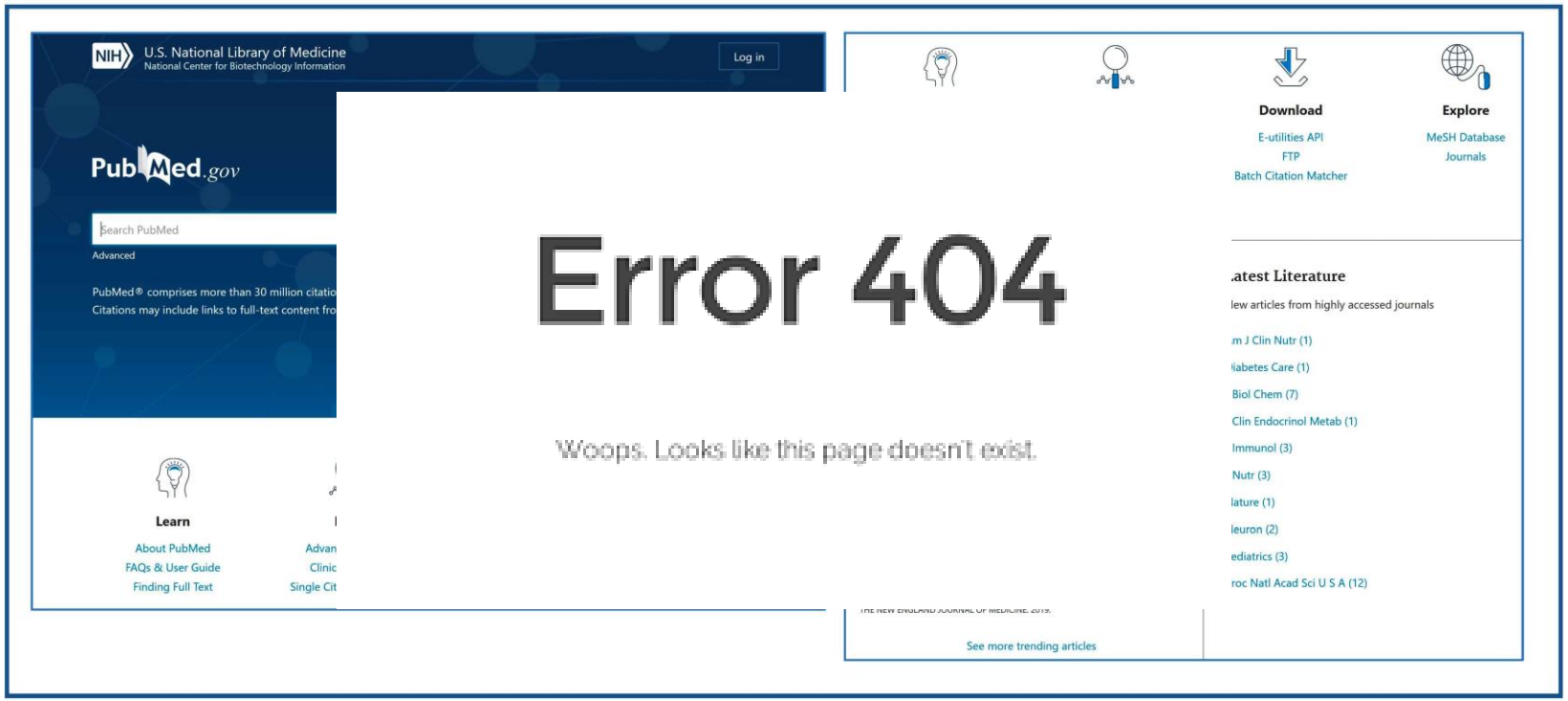
B. Quelard, O. Rachet, B. Sonnery-Cottet, P. Chambat

4 months



Get ready…?

OKC is dangerous?



OKC is safe?

Open- or closed-kinetic chain exercises after anterior cruciate ligament reconstruction?

Braden C Fleming [1], Heidi Oksendahl, Bruce D Beynnon

OKC + Low Load = 3,3 %

A comparison of tibiofemoral joint forces and electromyographic activity during open and closed kinetic chain exercises

K E Wilk [1], R F Escamilla, G S Fleisig, S W Barrentine, J R Andrews, M L Boyd

OKC + Heavy Load = 0,3 BW

The Effects of Walking Speed on Tibiofemoral Loading Estimated Via Musculoskeletal Modeling

Zachary F. Lerner[1], Derek J. Haight[1], Matthew S. DeMers[2], Wayne J. Board[1], and Raymond C. Browning[1]

Walking = 0,4 BW

In vivo measurement of ACL length and relative strain during walking

K A Taylor[1], H C Cutcliffe[1,4], R M Queen[1,2], G M Utturkar[1], C E Spritzer[3], W E Garrett[1], and L E DeFrate[1,4]

[1]Sports Medicine Center, Department of Orthopaedic Surgery, Duke University, Durham NC

[2]Michael W. Krzyzewski Human Performance Lab, Department of Orthopaedic Surgery, Duke University, Durham NC

[3]Department of Radiology, Duke University Medical Center, Duke University, Durham NC

[4]Department of Biomedical Engineering, Duke University, Durham NC

Walking = 14%

The question is?

What's the difference?

Healthy ACL

Predictive Methods

Standardized Load

Surgical Model

Orthopaedic Journal of Sports Medicine

Original Research

Evaluation of Muscle Strength and Graft Laxity With Early Open Kinetic Chain Exercise After ACL Reconstruction

A Cohort Study

Florian Forelli,*†‡§‖ PT, ATC, MSc, Wassim Barbar,†‡ PT, Gwendal Kersante,†‡ MSc, Amaury Vandebrouck,‡ MD, Pascal Duffiet,‡ MD, Louis Ratte,‡ MD, Timothy E. Hewett,¶ PhD, and Alexandre J.M. Rambaud,‖# PT, PhD

Investigation performed at Clinique de Domont, Ramsay Santé, Domont, France

Patients

Intervention group

OKC included at 31.4 days ± 7.6

Control group

CKC according Quelard et al

TABLE 1
Characteristics of Patients (N = 103)[a]

	Intervention Group (n = 51)	Control Group (n = 52)	*P*	Cohen *d*
Age, y	26.3 ± 5.3	30.5 ± 10.2	.71	0.22
Male sex, n	34	36	.94	NA
Height, cm	173.0 ± 9.0	174.0 ± 8.0	.94	0.11
Weight, kg	74.0 ± 13.5	73.1 ± 10.9	.96	0.07
BMI, kg/m^2	24.6 ± 3.5	24.4 ± 3.2	.96	0.05
Tegner score[b]	7.5 ± 1.0	7.0 ± 2.0	.82	0.31
Marx score[c]	13.5 ± 3.0	10.2 ± 3.3	.46	1.04

[a]Data are reported as mean ± SD unless otherwise indicated.
BMI, body mass index; NA, not applicable.
[b]All Tegner scores were between 6 and 10.
[c]All Marx scores were between 6 and 16.

OKC Protocol

8 sets - 10 repetitions (60°.s^{-1})

8 sets - 8 repetitions (60% MVIC)

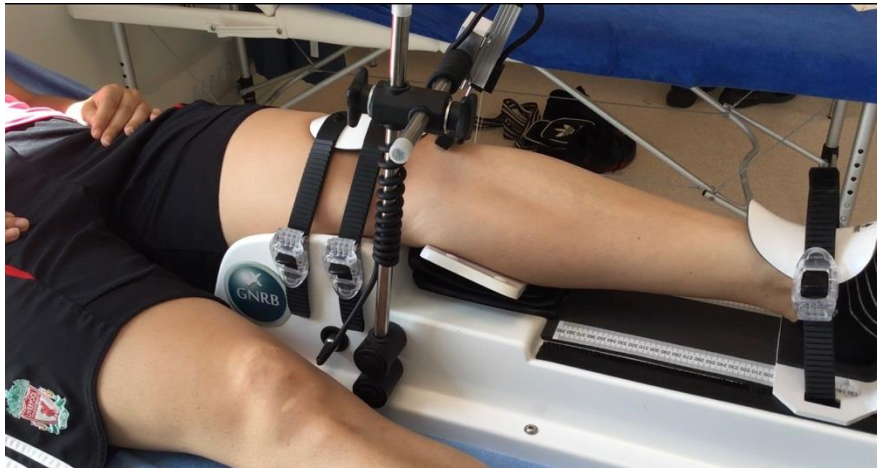
8 sets - 8 repetitions (60% MVIC)

3 times per week

MVIC assessed each week

Assessments

Isokinetic Test *(LSI & PT/BW)*



GNRB

102.3 days ± 18.9
&
203.4 days ± 42.2

Limb symmetry Index

TABLE 2
Limb Symmetry Index (%)[a]

	Intervention Group (n = 51)	Control Group (n = 52)	*P*	Cohen *d*
Quadriceps strength				
3 mo	76.14 ± 0.22	46.91 ± 0.21	**<.001**	–1.3
6 mo	91.05 ± 0.18	61.80 ± 0.26	**<.001**	–1.2
Hamstring strength				
3 mo	86.13 ± 0.22	64.26 ± 0.26	**<.001**	–0.9
6 mo	91.90 ± 0.17	82.42 ± 0.24	**.024**	–0.4

[a]Data are reported as mean ± SD. Boldface *P* values indicate a statistically significant difference between groups ($P < .05$).

+21.8%

+9.5 %

+29.2%

+29.2%

PT/BW

TABLE 3
Peak Torque to Body Weight Ratio (N·m/kg)[a]

	Intervention Group (n = 51)	Control Group (n = 52)	*P*	Cohen *d*
Quadriceps strength				
Operated side at 3 mo	1.81 ± 0.75	0.85 ± 0.50	**<.001**	–1.5
Nonoperated side at 3 mo	2.36 ± 0.62	1.81 ± 0.56	**<.001**	–1.0
Operated side at 6 mo	2.40 ± 0.73	1.39 ± 0.70	**<.001**	–1.3
Nonoperated side at 6 mo	2.62 ± 0.59	2.24 ± 0.52	**<.001**	–0.8
Hamstring strength				
Operated side at 3 mo	1.09 ± 0.36	0.67 ± 0.39	**<.001**	–0.9
Nonoperated side at 3 mo	1.29 ± 0.36	1.08 ± 0.40	**.005**	–0.5
Operated side at 6 mo	1.42 ± 0.41	1.07 ± 0.39	**<.001**	–0.6
Nonoperated side at 6 mo	1.55 ± 0.38	1.32 ± 0.42	**.005**	–0.5

[a]Data are reported as mean ± SD. Boldface *P* values indicate a statistically significant difference between groups ($P < .05$).

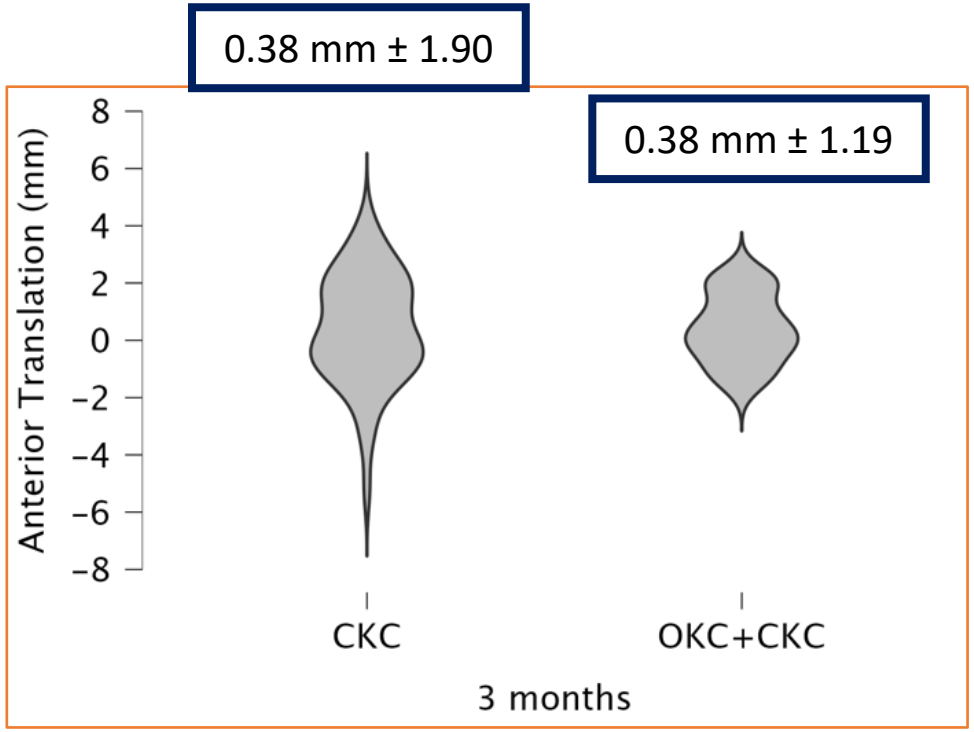
+0.960

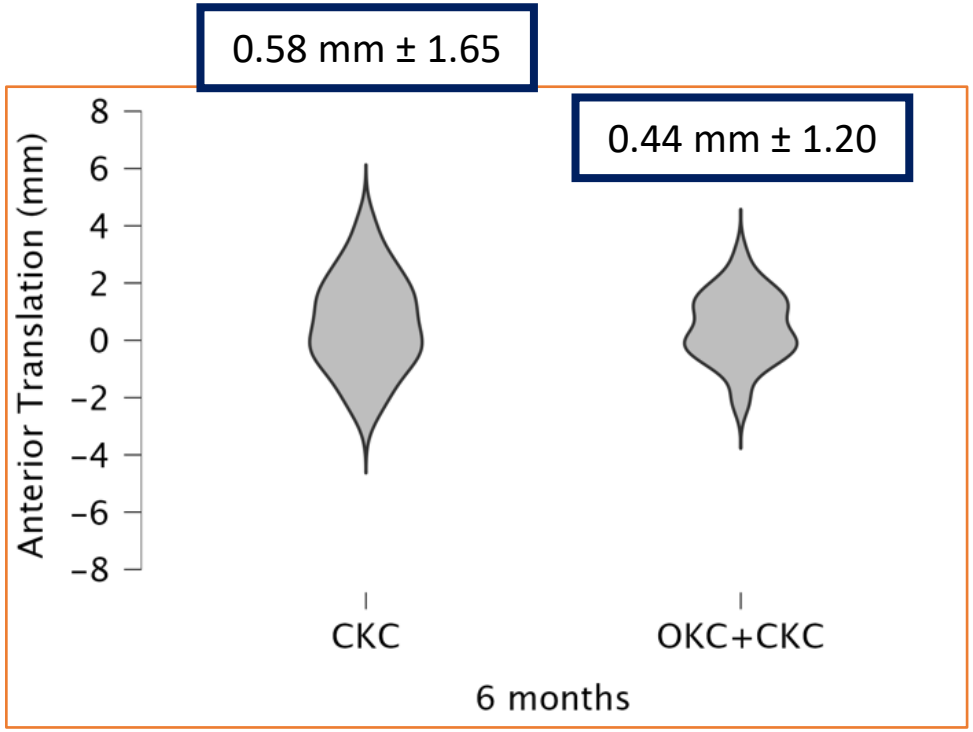
+1.010

+0.399

+0.353

Anterior tibial translation





Load?

Is Knee Laxity Change After ACL Injury and Surgery Related to Open Kinetic Chain Knee Extensor Training Load?

ABSTRACT

Morrissey MC, Perry MC, King JB: Is knee laxity change after ACL injury and surgery related to open kinetic chain knee extensor training load? Am J Phys Med Rehabil 2009;88:369–375.

Maximal Contractions
No laxity

J. Phys. Ther. Sci.
24: 1055–1057, 2012

Comparison of Strength and Endurance between Open and Closed Kinematic Chain Exercises after Anterior Cruciate Ligament Reconstruction: Randomized Control Trial

Hyungkyu Kang, MSc, PT[1)], Jinhwa Jung, PhD, OT[2)], Jaeho Yu, PhD, PT[3)]

70% RM

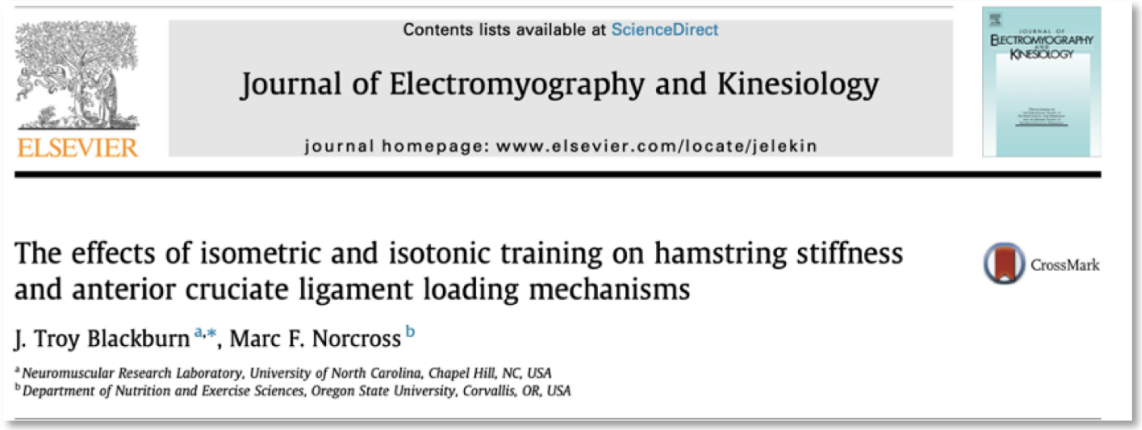
[Effect of isokinetic training of thigh muscle group on graft remodeling after anterior cruciate ligament reconstruction]

[Article in Chinese]

Haifeng Liu [1], Wei Lu [2], Daqiang Liang [1], Hongli Geng [1], Weimin Zhu [1], Kan Ouyang [1], Hao Li [1], Liangquan Peng [1], Wenzhe Feng [1], Mingjin Zhong [1], Kang Chen [1], Ying Li [1], Zhenhan Deng [1], Daping Wang [3]

Early isokinetic strengthening
No Laxity
Better graft vascularization

Hamstring ?



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The effects of isometric and isotonic training on hamstring stiffness and anterior cruciate ligament loading mechanisms

J. Troy Blackburn [a,*], Marc F. Norcross [b]

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[b] Department of Nutrition and Exercise Sciences, Oregon State University, Corvallis, OR, USA

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Influences of hamstring stiffness and strength on anterior knee joint stability

J. Troy Blackburn [a,*], Marc F. Norcross [a], Darin A. Padua [b]

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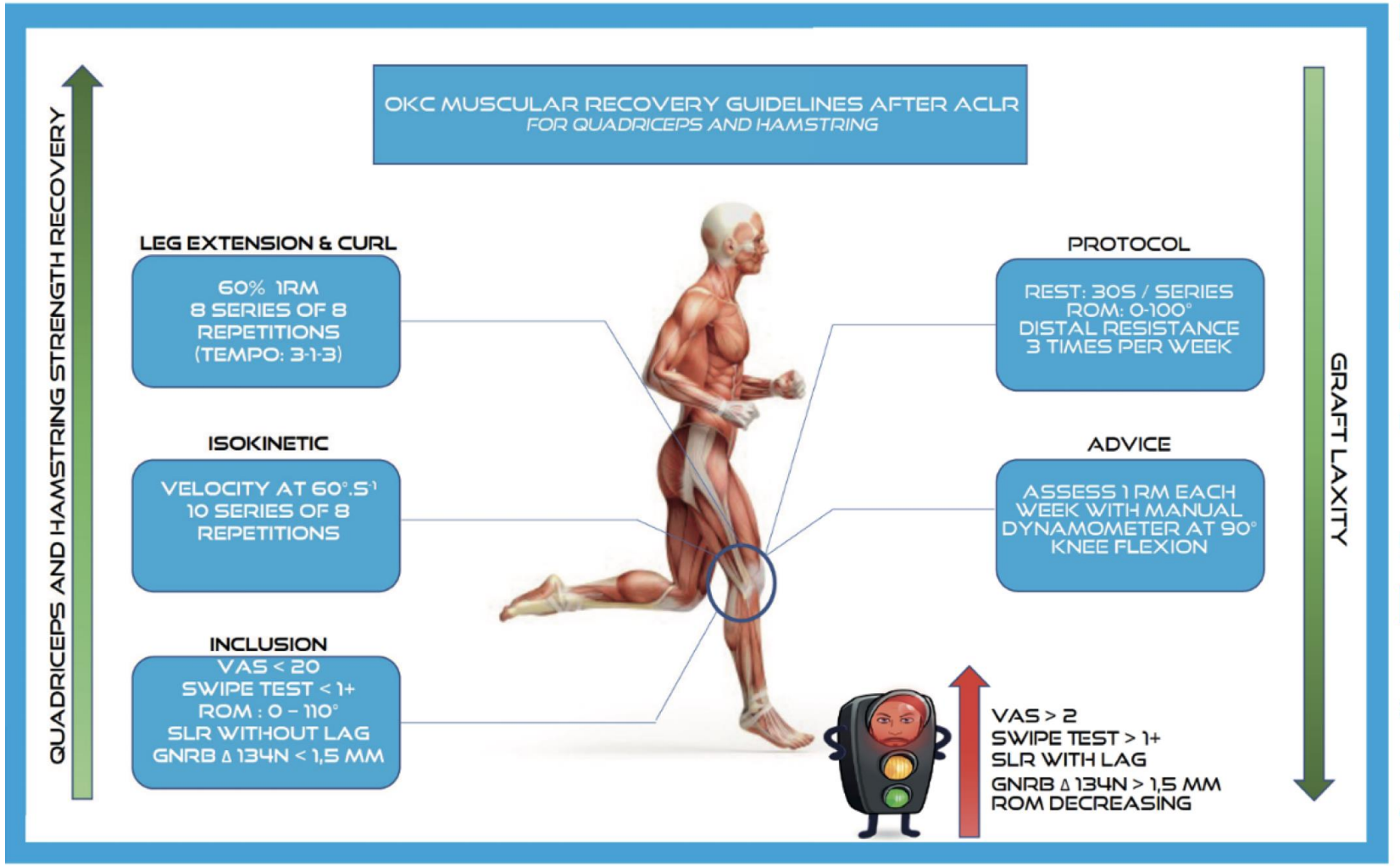
[b] Sports Medicine Research Laboratory, University of North Carolina at Chapel Hill, NC, USA

Stiffness increasing
Anterior tibial translation decreasing
Improvement of knee stability during landing

Knee anterior stability improvement
Compressives tibial forces increasing
Graft length decreasing

Conclusion


OKC MUSCULAR RECOVERY GUIDELINES AFTER ACLR
FOR QUADRICEPS AND HAMSTRING
QUADRICEPS AND HAMSTRING STRENGTH RECOVERY
GRAFT LAXITY
LEG EXTENSION & CURL
60% 1RM
8 SERIES OF 8 REPETITIONS
(TEMPO: 3-1-3)
ISOKINETIC
VELOCITY AT 60°.S-1
10 SERIES OF 8 REPETITIONS
INCLUSION
VAS < 20
SWIPE TEST < 1+
ROM : 0 – 110°
SLR WITHOUT LAG
GNRB Δ 134N < 1,5 MM
PROTOCOL
REST: 30S / SERIES
ROM: 0-100°
DISTAL RESISTANCE
3 TIMES PER WEEK
ADVICE
ASSESS 1 RM EACH WEEK WITH MANUAL DYNAMOMETER AT 90° KNEE FLEXION
VAS > 2
SWIPE TEST > 1+
SLR WITH LAG
GNRB Δ 134N > 1,5 MM
ROM DECREASING

Thank You !

Here's how to connect...
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Timothy Hewett
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Tim-Hewett

Duolingo
Tim-Hewett
TimHewett2

Skype
Tim-Hewett

Whattsapp
Timothy-Hewett

YouTube
YouTube.com/c/TimHewettPhD

Hi A

My information is below:

My MAILING ADDRESS for the sticker & sleeve shipment:

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614-395-7207
"The best way to 'predict' your future… is to create it!"
Abraham Lincoln

Limits

- CKC group standardization and compliance
- OKC + CKC group performed rehabilitation in the same center
- CKC group performed rehabilitation in other centers
- CKC might have low training volume
- No randomization
- No blinded procedure for investigators

Early RTP?

[LITERATURE REVIEW]

NICKY VAN MELICK, PT, PhD[1] • WALTER VAN DER WEEGEN, PhD[1] • NICK VAN DER HORST, PT, PhD[2]

Quadriceps and Hamstrings Strength Reference Values for Athletes With and Without Anterior Cruciate Ligament Reconstruction Who Play Popular Pivoting Sports, Including Soccer, Basketball, and Handball: A Scoping Review

Male
PTQ/BW = 2,70 $Nm.kg^{-1}$
PTH/BW = 1,58 $Nm.kg^{-1}$

Female
PTQ/BW = 2,27 $Nm.kg^{-1}$
PTH/BW = 0,96 $Nm.kg^{-1}$

Original article

Editor's choice
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Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study

Hege Grindem,[1] Lynn Snyder-Mackler,[2] Håvard Moksnes,[3] Lars Engebretsen,[3,4] May Arna Risberg[1,4]

RTP at 8 months : 2nd ACL 38% decrease

RTP at 9 months : 2nd ACL 51% decrease

But…

ELSEVIER

Journal of Biomechanics 39 (2006) 2943–2950

JOURNAL OF BIOMECHANICS

www.elsevier.com/locate/jbiomech
www.JBiomech.com

Sex-based differences in the tensile properties of the human anterior cruciate ligament

Naveen Chandrashekar[a], Hossein Mansouri[b], James Slauterbeck[c], Javad Hashemi[a,d,*]

[a]*Department of Mechanical Engineering, Texas Tech University, Lubbock, TX 79409-1021, USA*
[b]*Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX 79409, USA*
[c]*Department of Orthopaedic Rehabilitation, University of Vermont, Burlington, VT 05405-0084, USA*
[d]*Department of Orthopaedic Surgery, Texas Tech University Health Sciences Center, Lubbock, TX 79430-9436, USA*

Accepted 26 October 2005

Maximal stretching capacities between 19 and 36%

In vivo measurement of ACL length and relative strain during walking

K A Taylor[1], **H C Cutcliffe**[1,4], **R M Queen**[1,2], **G M Utturkar**[1], **C E Spritzer**[3], **W E Garrett**[1], and **L E DeFrate**[1,4]

[1]Sports Medicine Center, Department of Orthopaedic Surgery, Duke University, Durham NC

[2]Michael W. Krzyzewski Human Performance Lab, Department of Orthopaedic Surgery, Duke University, Durham NC

[3]Department of Radiology, Duke University Medical Center, Duke University, Durham NC

[4]Department of Biomedical Engineering, Duke University, Durham NC

Walking = 14%

Perspectives

Intrinsic Graft Laxity Variation With Open Kinetic Chain Exercise After ACL Reconstruction

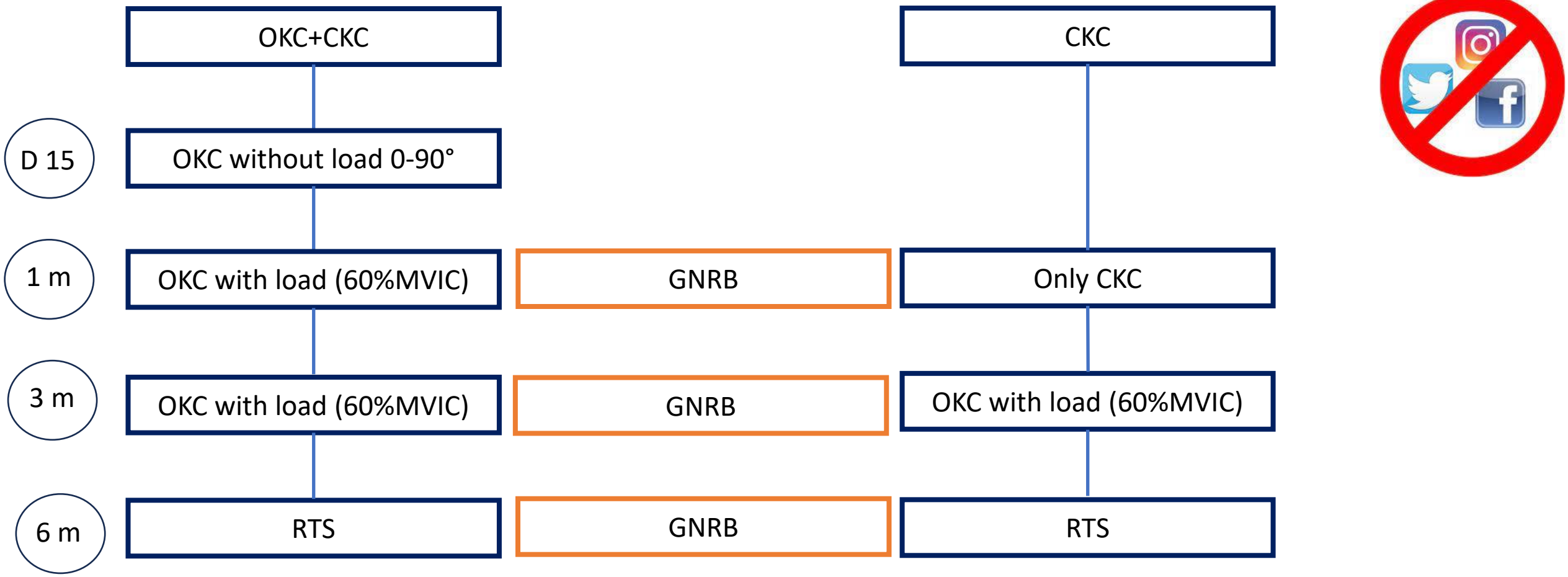
F.FORELLI; Y. ZEGHOUDI; J.MAZEAS; A. VANDEBROUCK; P.DUFFIET; L.RATTE; G. KAKAVAS; A.JM. RAMBAUD ; T.E. HEWETT

Participants

	OKC+CKC Group n=10 Mean ± SD	CKC Group n=10 Mean ± SD	P-value
Age (y)	24 ± 3,25	23 ± 5,13	0,87
BMI ($kg/m^{2)}$	26 ± 3,25	26 ± 3,53	0,67
Sex (M/F)	6/4	5/5	/

Forelli et al. (unpublished)

Protocol & Assessment



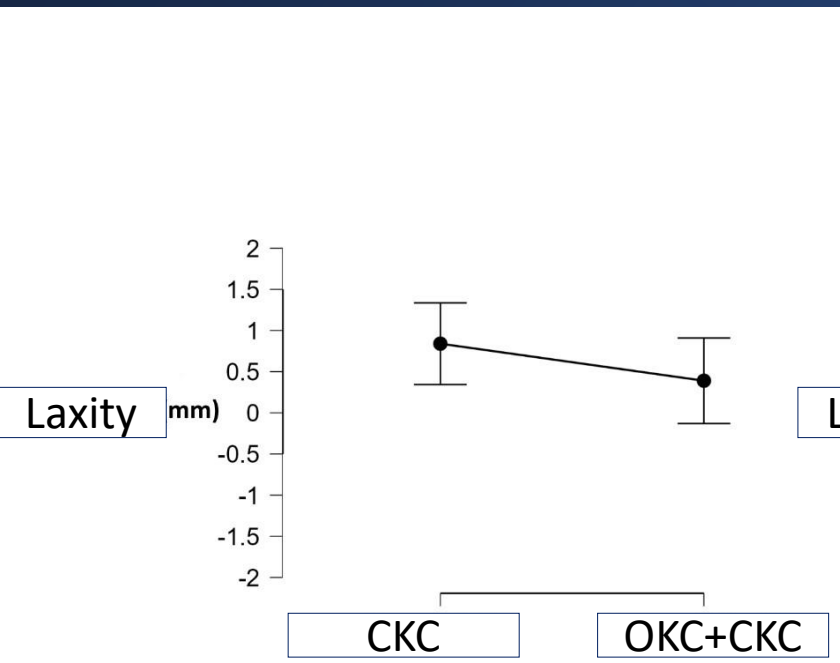
Forelli et al. (unpublished)

Results

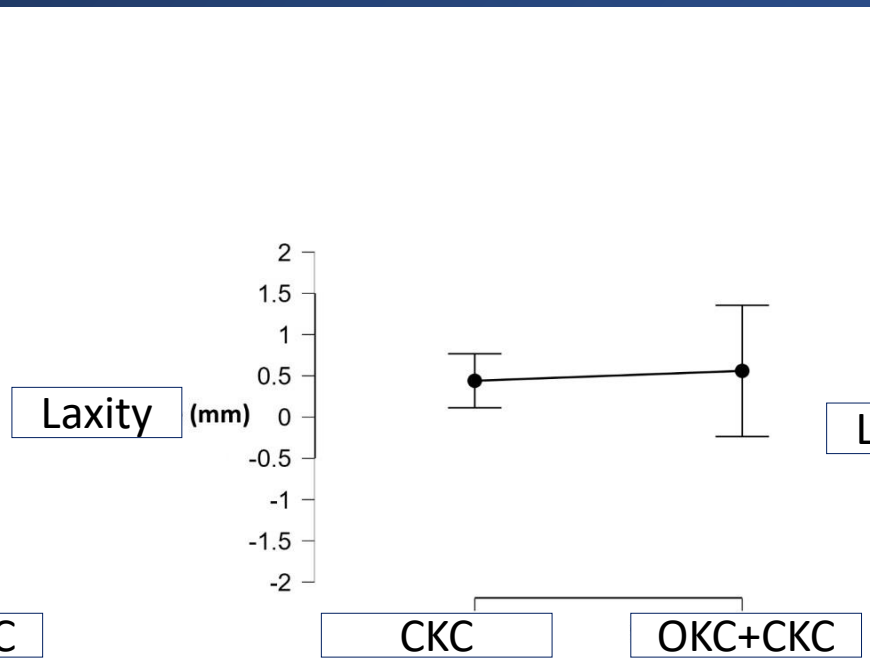
Time after surgery	OKC+CKC group n=10 Mean ± SD	CKC group n=10 Mean ± SD	P- Value
1 month	0,390 ± 0,726	0,840 ± 0,693	0,173
3 months	0,560 ± 1,112	0,440 ± 0,458	0,150
6 months	0,600 ± 0,688	0,890 ± 0,997	0,545

Forelli et al. (unpublished)

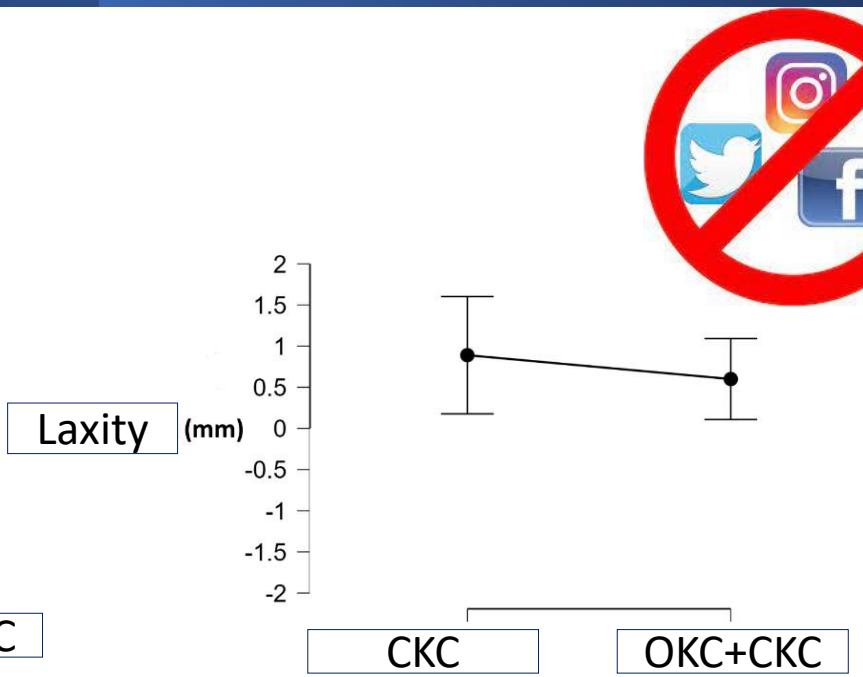
Results



1 month



3 months



6 months

Forelli et al. (unpublished)