

Kinematics in the NBA

Jarrold Lee Antflick

Consultant Sports Physiotherapist

- NBA
- English Premiere League
- Premiership Rugby



Dr Chris Richter

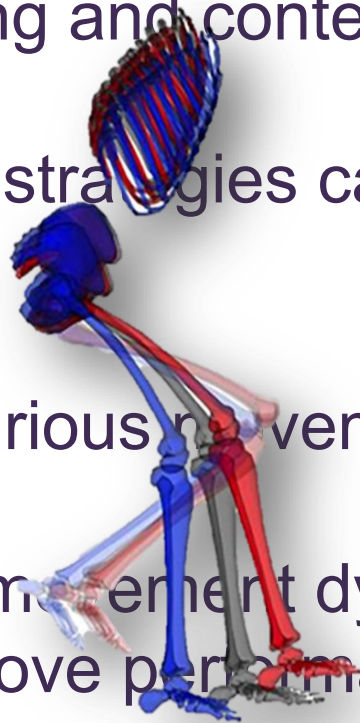
Consultant Biomechanist

Head of Data and Innovation SSC Sports Medicine (Dublin)

Why kinematics?

Reviews the interaction between joints and forces as a system rather than independent motion segments.

- Gives forces meaning and context
- Different movement strategies can produce similar forces and asymmetries
- Identify possible injurious movement patterns
- Objectively identify movement dysfunction and provides clear targets to improve performance and movement strategies
 - **High forces, with good kinematics are beneficial!**



State of Play:

ACL



Use Knee
Extensor
Strength

Ostenberg (1998) Scand J Med Sci Sports. ≠ Delay (2001) Am J Knee Surg.

Use Jumping
task (Drop Jump)

Hewett (2005) Am J Sports Med. ≠ Krosshaug (2016) Am J Sports Med.

Use symmetry

Osteras (1998) Scand J Med Sci Sports. ≠ Pairoto (2015) Knee.

Why kinematics?

Review



Why screening tests to predict injury do not work—
and probably never will...: a critical review

Roald Bahr^{1,2}

“To date, there is **no** screening **test** available to **predict sports injuries** with adequate test properties and **no intervention** study **providing** evidence in **support** for **screening** for injury **risk**.”

Confusion: Why?



Studies often do not:
explore data **beyond max and min** values



Studies often **lose**
the **interaction between joints**



We assume:
Controls are Healthy

Analyzing Human Movements - Introducing A Framework To Extract And Evaluate Biomechanical Data

Chris Richter, Enda King, Siobhan Strike, Andrew Franklyn-Miller

doi: <https://doi.org/10.1101/442087>

This article is a preprint and has not been peer-reviewed [what does this mean?].

When Viewing the Whole Picture

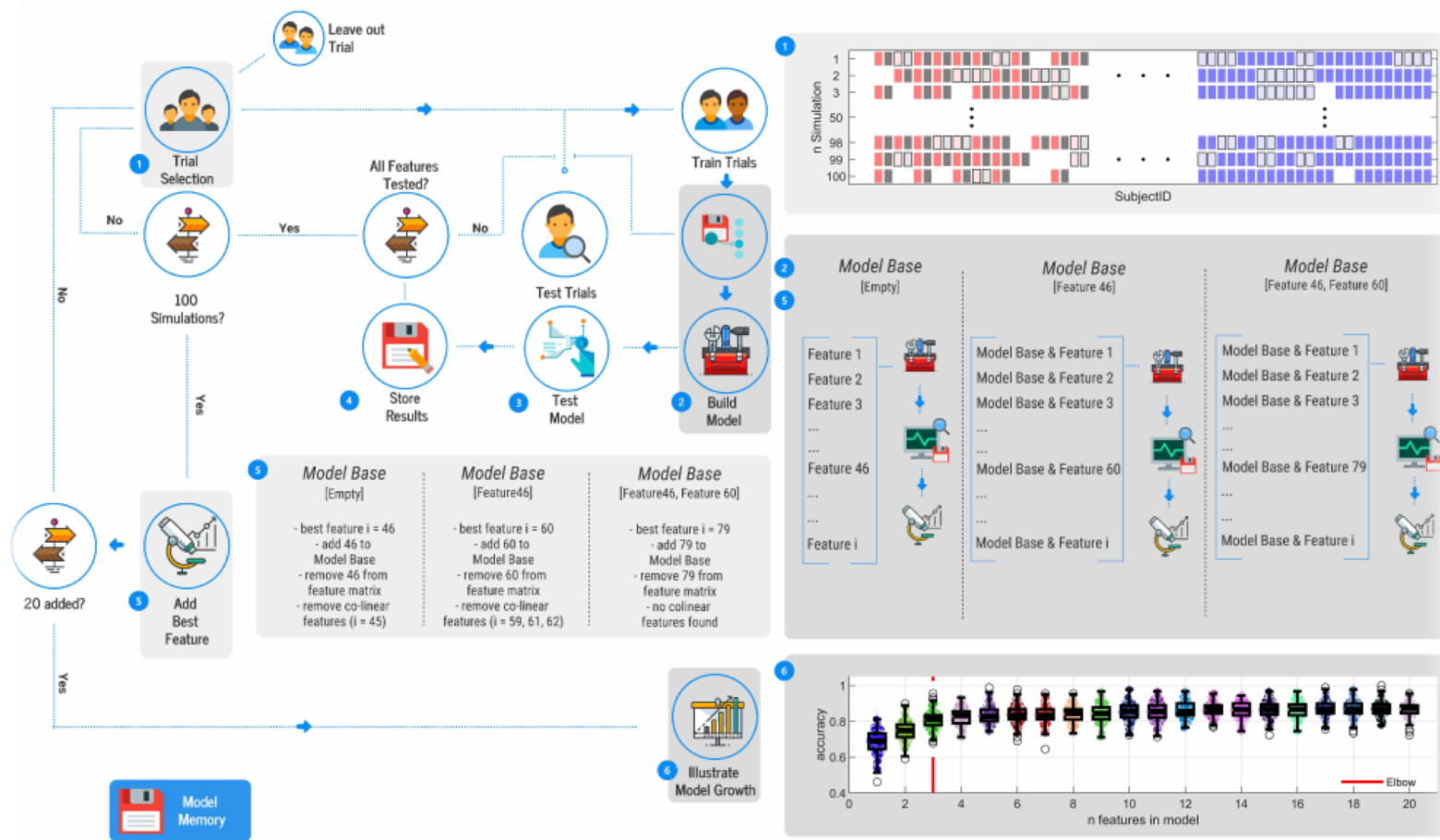


Fig 3. Illustration of the workflow to identify key features toward classification.

Analyzing Human Movements - Introducing A Framework To Extract And Evaluate Biomechanical Data

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When Viewing the Whole Picture

Table 4. Description of minimal feature models: used machine learning techniques, identified features and corresponding accuracies.

Exercise	Technique	Feature	Accuracy (%)
SLCMJ	neural network model	ankle rotation moment(83-87 %)	46
		CoM in pelvis (sagittal plane)(79 to 85 %)	53
DLCMJ	logistic regression	knee flexion angle symmetry (46 to 51 %)	56
		resultant CoM velocity (87 to 95 %)	61
		knee rotation angle symmetry (27 to 33 %)	70
		ankle abduction angle symmetry (1 to 13 %)	73
SLDJ	discriminant analysis	resultant CoM velocity (94-100 %)	51
		vertical CoM velocity (1 to 7%)	56
DLDJ	neural network	vertical ground reaction force symmetry (80 to 86 %)	69
		resultant CoM velocity (80 to 84 %)	75
		knee flexion angular velocity (74 to 81 %)	81
SLHop	logistic regression model	ankle flexion angular velocity (7 to 11 %)	58
		CoM in knee(transversal plane) (89 to 100 %)	65
		vertical CoM velocity (1 to 7 %)	68
		vertical ground reaction force (14 to 19 %)	72
		pelvic rotation angles (42 to 50 %)	75
HuHo	logistic regression model	knee flexion work (67 to 71 %)	48
		vertical ground reaction force (76 to 80 %)	56
		knee abduction moment (38 to 42 %)	63
		vertical CoM velocity (66 to 76 %)	67
		knee flexion angular velocity (84 to 89 %)	69
CoDP	discriminant analysis	knee flexion angular velocity (96 to 100 %)	48
		knee flexion angle (57 to 61 %)	57
		knee abduction moment (52 to 56 %)	63
CoDU	discriminant analysis	vertical CoM velocity (86 to 91 %)	48
		hip flexion moment (91 to 95 %)	52

Hardware & Software:

- 9 Noraxon IMU's & Bertec 600x900 Tri-axial plates
- ForceDecks Software with FD Lite plates

“Total Performance Biomech Tool”:

Wave form & force output visualisation:

- Custom developed program for Total Performance written by Dr Richter
- Constantly assimilating and learning more data and evolving over time as research changes

Questions?

We may not have time for questions

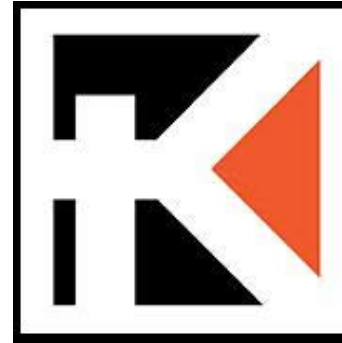
Chat during the break or after the conference

Live CMJ Demonstration

Key Components:

- Stable bodyweight measure
- Standing tall: knees and hips in **full extension**
- Hands on hips (or wooden dowel)
- “As fast and as high as you can jump”
- Landing back onto plates
- Pause in between trials

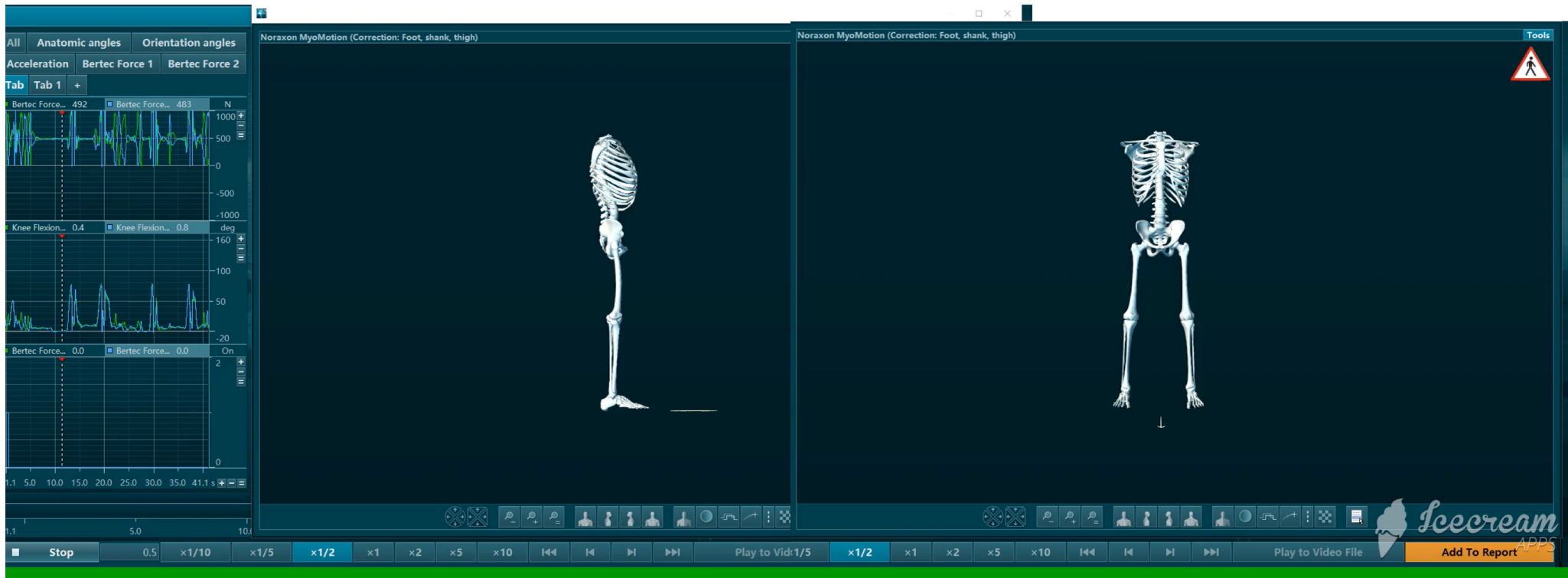
ISO Demonstration



Key Components:

- Measure “loaded/pre-tension” weight (with bar and bodyweight) if not using a ISO rig
- Ensure a balanced bar
- Pull as “Hard and fast” as you can
- Hold for 3 sec’s
- Minimum 5 sec rest between trials

Athlete: NBA "Shooting Guard" Kinematic & Kinetics Session



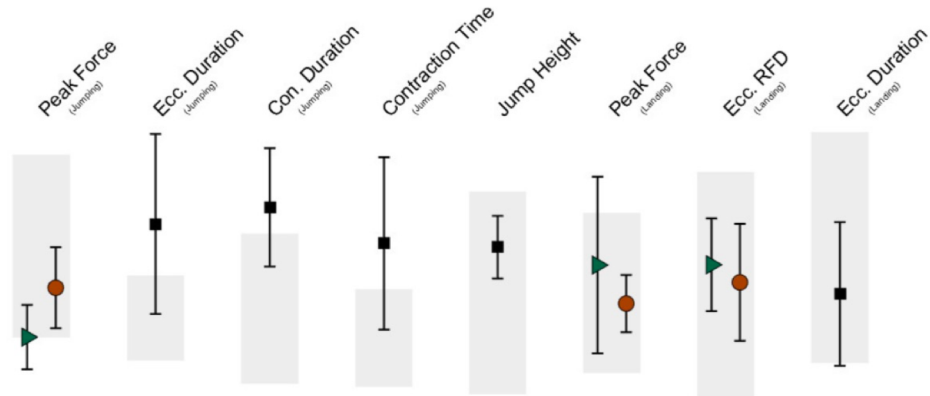
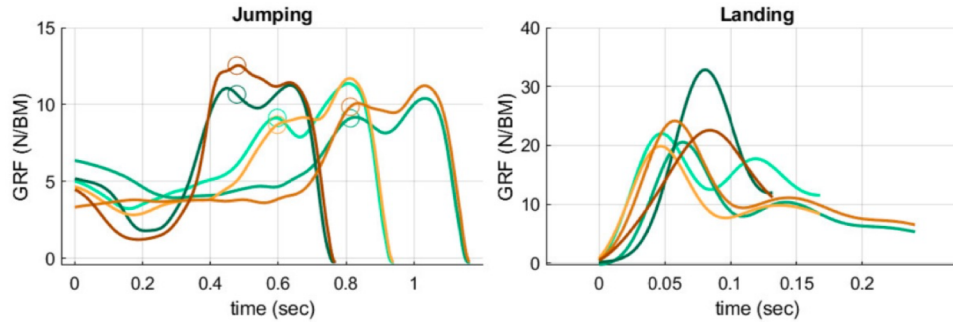
Strength Assessment I
Double Leg Countermovement Jump



Kinetics:

Athlete 2:

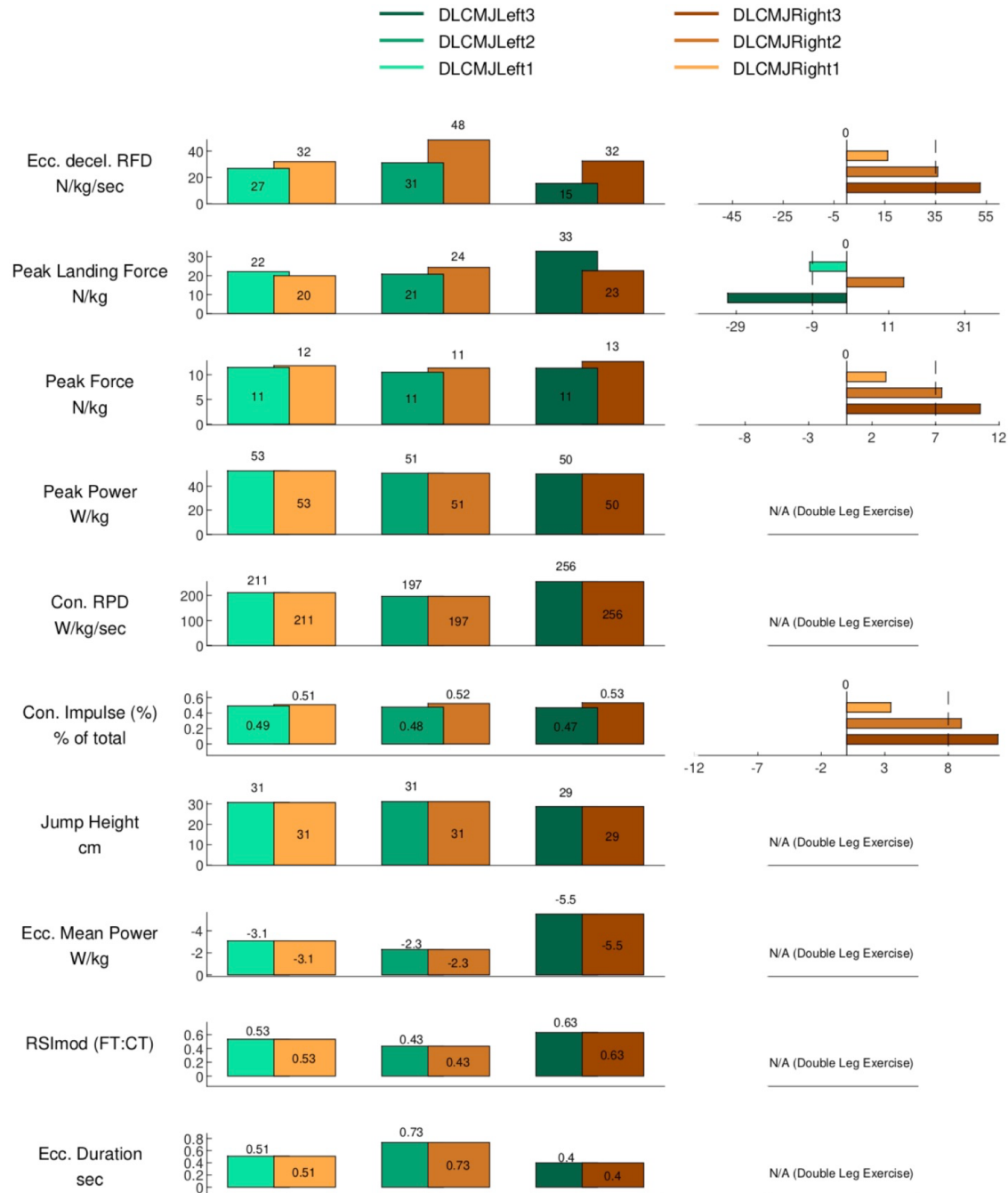
- DLCMJLeft3
- DLCMJLeft2
- DLCMJLeft1
- DLCMJRight3
- DLCMJRight2
- DLCMJRight1



	Variable	Left Trials Mean (CoV)	Right Trials Mean (CoV)	Asymmetry (%)
Jumping	Peak Force (N/kg)	11.01 (0.04)	11.82 (0.05)	7
	Ecc. Duration (sec)		0.62 (0.26)	-
	Con. Duration (sec)		0.32 (0.10)	-
	Contraction Time		0.95 (0.20)	-
	Jump Height (cm)		30.18 (0.04)	-
	Landing	Peak Force (N/kg)	25.13 (0.26)	22.21 (0.09)
Ecc. RFD (N/kg/sec)		397.97 (0.17)	371.25 (0.23)	7
Ecc. Duration (sec)			0.18 (0.30)	-

Strength Assessment II

Double Leg Countermovement Jump



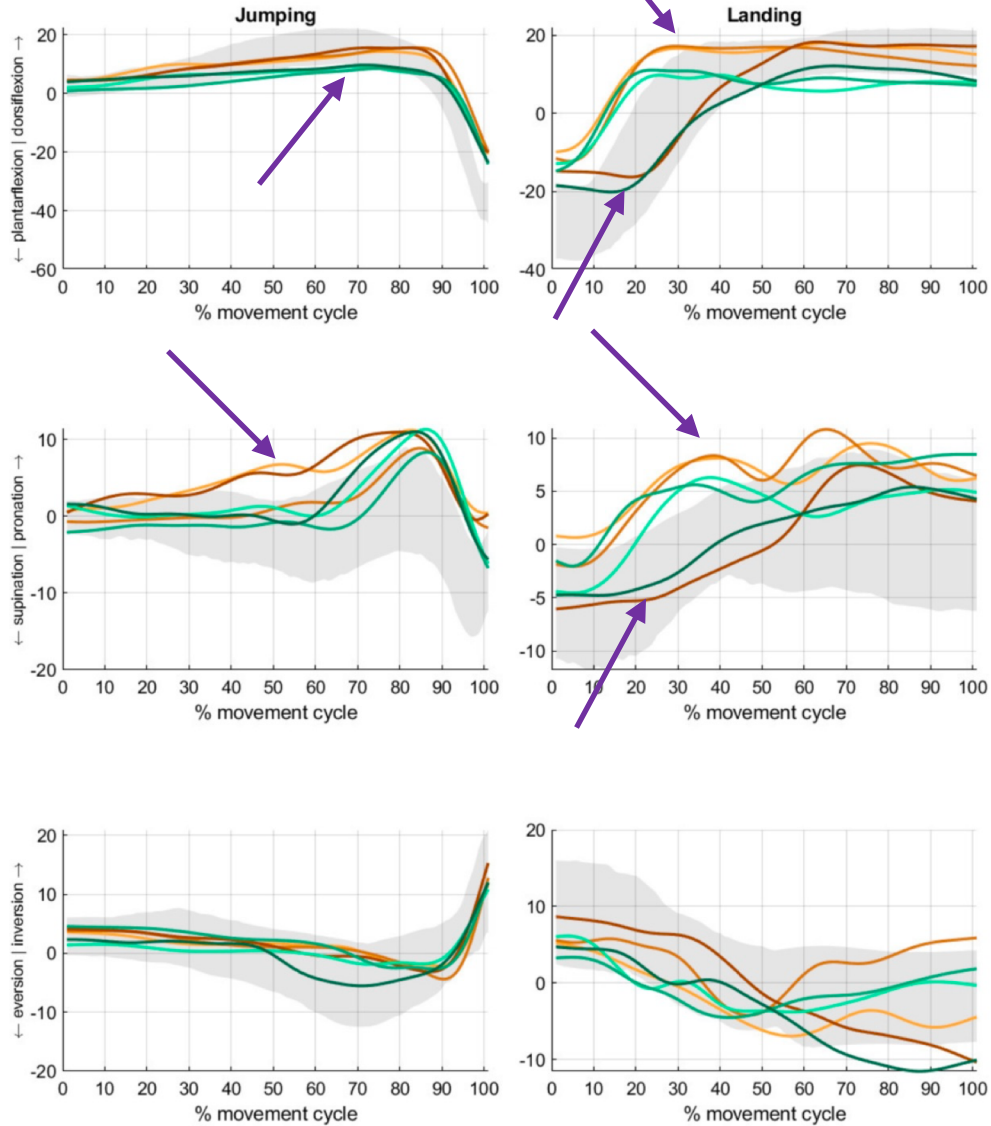
AnkleAngles

Double Leg Countermovement Jump



DLCMJLeft3
DLCMJLeft2
DLCMJLeft1
DLCMJRight3
DLCMJRight2
DLCMJRight1

Summary So Far:
+ Limited ankle DF L>R
+ High R foot pronation

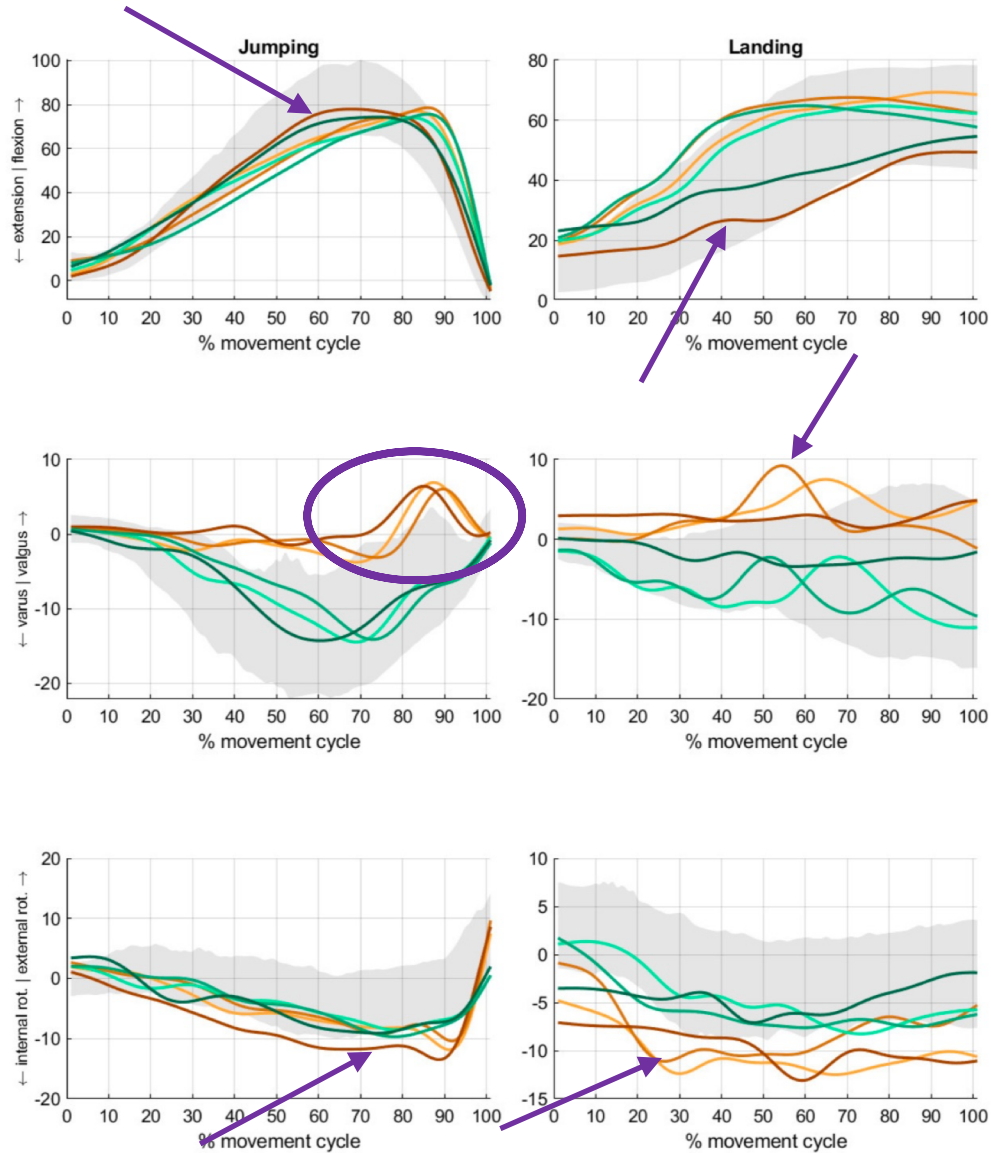


KneeAngles
Double Leg Countermovement Jump



- DLCMJLeft3
- DLCMJLeft2
- DLCMJLeft1
- DLCMJRight3
- DLCMJRight2
- DLCMJRight1

Summary So Far:
 + Limited ankle DF L>R
 + High **R** foot pronation
 + Low knee flexion
 + High **R** knee valgus prior to take off & landing
 + **R** knee Internal rotation



HipAngles

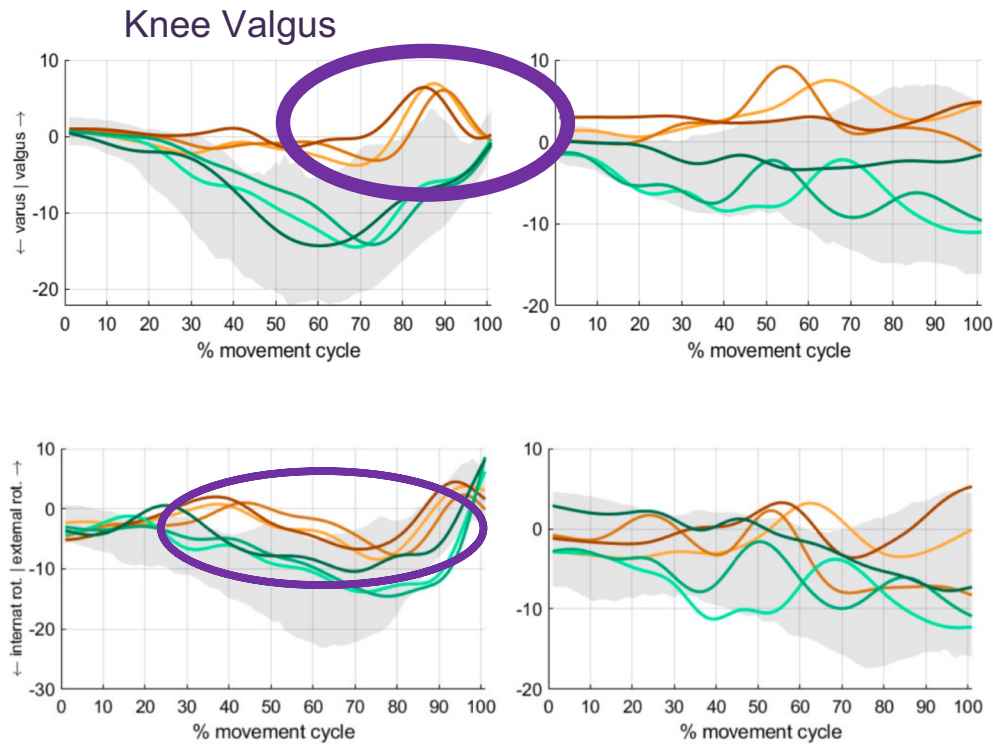
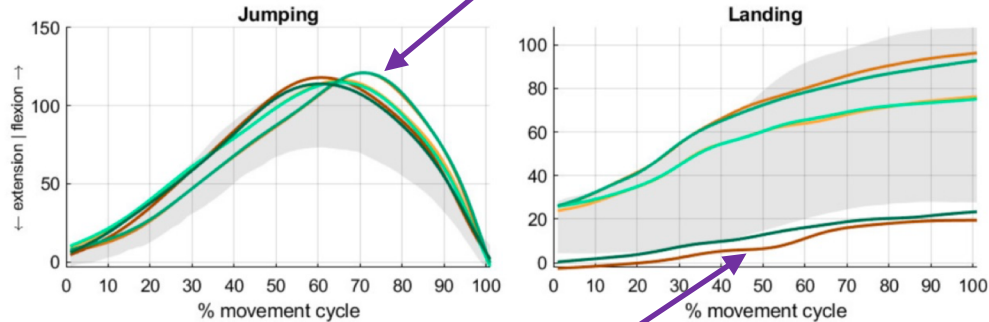
Double Leg Countermovement Jump



- DLCMJLeft3
- DLCMJLeft2
- DLCMJLeft1
- DLCMJRight3
- DLCMJRight2
- DLCMJRight1

Summary So Far:

- + Limited ankle DF L>R
- + High R foot pronation
- + Low Knee flexion
- + High R knee Valgus prior to take off & landing
- + R knee Internal rotation
- + High Hip Flexion
- + ER-->IR Hip Rot



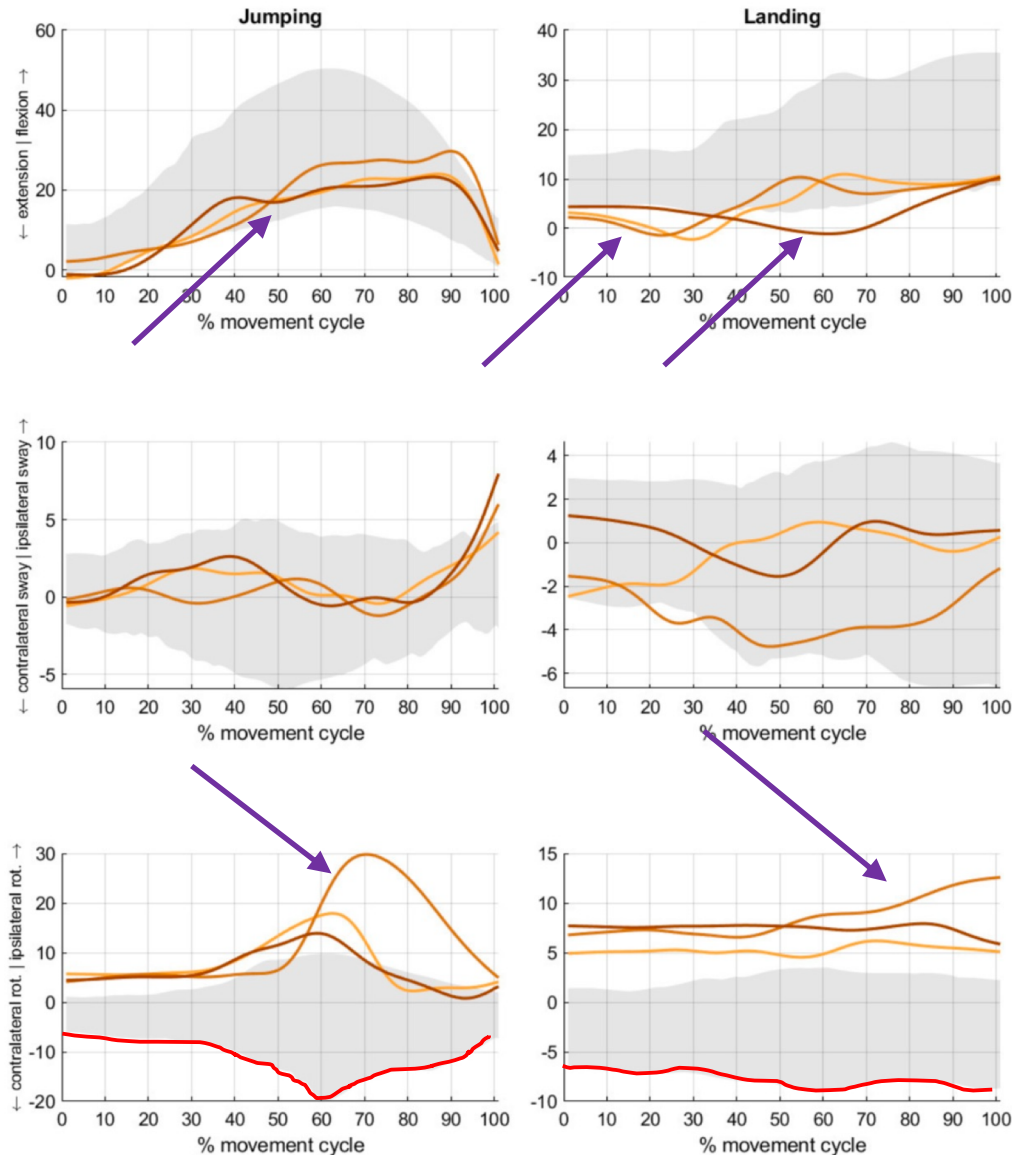
LumbarAngles
Double Leg Countermovement Jump



— DLCMJ3
— DLCMJ2
— DLCMJ1

Summary So Far:

- + Limited ankle DF L>R
- + High **R** foot pronation
- + Low Knee flexion
- + High **R** knee Valgus prior to take off & landing
- + **R** knee Internal rotation
- + High Hip Flexion
- + ER-->IR Hip Rot
- + Low L/Sp flex (CON)
- + High L/Sp EXT on landing
- + High right side L/Sp ROT



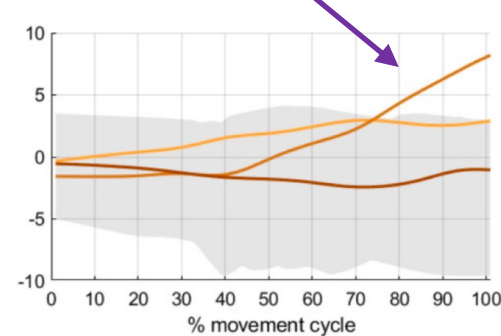
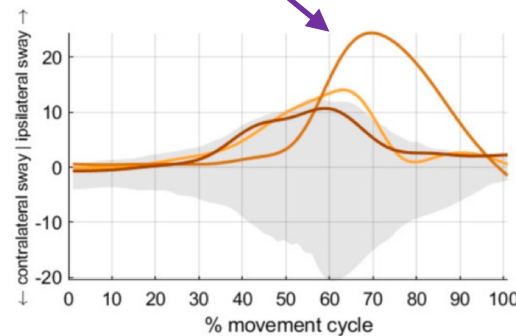
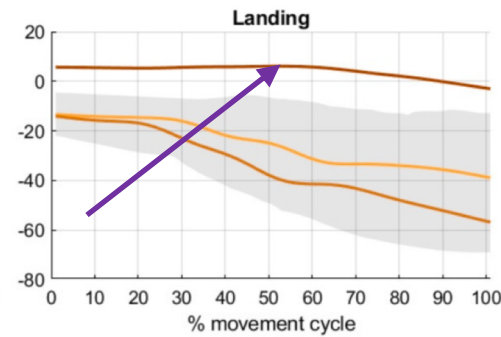
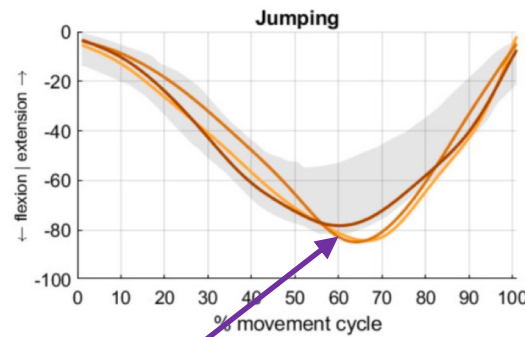
ThoraxSegment
Double Leg Countermovement Jump



— DLCMJ3
— DLCMJ2
— DLCMJ1

Summary So Far:

- + Limited ankle DF L>R
- + High R foot pronation
- + Low Knee flexion
- + High R knee Valgus prior to take off & landing
- + R knee Internal rotation
- + High Hip Flexion
- + ER-->IR Hip Rot
- + Low L/Sp flex (CON)
- + High L/Sp EXT on landing
- + High L/Sp EXT on landing
- + High trunk flexion (CON)



Kinematics Summary

Overall:

- Limited ankle DF **L>R**
- High **R** foot pronation
- Low Knee flexion
- High **R** knee Valgus prior to take off & landing
- **R** knee Internal rotation
- High Hip Flexion
- ER-->IR Hip Rot
- Low L/Sp flex (CON)
- High L/Sp EXT on landing
- High L/Sp EXT on landing
- High trunk flexion (CON)

Trial 2:

- High R hip ABD
- R rotation
- R sided rotation
- R sided lateral sway

Explains right sided landing force asymmetry

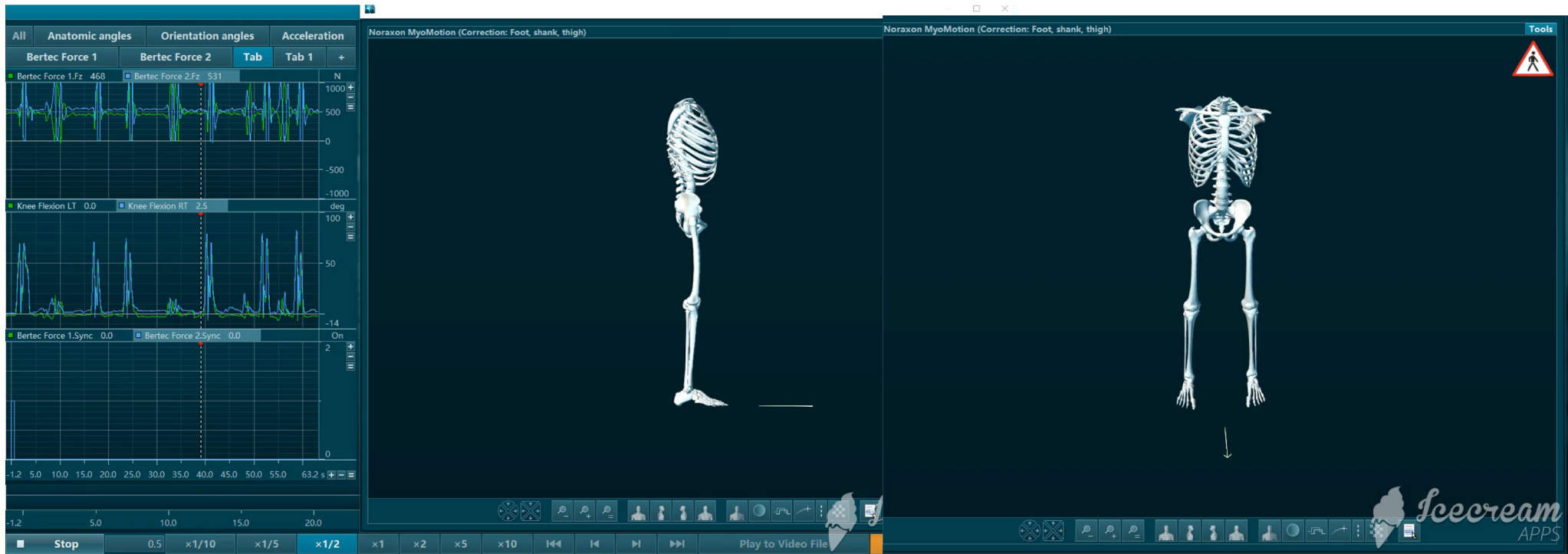
Trial 3:

- Lands in PF
- Greater supination
- Greater knee EXT landing
- Greater Hip EXT on landing
- Greater L/Sp EXT on landing
- High Trunk EXT on landing

Explains higher Peak landing forces

Kinematic & Kinetics Session

Athlete: NBA "Point Guard"



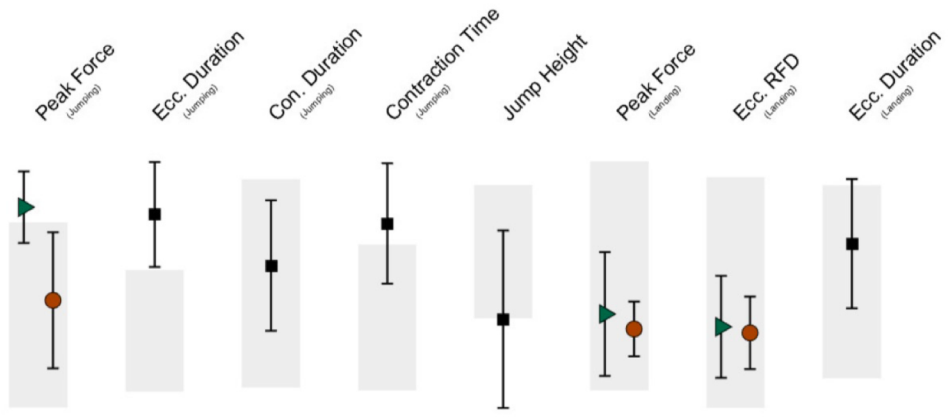
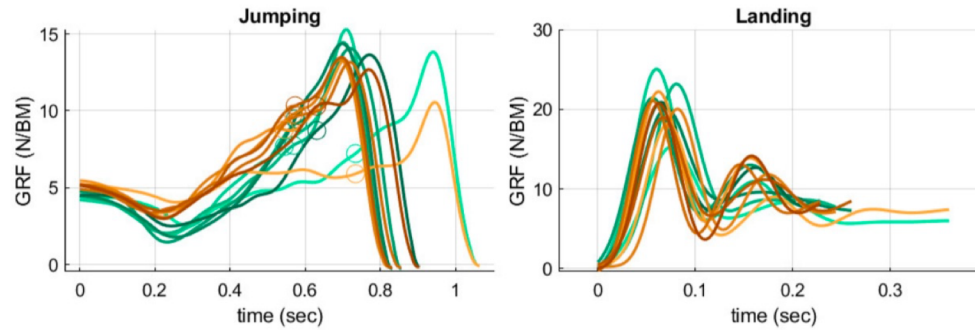
Strength Assessment I
 Double Leg Countermovement Jump



Kinetics:

Athlete 3:

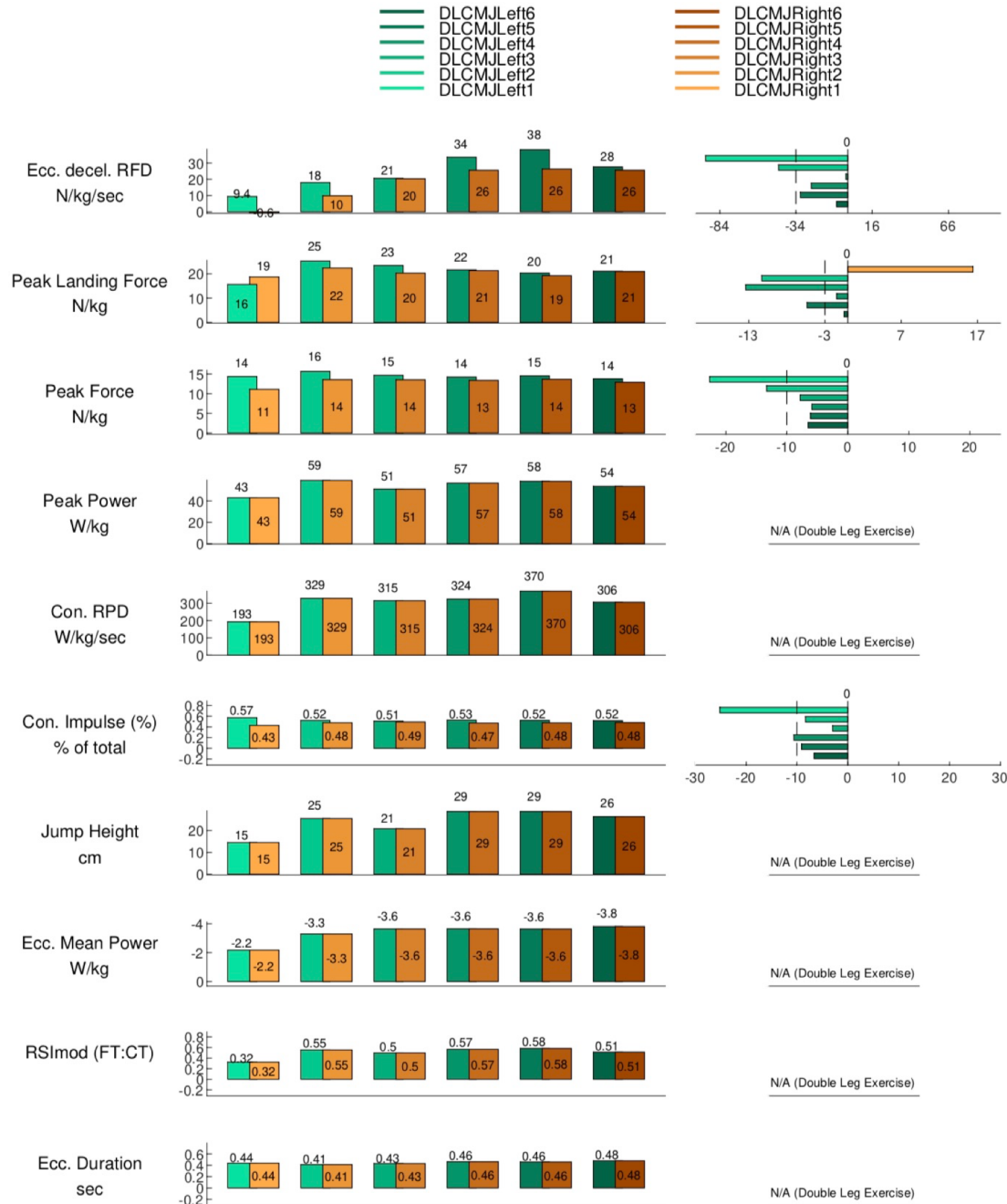
- DLCMJLeft6
- DLCMJLeft5
- DLCMJLeft4
- DLCMJLeft3
- DLCMJLeft2
- DLCMJLeft1
- DLCMJRight6
- DLCMJRight5
- DLCMJRight4
- DLCMJRight3
- DLCMJRight2
- DLCMJRight1



	Variable	Left Trials Mean (CoV)	Right Trials Mean (CoV)	Asymmetry (%)
Jumping	Peak Force (N/kg)	14.26 (0.04)	12.75 (0.08)	11
	Ecc. Duration (sec)		0.60 (0.11)	-
	Con. Duration (sec)		0.27 (0.09)	-
	Contraction Time		0.88 (0.10)	-
	Jump Height (cm)		24.11 (0.22)	-
Landing	Peak Force (N/kg)	20.99 (0.15)	20.19 (0.07)	4
	Ecc. RFD (N/kg/sec)	315.85 (0.24)	306.88 (0.17)	3
	Ecc. Duration (sec)		0.25 (0.23)	-

Strength Assessment II

Double Leg Countermovement Jump



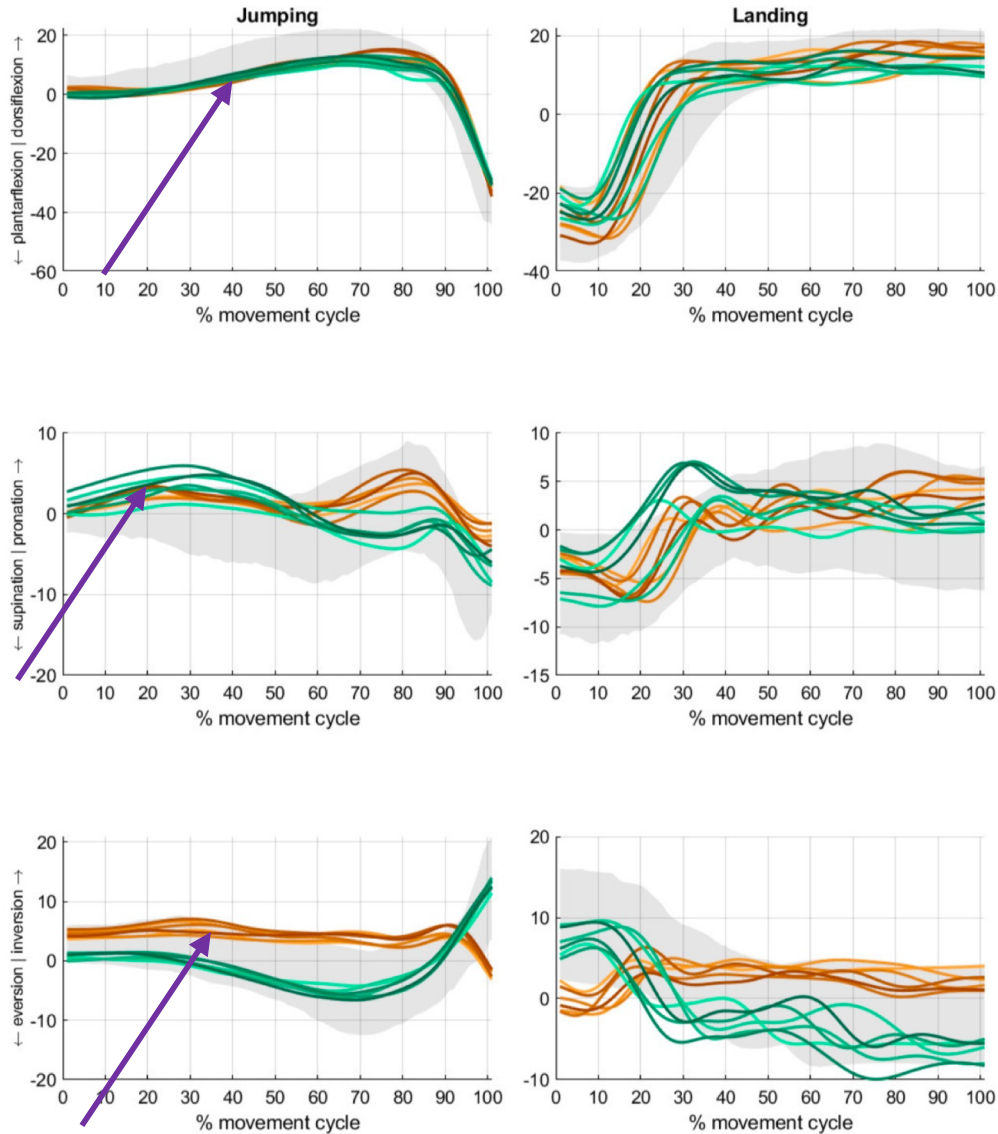
AnkleAngles

Double Leg Countermovement Jump



- DLCMJLeft6
- DLCMJLeft5
- DLCMJLeft4
- DLCMJLeft3
- DLCMJLeft2
- DLCMJLeft1
- DLCMJRight6
- DLCMJRight5
- DLCMJRight4
- DLCMJRight3
- DLCMJRight2
- DLCMJRight1

Summary So Far:
+ Bilaterally Low DF angles
+ **L** foot over pronates
+ Abnormal **R** foot INV



KneeAngles

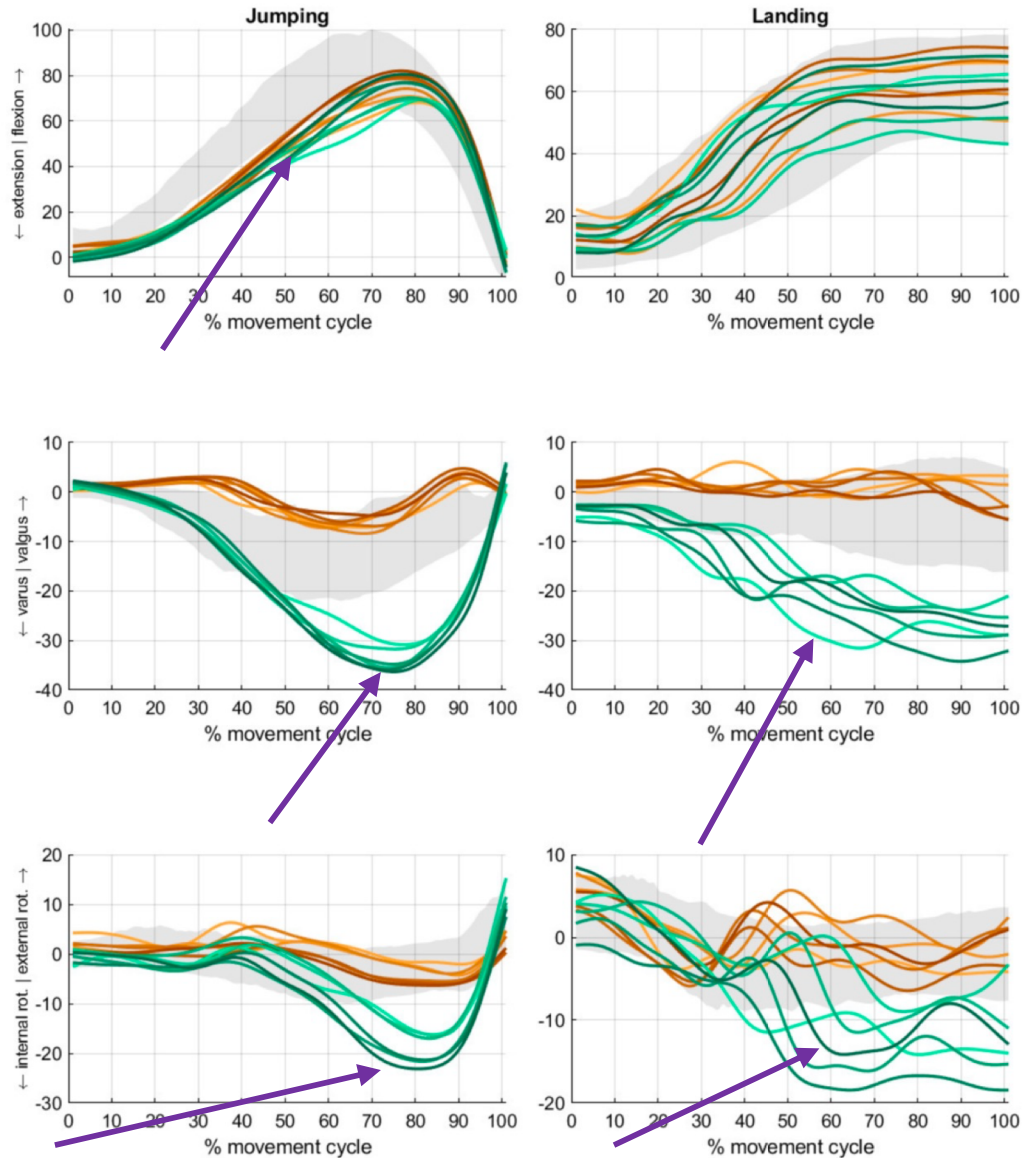
Double Leg Countermovement Jump



- DLCMJLeft6
- DLCMJLeft5
- DLCMJLeft4
- DLCMJLeft3
- DLCMJLeft2
- DLCMJLeft1
- DLCMJRight6
- DLCMJRight5
- DLCMJRight4
- DLCMJRight3
- DLCMJRight2
- DLCMJRight1

Summary So Far:

- + Bilaterally Low DF angles
- + L foot over pronates
- + Abnormal R foot INV
- + Reduced knee Flex
- + Very high L knee varus
- + Very high L knee IR



HipAngles

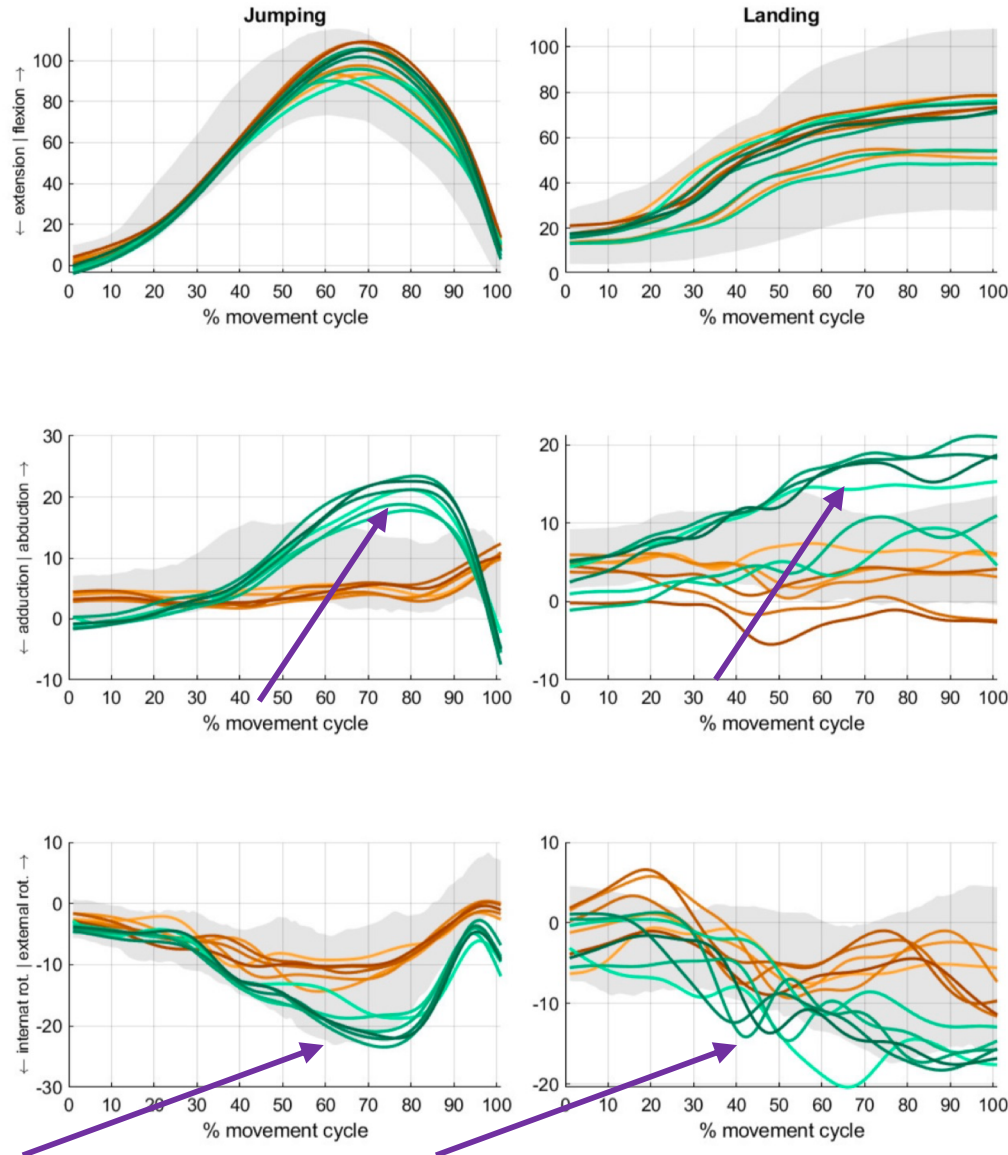
Double Leg Countermovement Jump



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- DLCMJLeft4
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Summary So Far:

- + Bilaterally Low DF angles
- + L foot over pronates
- + Abnormal R foot INV
- + Reduced knee Flex
- + Very high L knee varus
- + Very high L knee IR
- + Very high L ABD (CON + Landing)
- + Very high L hip IR (CON + Landing)



LumbarAngles

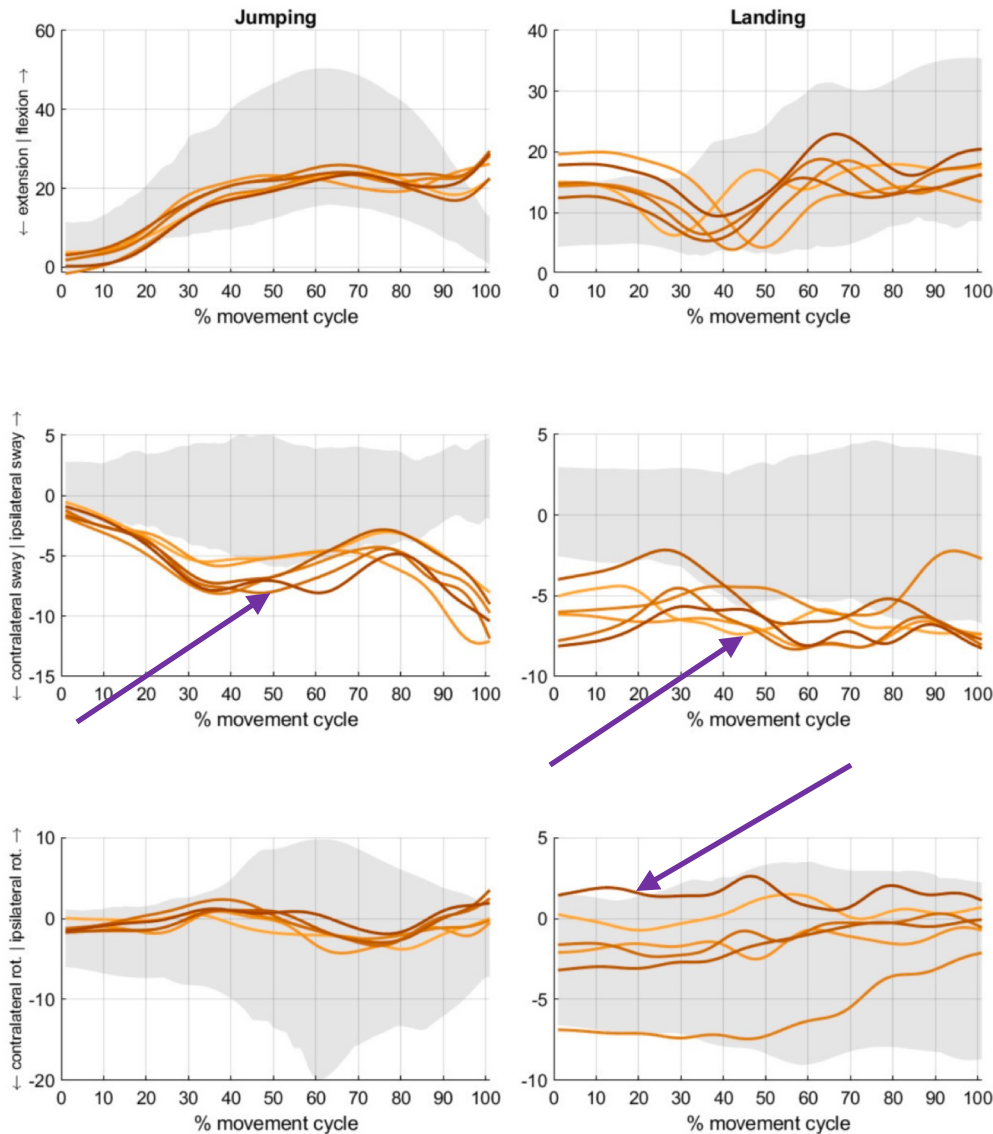
Double Leg Countermovement Jump



- DLCMJ6
- DLCMJ5
- DLCMJ4
- DLCMJ3
- DLCMJ2
- DLCMJ1

Summary So Far:

- + Bilaterally Low DF angles
- + L foot over pronates
- + Abnormal R foot INV
- + Reduced knee Flex
- + Very high L knee varus
- + Very high L knee IR
- + Very high L ABD (CON + Landing)
- + Very high L hip IR (CON + Landing)
- + High L sided L/Sp sway (CON + Landing)



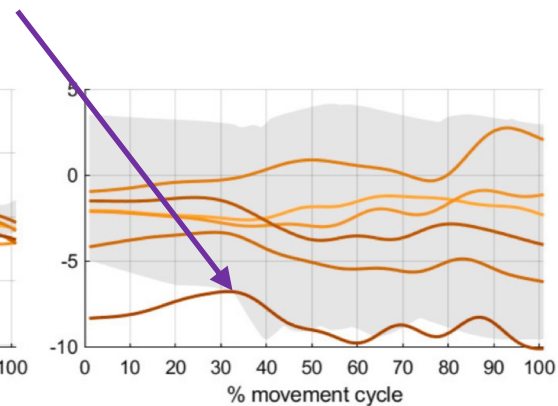
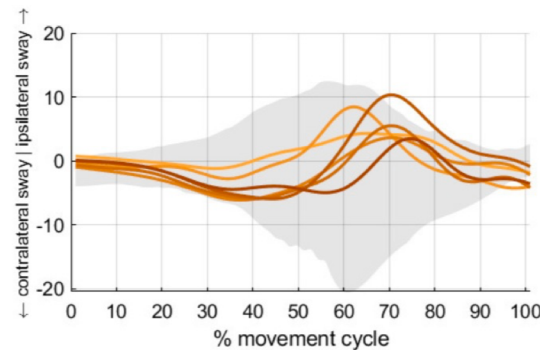
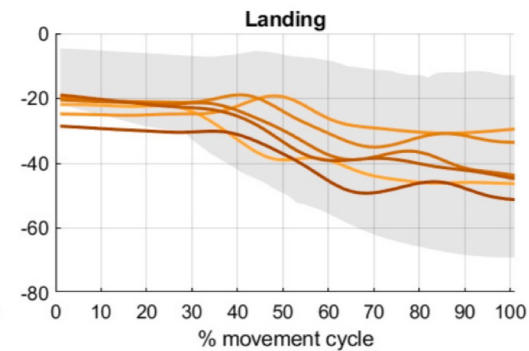
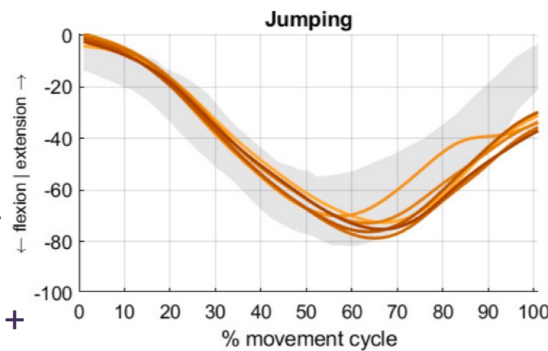
ThoraxSegment
Double Leg Countermovement Jump



- DLCMJ6
- DLCMJ5
- DLCMJ4
- DLCMJ3
- DLCMJ2
- DLCMJ1

Summary So Far:

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- + L foot over pronates
- + Abnormal R foot INV
- + Reduced knee Flex
- + Very high L knee varus
- + Very high L knee IR
- + Very high L ABD (CON + Landing)
- + Very high L hip IR (CON + Landing)
- + High L sided L/Sp sway (CON + Landing)
- + High R sided trunk sway on 6th Trial



Strength Assessment II

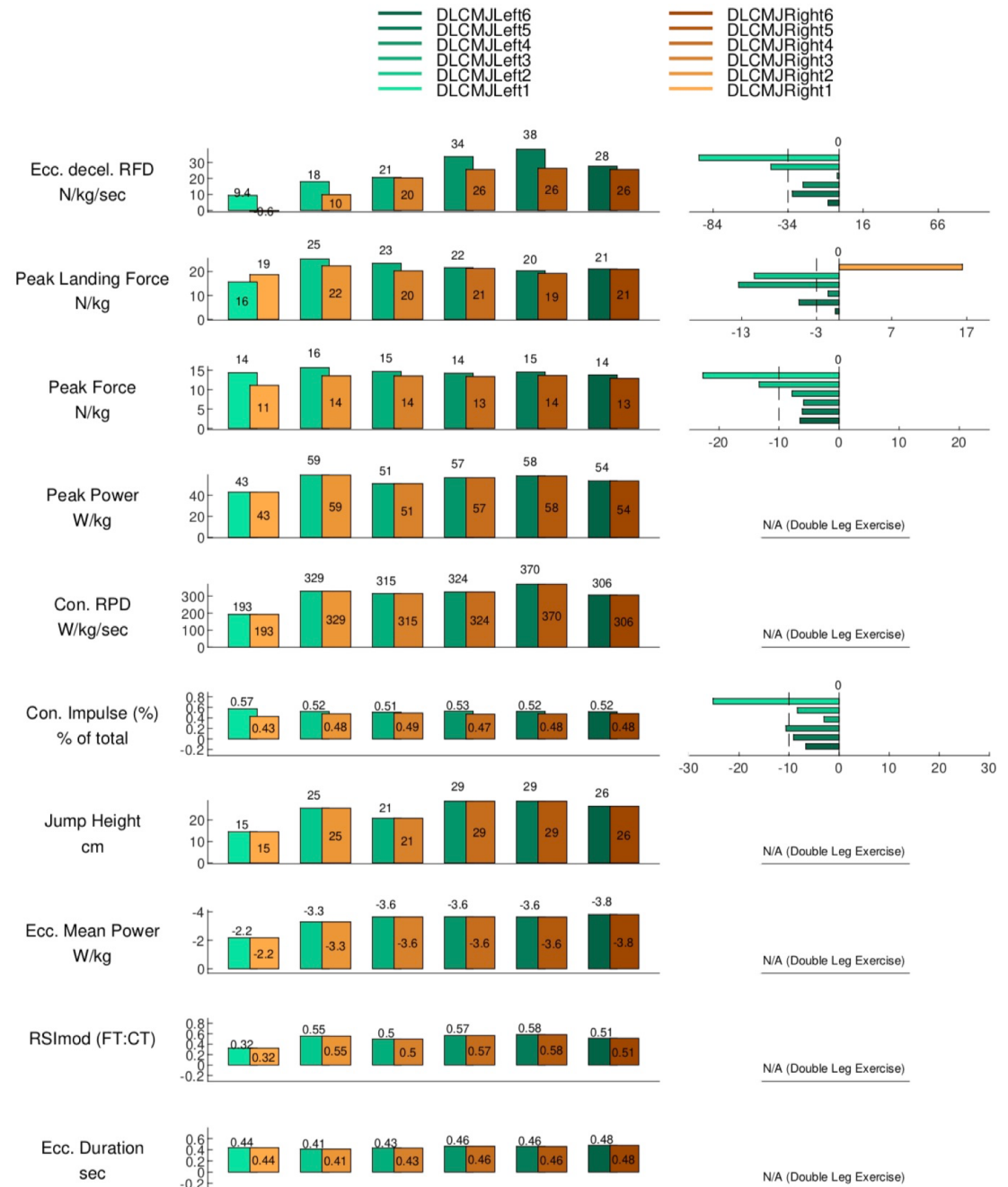


Double Leg Countermovement Jump

Summary So Far:

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- + L foot over pronates
- + Abnormal R foot INV
- + Reduced knee Flex
- + Very high L knee varus
- + Very high L knee IR
- + Very high L ABD (CON + Landing)
- + Very high L hip IR (CON + Landing)
- + High L sided L/Sp sway (CON + Landing)
- + High R sided trunk sway on 6th Trial

Can't explain the 1st trial R landing force asymmetry (??poor trial)



Contact

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