SUPSI

GTM
GRUPPO DI TERAPIA MANUALE

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The Effect of Manual Techniques on Cervical Kinematic. An Innovative Approach using Helical Axis

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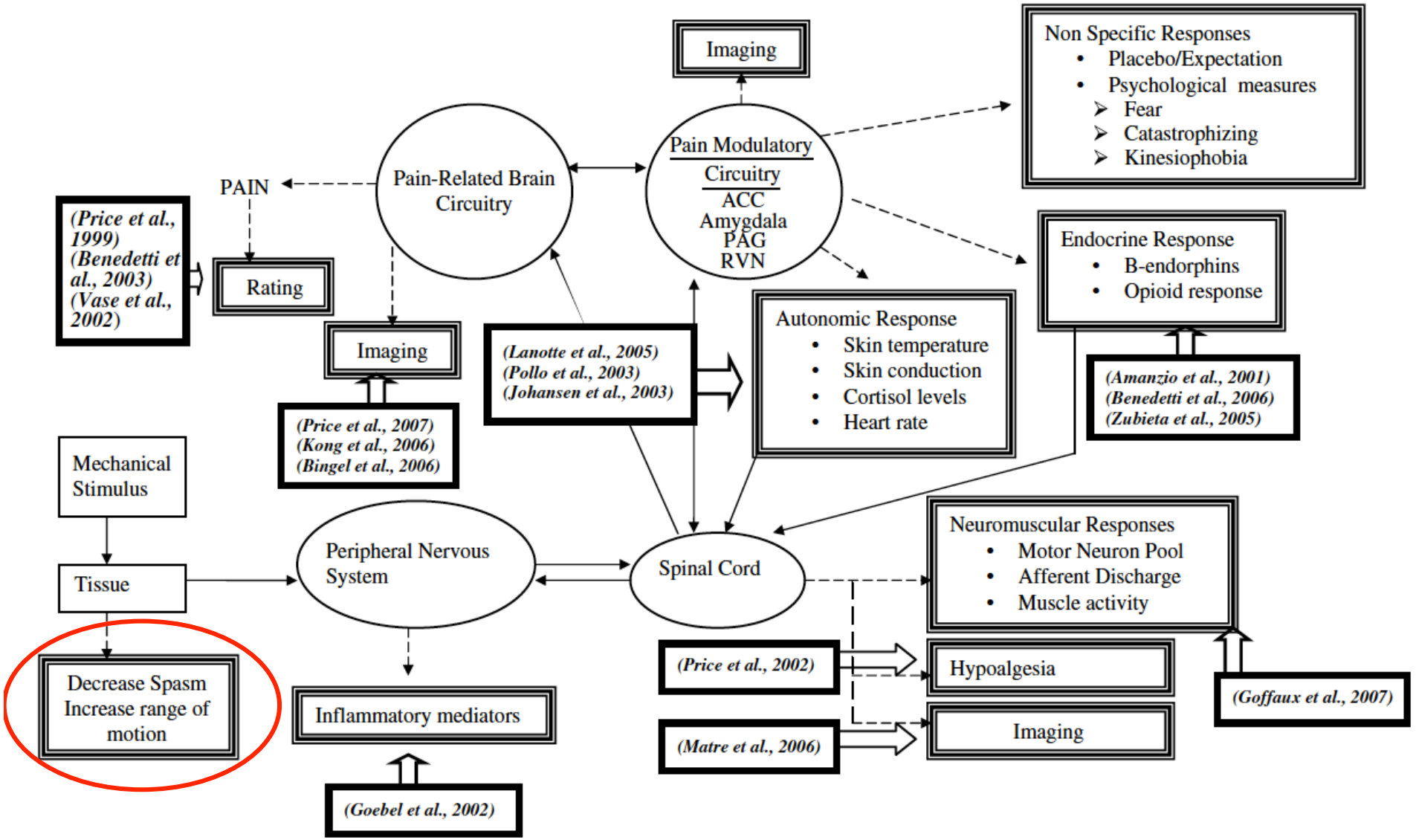
Background

- RCTs show that MT techniques are effective in treating NP
  - *Dunning et al. 2012*, (8/10)
  - *Lau et al. 2011*, (8/10)
  - *Leaver et al. 2010*, (8/10)
  - *Puentedura et al. 2011* (7/10)
- Clinical guidelines recommend MT for NP
  - *Childs et al. 2008*

Background

- What's the underline mechanisms of MT techniques?
- Comprehensive model *(Bialosky et al. 2009)*
  - Peripheral mechanisms
  - Spinal mechanisms
  - Supraspinal mechanisms
- "The mechanisms behind the clinical effectiveness of MT are not established"


Imaging
Non Specific Responses
• Placebo/Expectation
• Psychological measures
➢ Fear
➢ Catastrophizing
➢ Kinesiophobia
Pain-Related Brain Circuitry
Pain Modulatory Circuitry
ACC
Amygdala
PAG
RVN
PAIN
(Price et al., 1999)
(Benedetti et al., 2003)
(Vase et al., 2002)
Rating
Endocrine Response
• B-endorphins
• Opioid response
Imaging
(Lanotte et al., 2005)
(Pollo et al., 2003)
(Johansen et al., 2003)
Autonomic Response
• Skin temperature
• Skin conduction
• Cortisol levels
• Heart rate
(Amanzio et al., 2001)
(Benedetti et al., 2006)
(Zubieta et al., 2005)
(Price et al., 2007)
(Kong et al., 2006)
(Bingel et al., 2006)
Mechanical Stimulus
Peripheral Nervous System
Spinal Cord
Neuromuscular Responses
• Motor Neuron Pool
• Afferent Discharge
• Muscle activity
Tissue
(Price et al., 2002)
Hypoalgesia
(Goffaux et al., 2007)
Decrease Spasm
Increase range of motion
Inflammatory mediators
(Matre et al., 2006)
Imaging
(Goebel et al., 2002)

Research questions

- What's the effect of MT techniques on cervical kinematic?
- How different MT techniques affect cervical kinematic?
- What's the relationship between cervical kinematic changes due to MT techniques and the clinical outcomes?

The aim

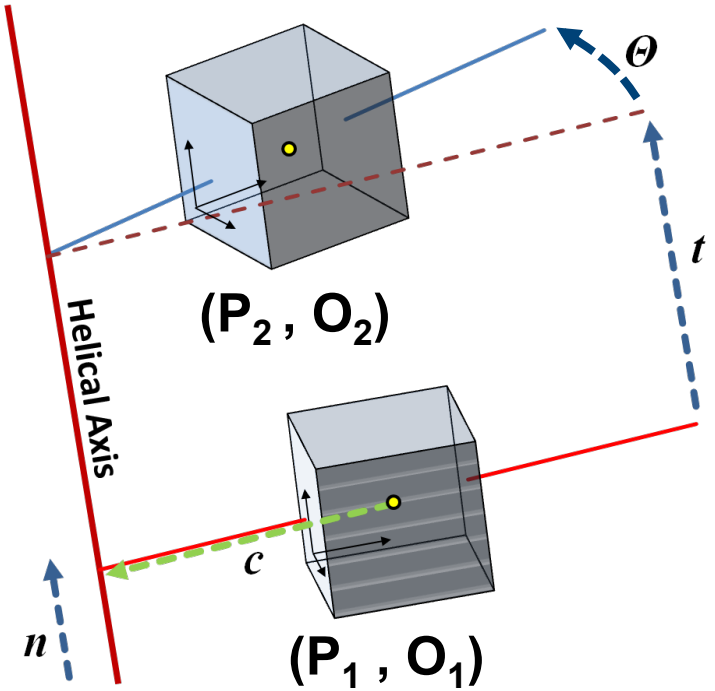
- Develop a kinematic analysis suitable to describe the effect of manual techniques (MT) on cervical spine movements
  - Not only estimation of ROM
  - Parameters to describe “quality of active movements”

Development of the kinematic analysis

- Active movements: rotations and flexion-extension
- 3D kinematics approach
  - Coupling movement *(Cook et al. 2008)*
- Helical axis
  - *Woltring et al., 1985*
  - *Blankevoort et al., 1990*

Helical axis definition

- The motion of an object from one position to another can be broken down into a rotation about and a translation along the instantaneous axis of rotation.
- **(P_{xyz} , O_{xyz})**



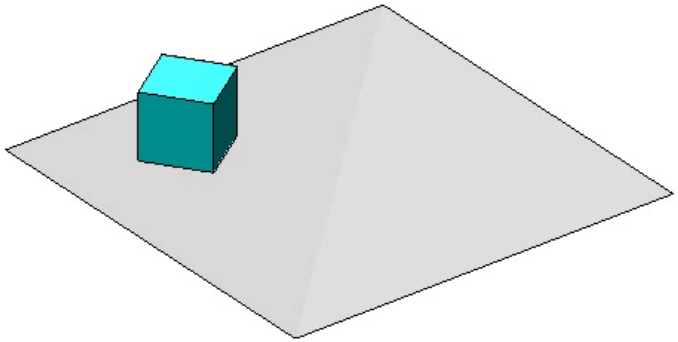
Helical axis and cervical spine

- During head movements the helical axis moves and describe the movement of the cervical spine *(Grip et al 2008)*
- NP may effect the position of the instantaneous axis of rotation *(Winters et al., 1993; Woltring et al., 1994; Moore et al., 2005).*
- Increased variation in axis movement in a group of NP patients as compared with a control group *(Grip et al. 2007)*

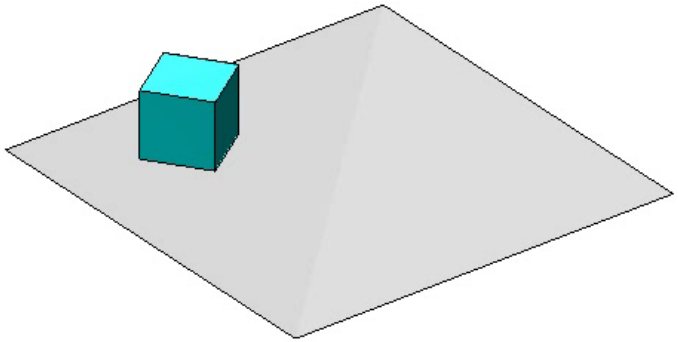
Helical axis and cervical spine

- Theoretical model using animations
  - "Ideal" head rotation
  - Head rotation with position variations
  - Head rotation with with angular variations
  - Head rotation with position and orientation variations

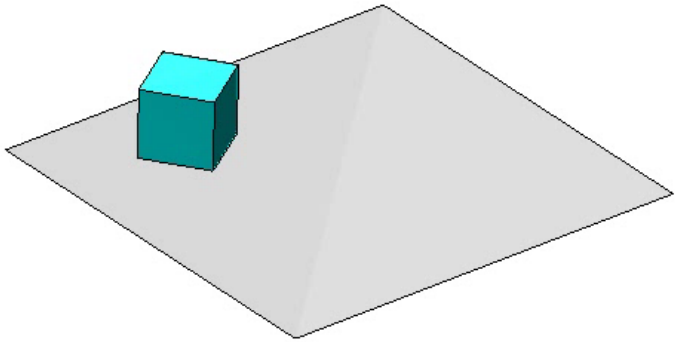
“Ideal” head rotation



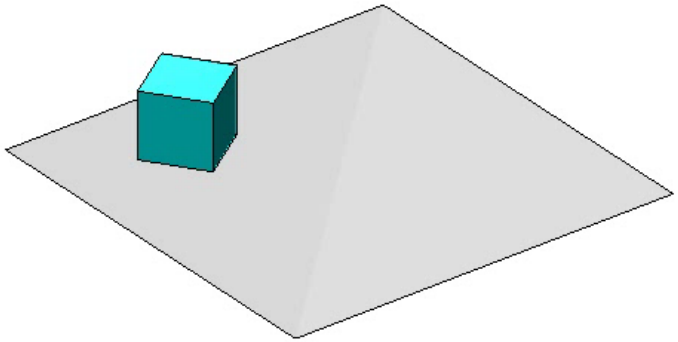
Head rotation with position variations



Head rotation with with angular variations

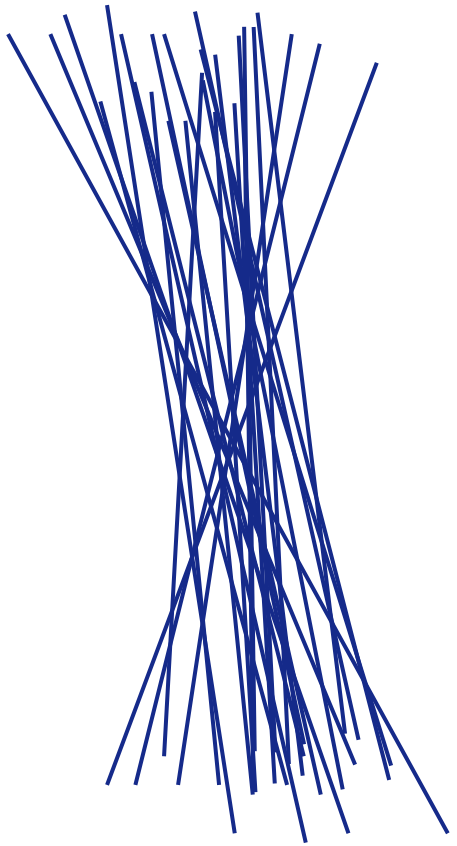


Head rotation with position and angular variations



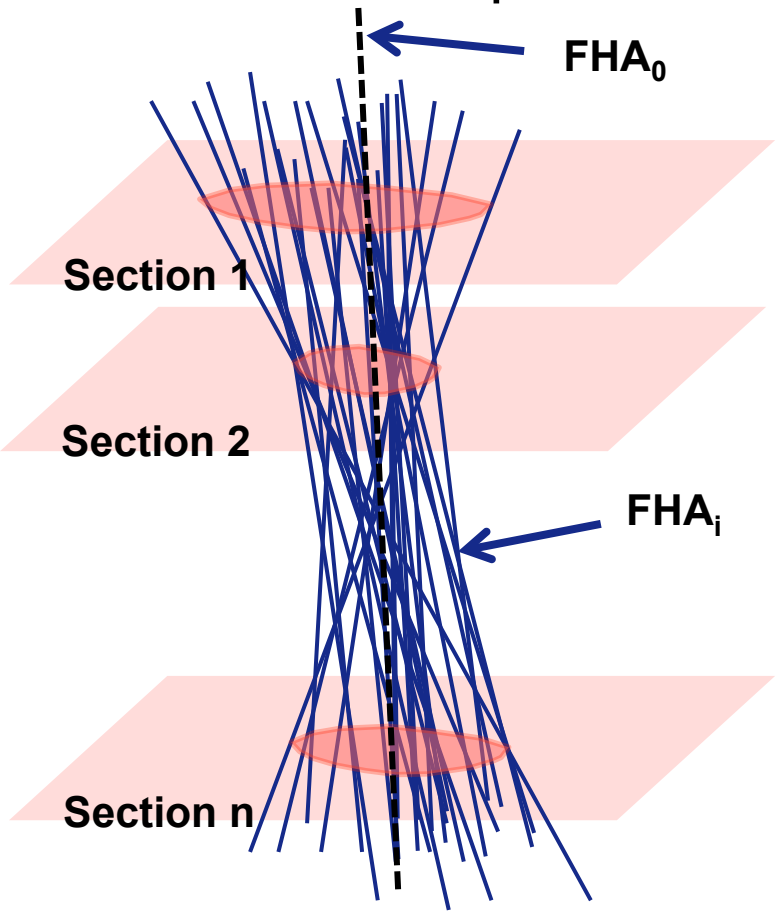
Parameters to describe HA behaviour

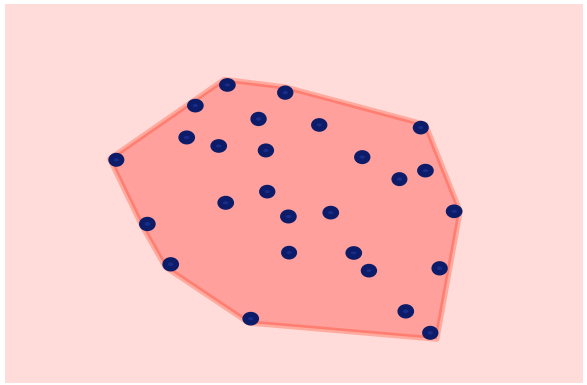
- Comprehensive 3D graphical description of joint motion
- Quantification?
  - Positions
  - Orientation
- Statistical analysis for a dataset?

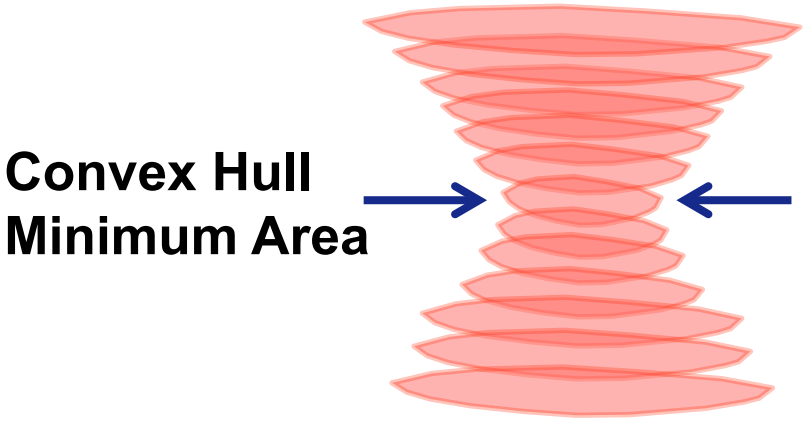


Convex hull area

- Position and dispersion of finite helical axis

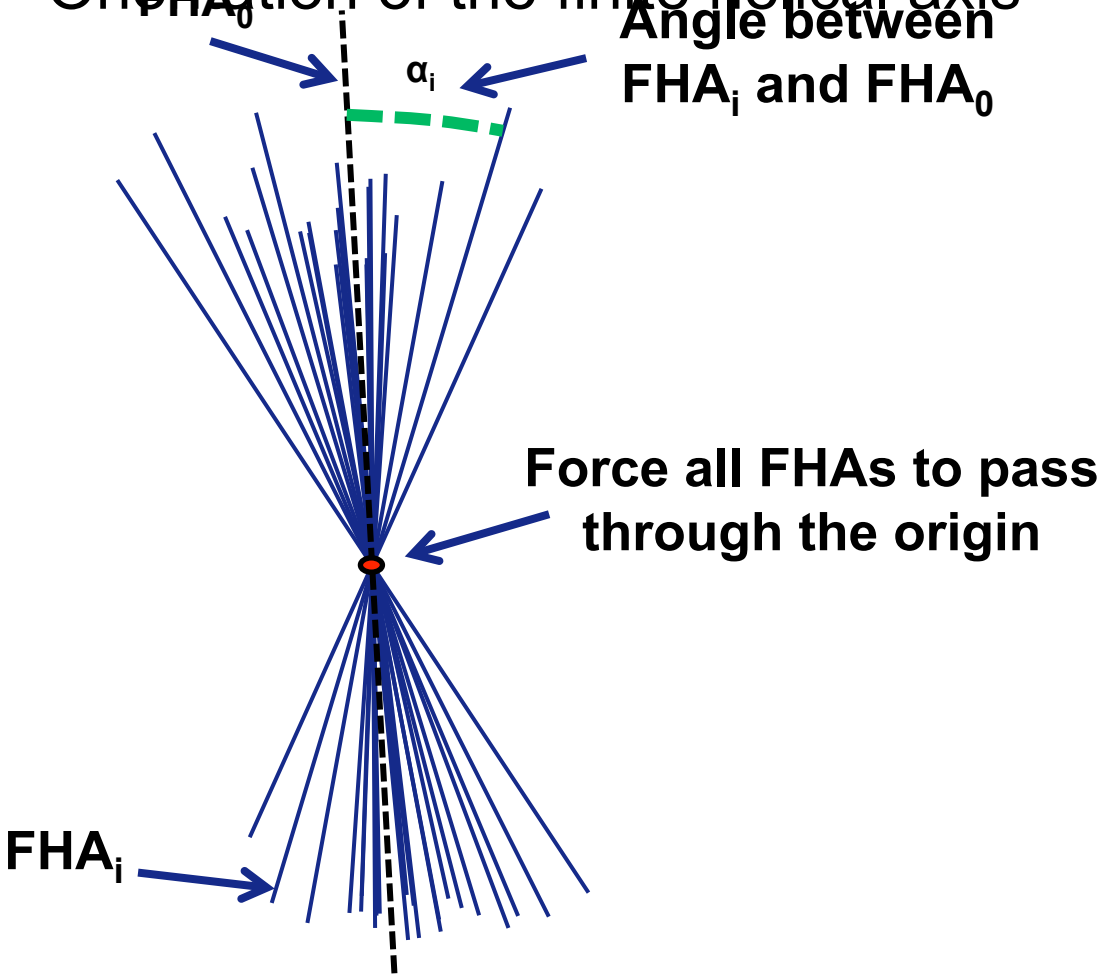


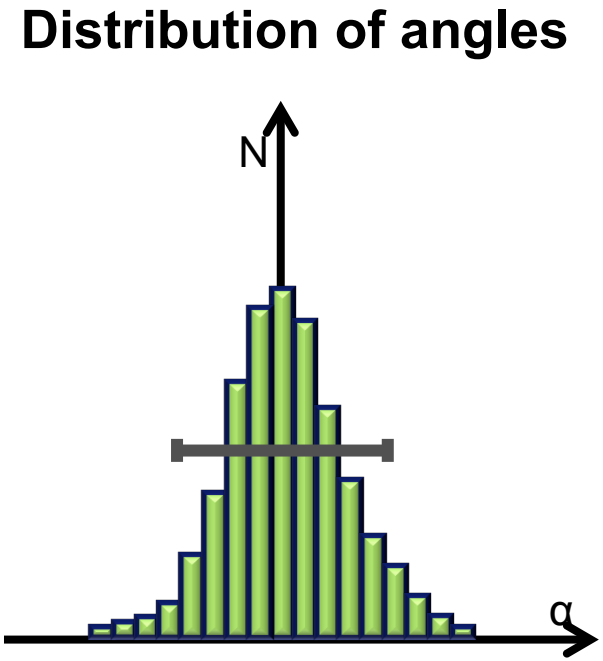




Mean angle devition

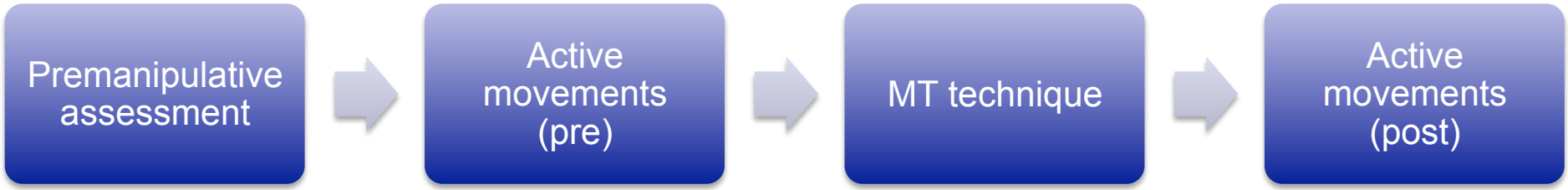
- Orientation of the finite helical axis





Feasibility investigation

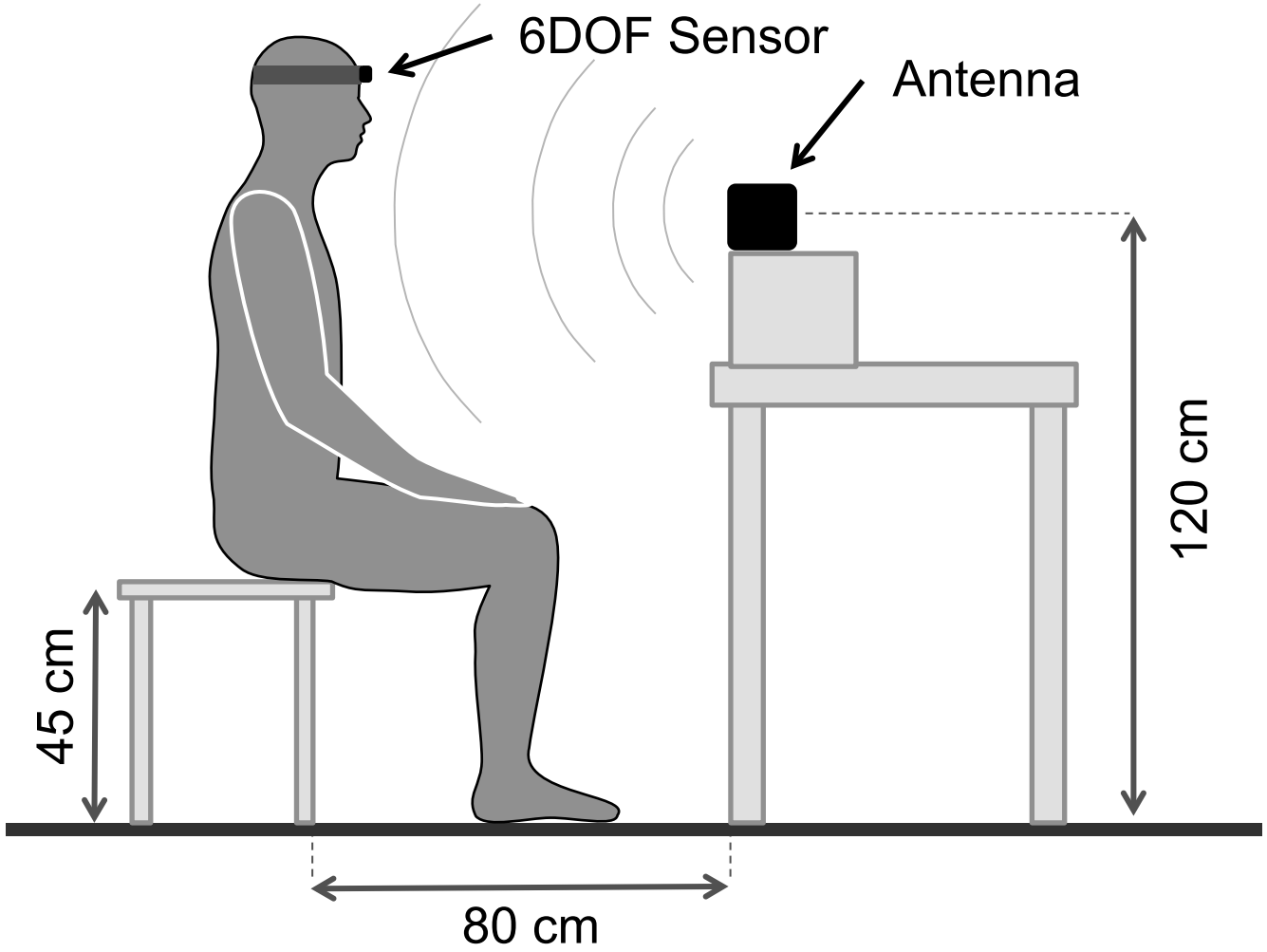
- 2 Healthy volunteers, Montichiari, Italy
- 10 Active rotations and 10 active flexion-extension
- Experienced manual therapist
  - C1-2 rotatory HVLA thrust manipulation (left and right)
  - PA C2 mobilizations (3 sets x 30 ripetitions)



Methods

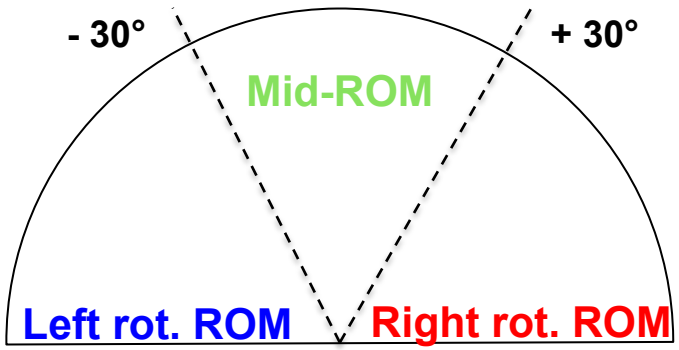
- Electromagnetic tracking system – VRRS, Khymeia

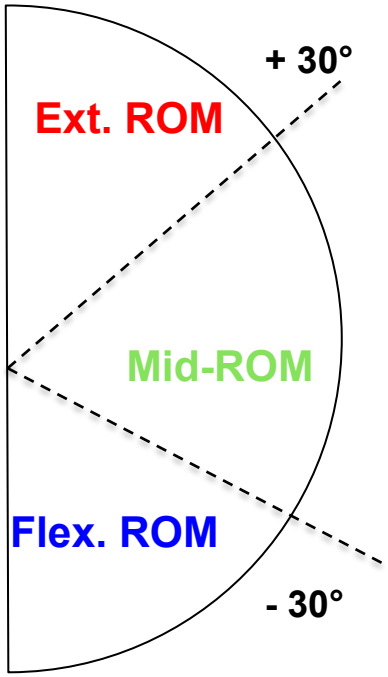
Methods

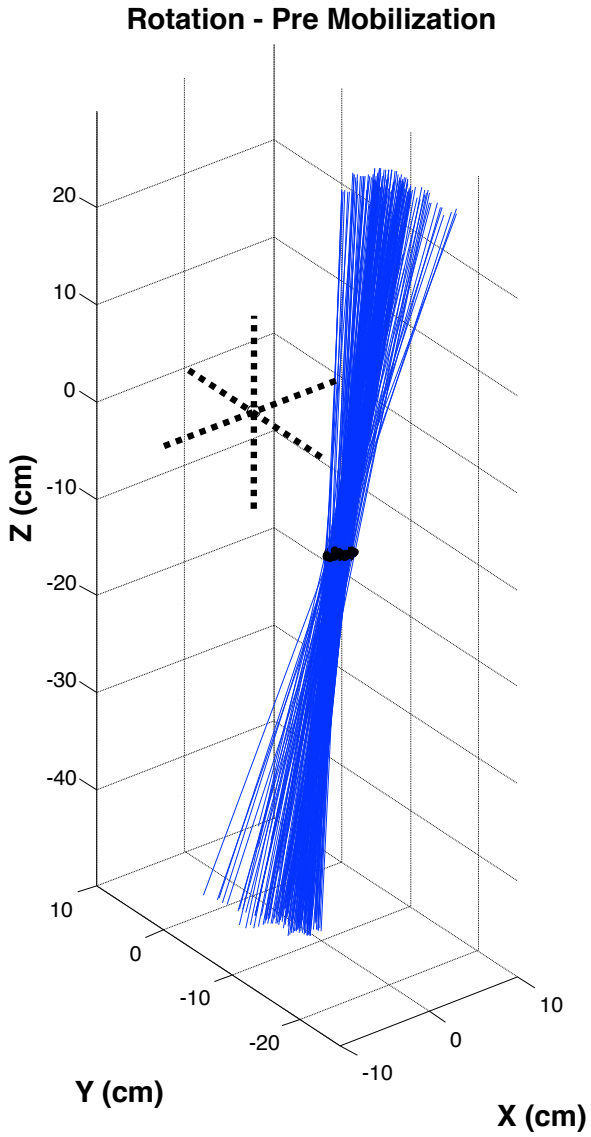


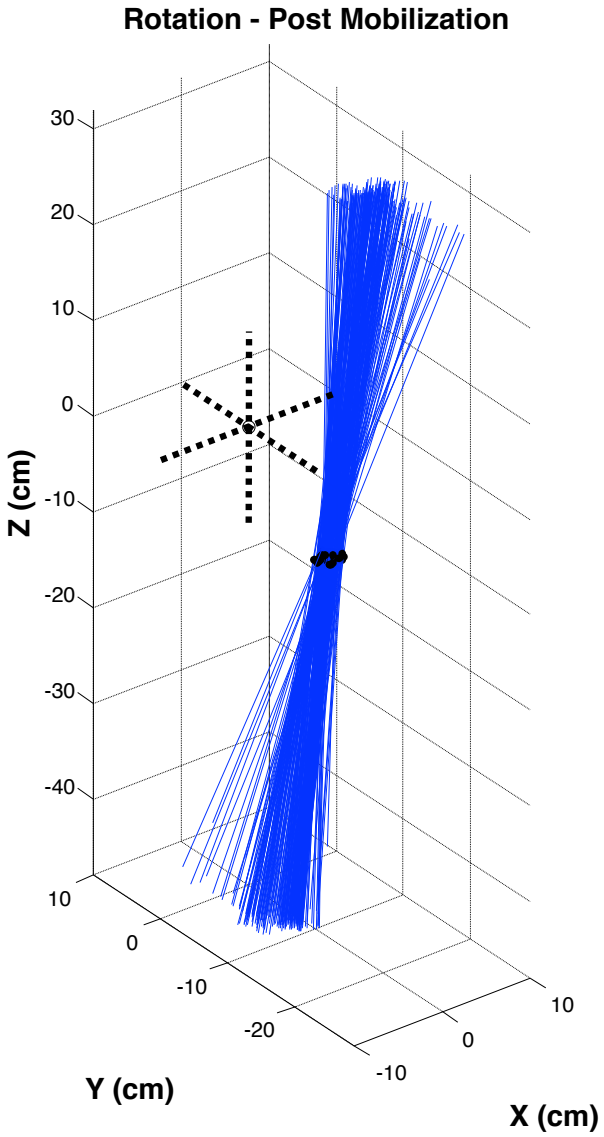
Data processing

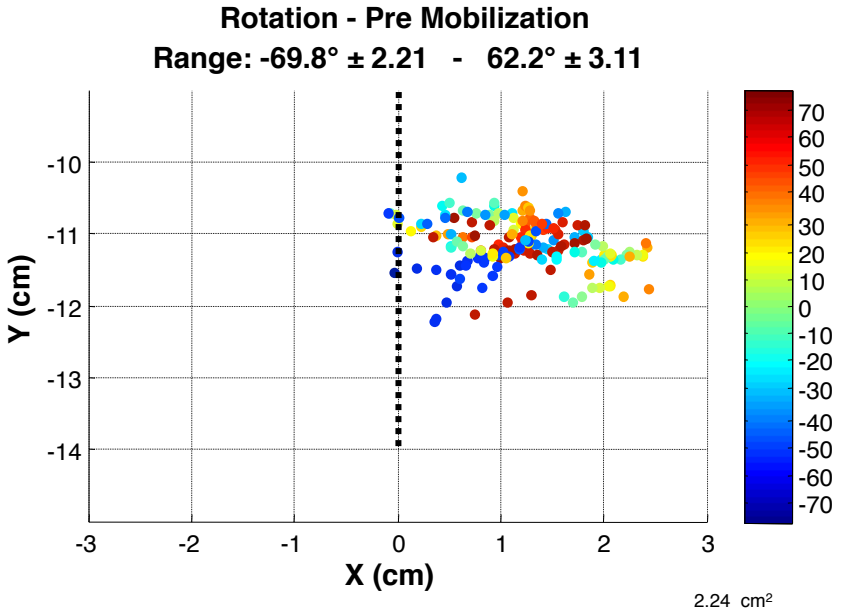
- Helical axis estimantion every 10° degrees at steps of 1°
- Pre/post Convex hull and mean angle deviation

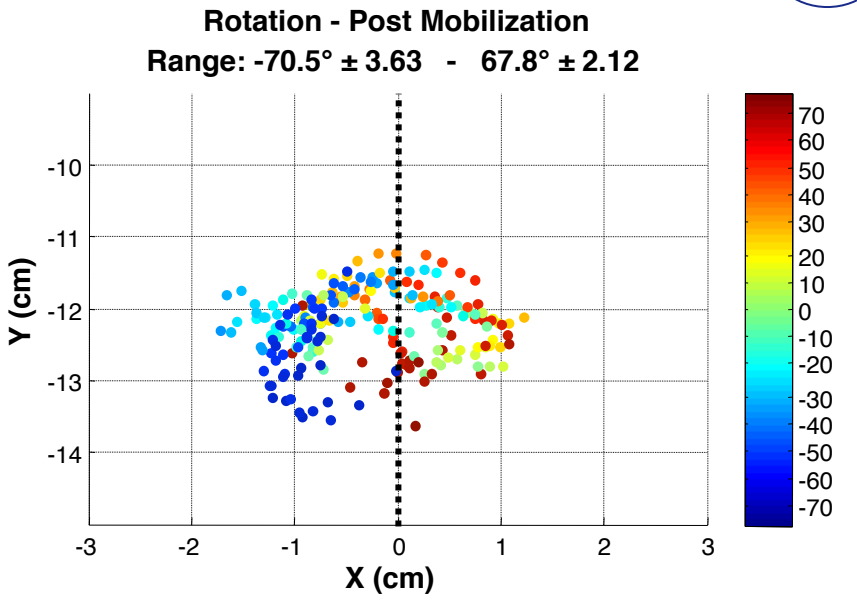





Rotation - Pre Mobilization
Z (cm)
20
10
0
-10
-20
-30
-40
10
0
-10
-20
Y (cm)
10
0
-10
X (cm)


Rotation - Post Mobilization
Z (cm)
30
20
10
0
-10
-20
-30
-40
10
0
-10
-20
Y (cm)
10
0
-10
X (cm)

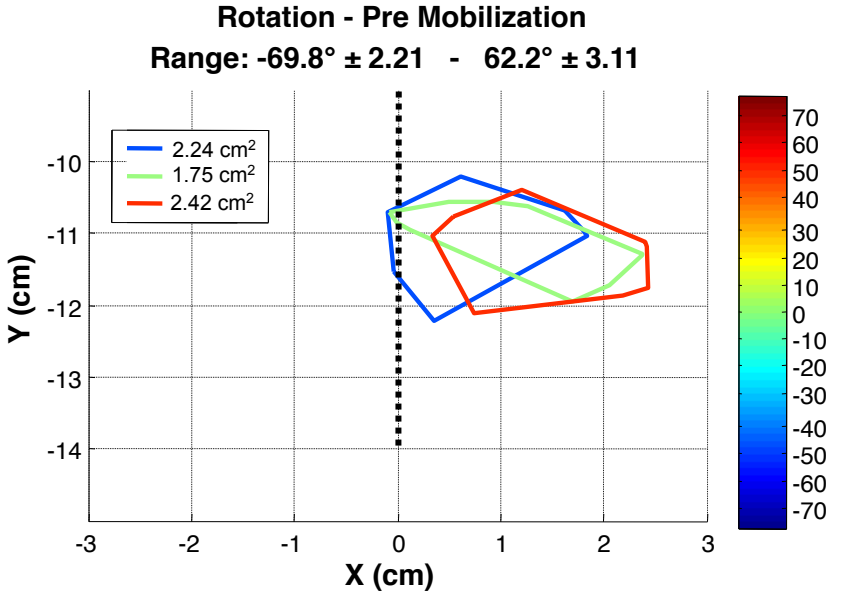


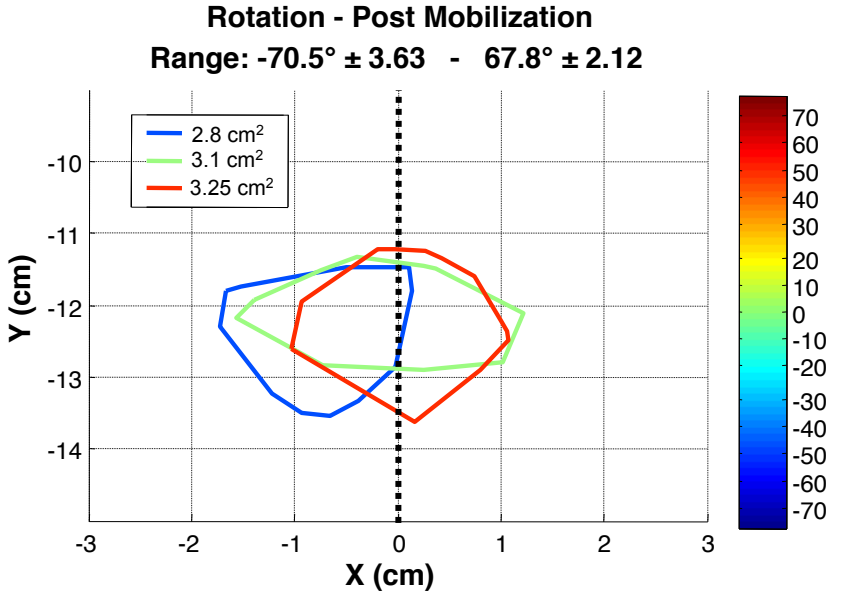


2.24 cm²

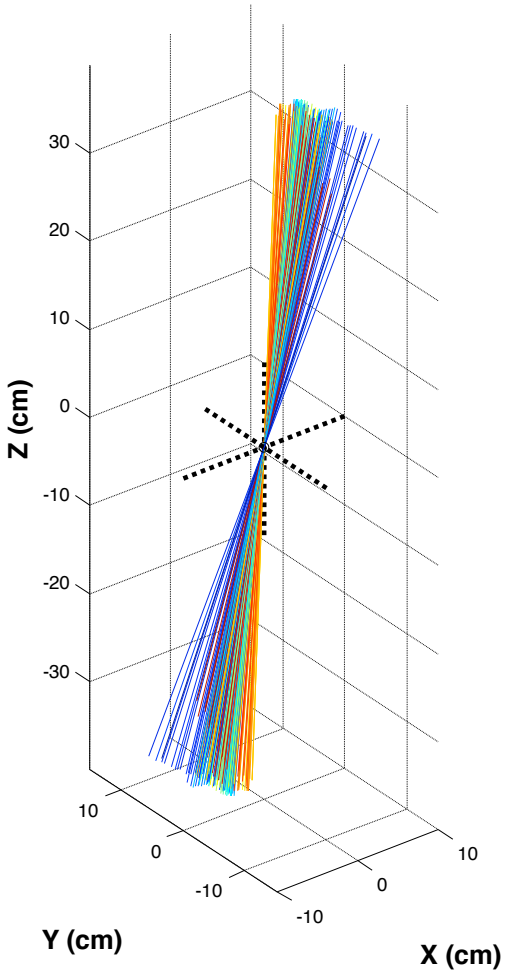
1.75 cm²

2.42

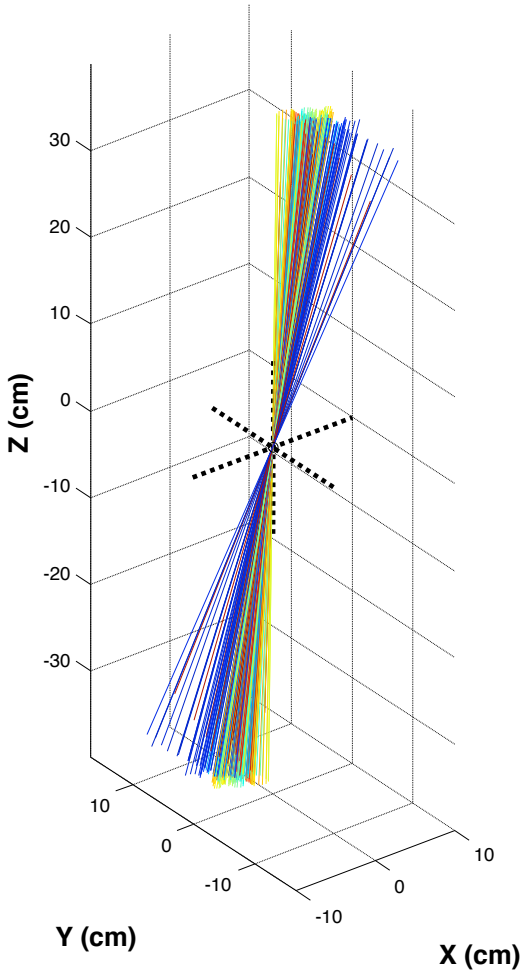


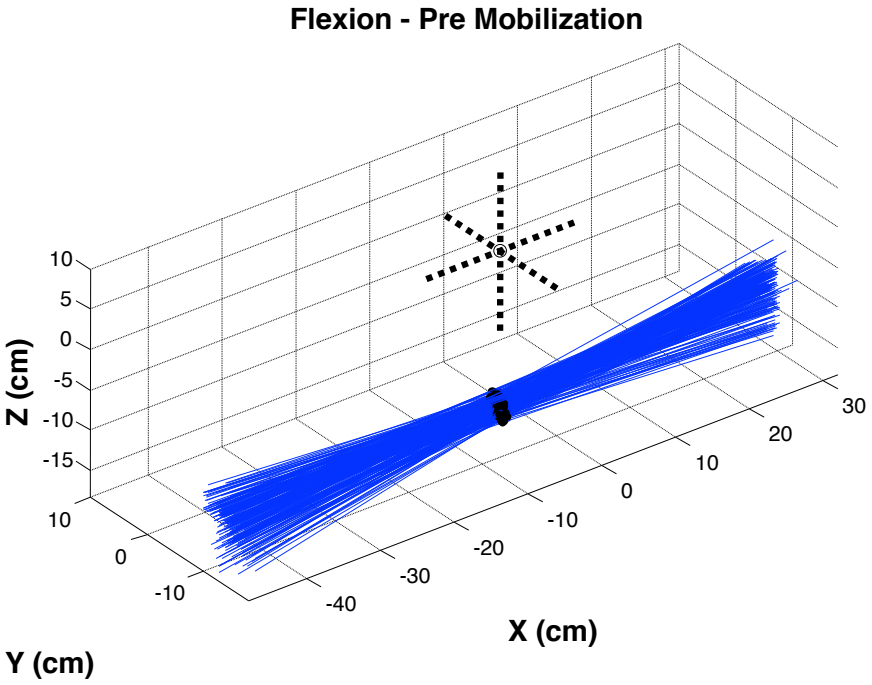


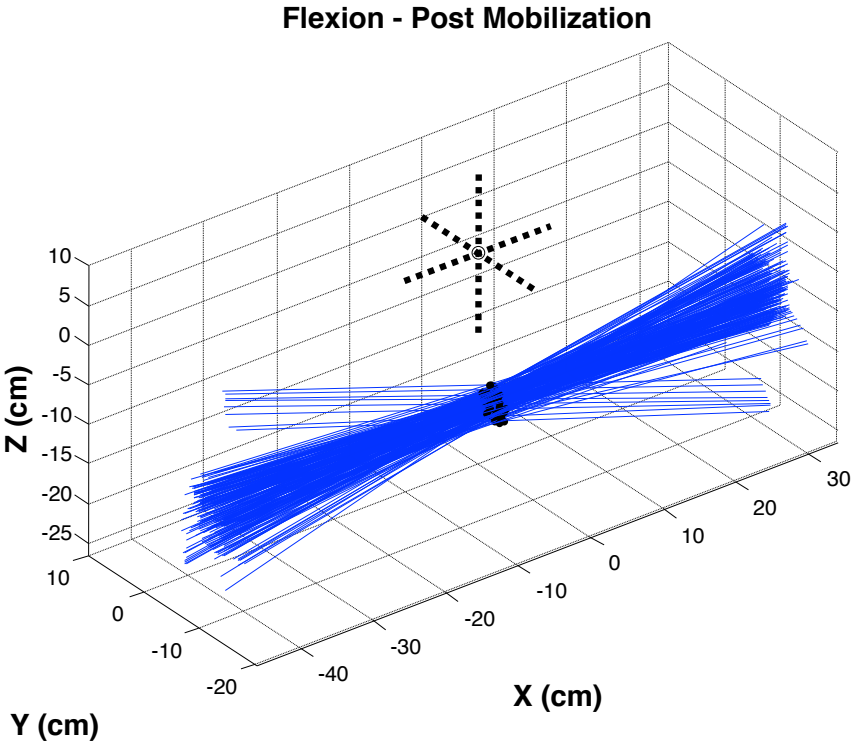
Rotation - Pre Mobilization - Angle: 4° ± 2.65°

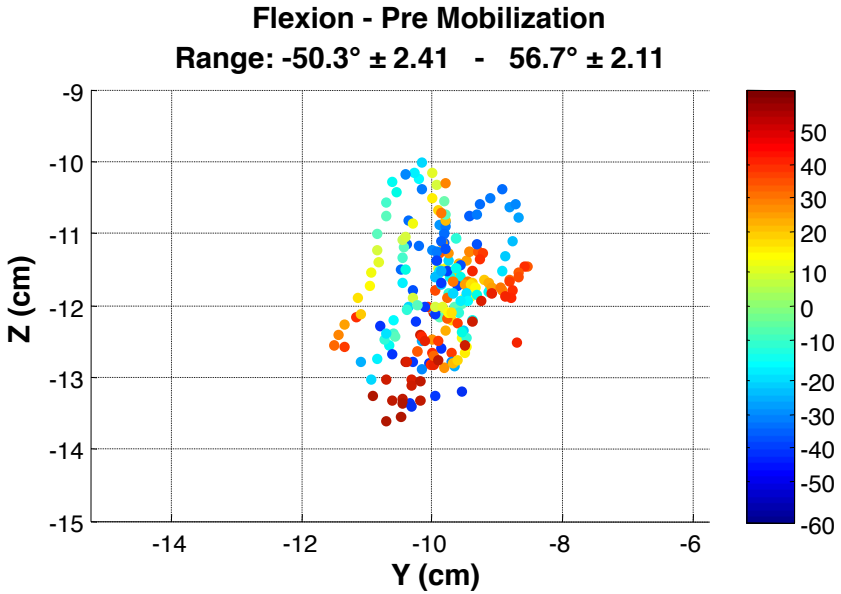


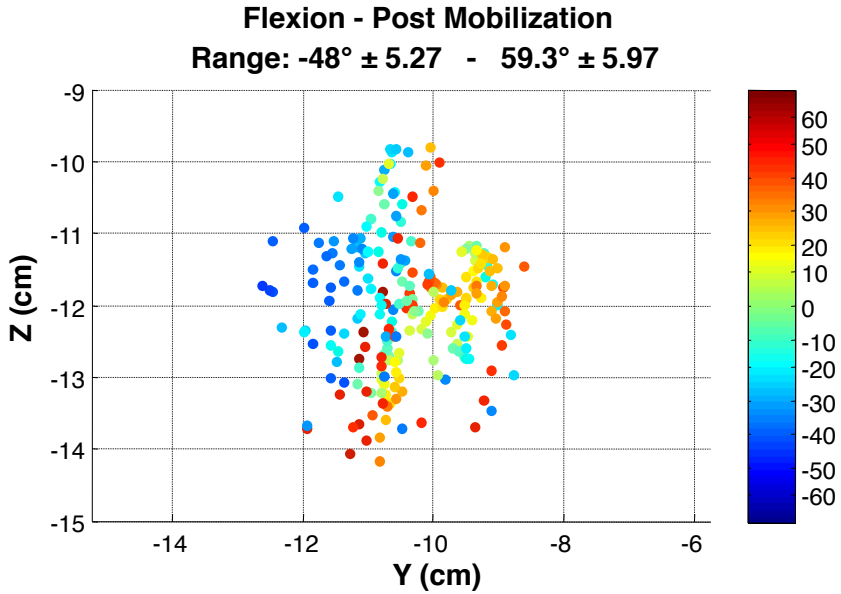
Rotation - Post Mobilization - Angle: 3.46° ± 2.69°

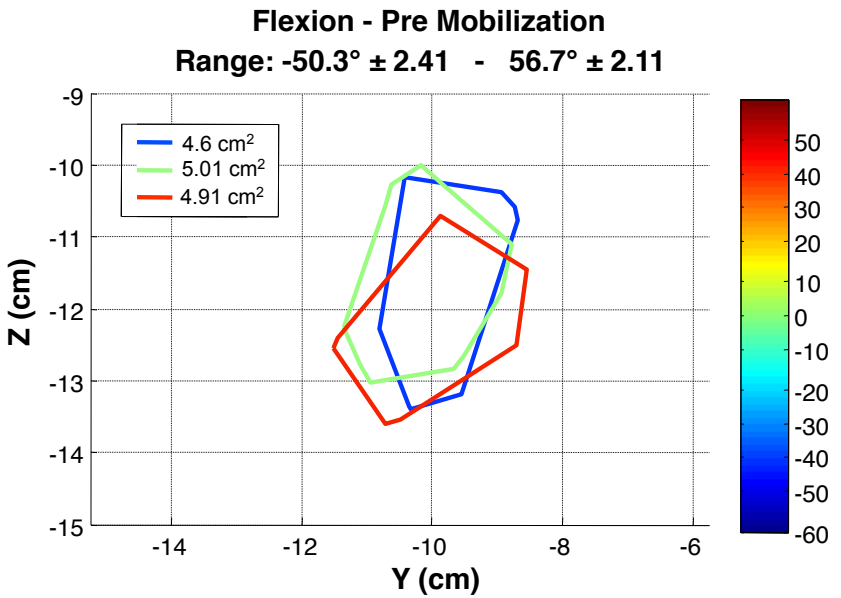


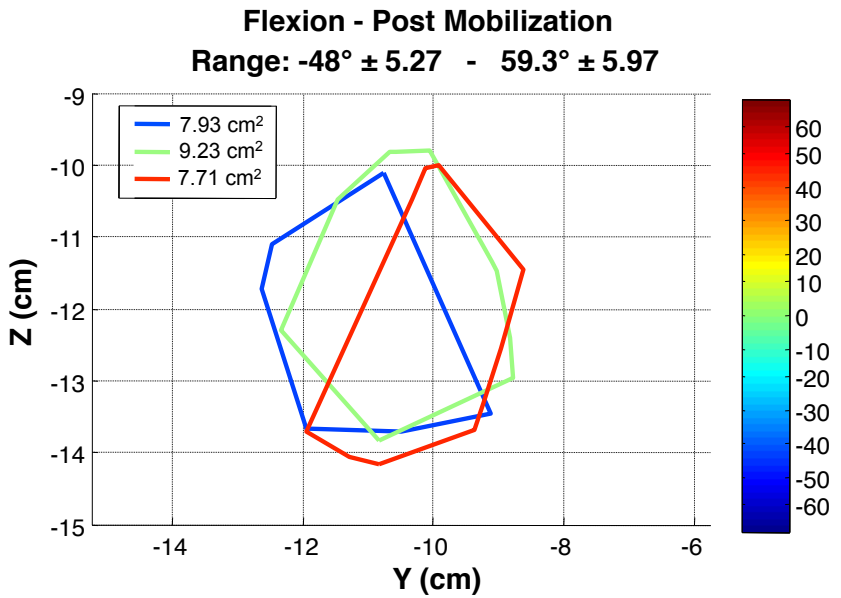

Flexion - Pre Mobilization
Z (cm)
10
5
0
-5
-10
-15
10
0
-10
Y (cm)
-40
-30
-20
-10
0
10
20
30
X (cm)

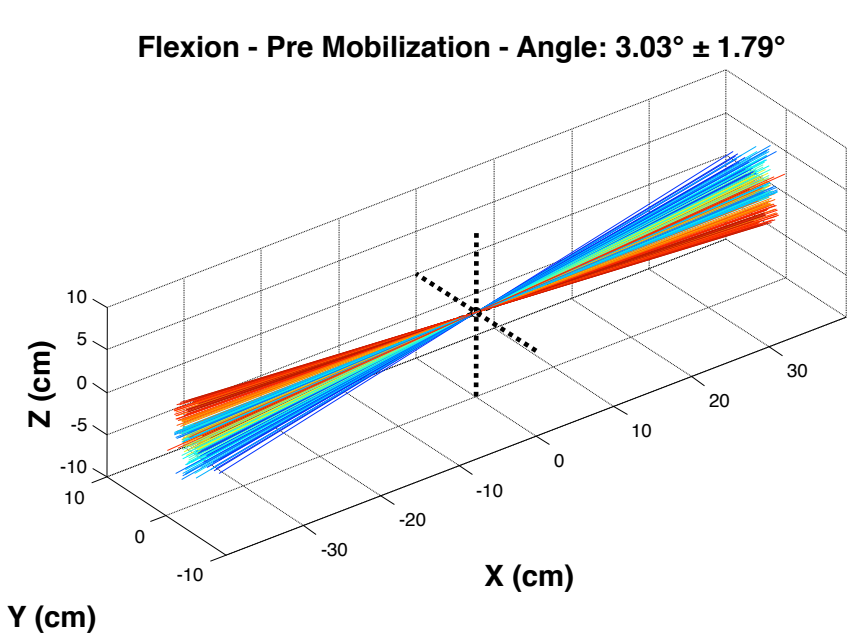

Flexion - Post Mobilization
Z (cm)
10
5
0
-5
-10
-15
-20
-25
10
0
-10
-20
Y (cm)
-40
-30
-20
-10
0
10
20
30
X (cm)

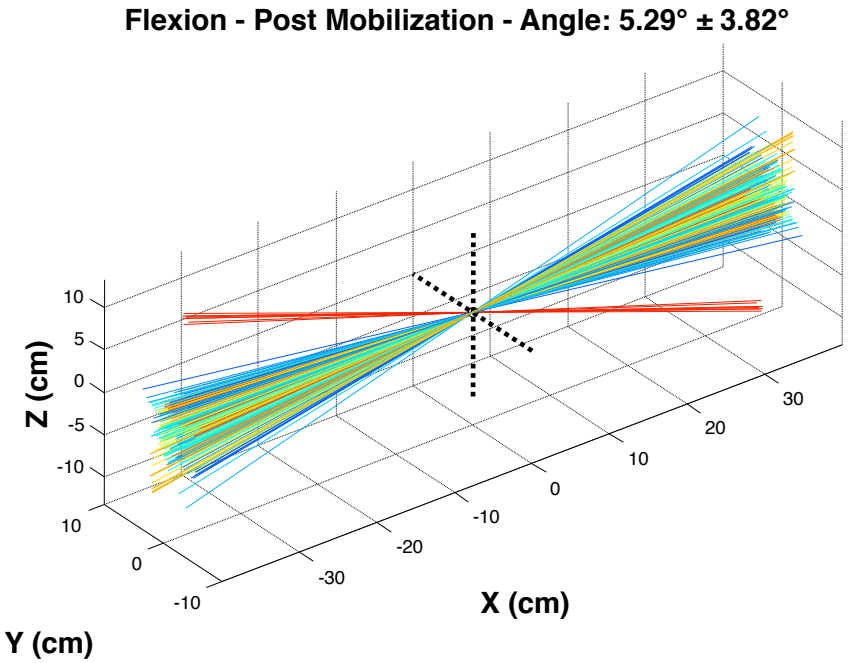

Flexion - Pre Mobilization
Range: -50.3° ± 2.41 - 56.7° ± 2.11
Z (cm)
Y (cm)

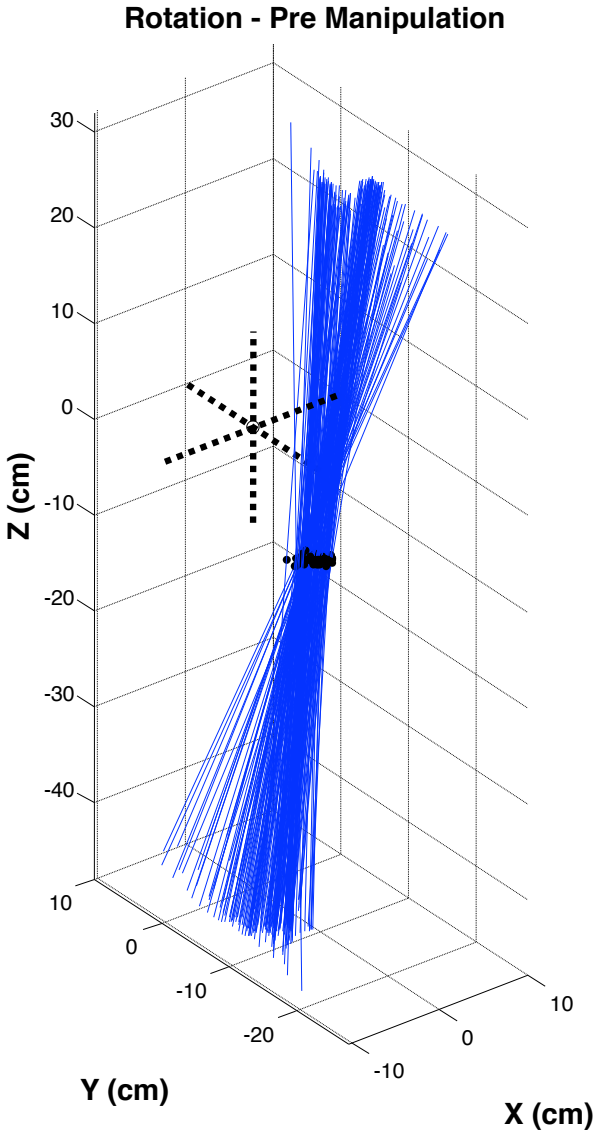

Flexion - Post Mobilization
Range: -48° ± 5.27 - 59.3° ± 5.97
Z (cm)
Y (cm)

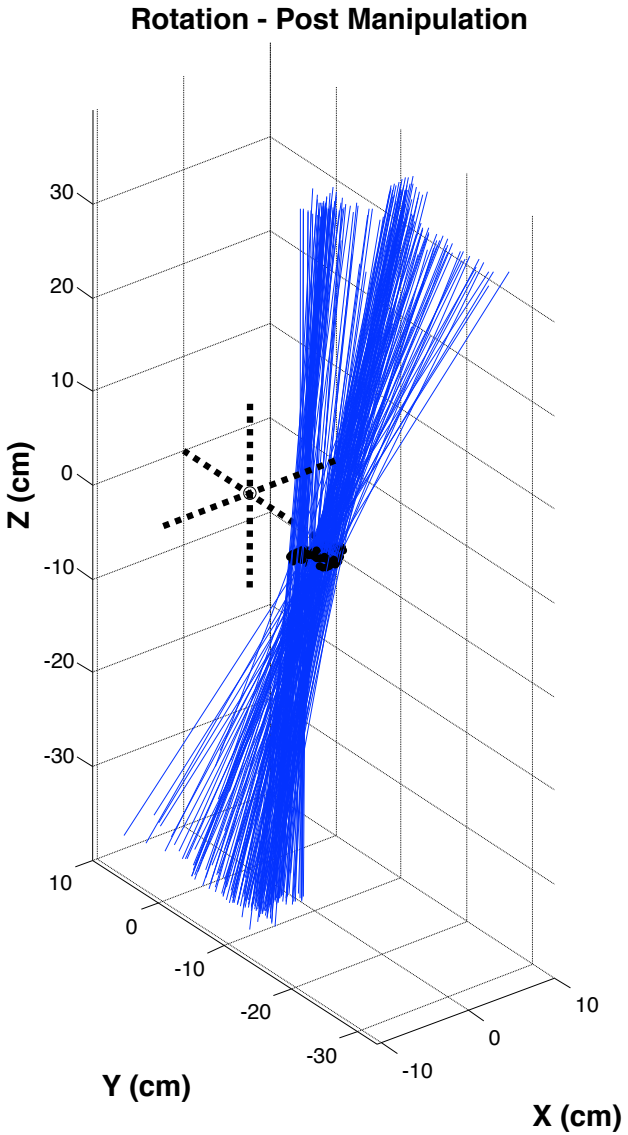

Flexion - Pre Mobilization
Range: -50.3° ± 2.41 - 56.7° ± 2.11
4.6 cm²
5.01 cm²
4.91 cm²
Z (cm)
Y (cm)

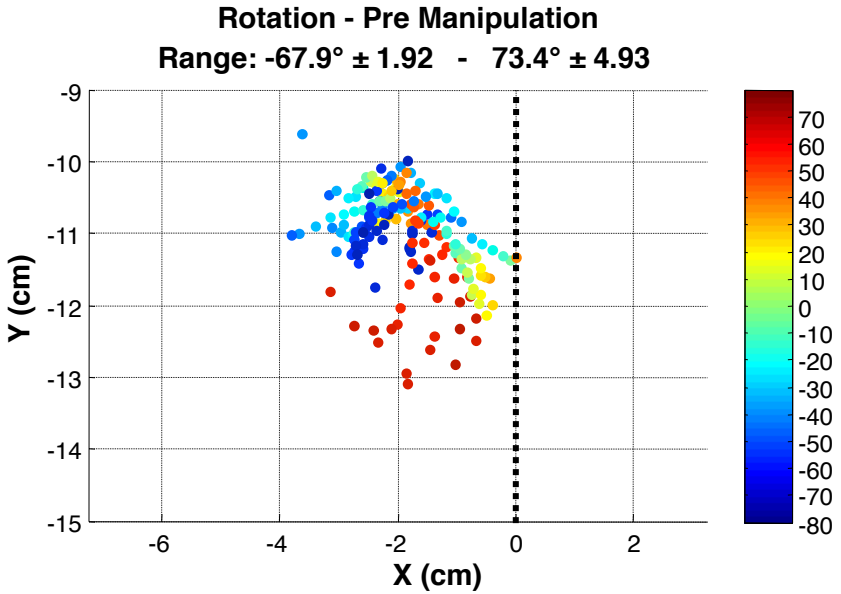

Flexion - Post Mobilization
Range: -48° ± 5.27 - 59.3° ± 5.97
7.93 cm²
9.23 cm²
7.71 cm²
Z (cm)
Y (cm)

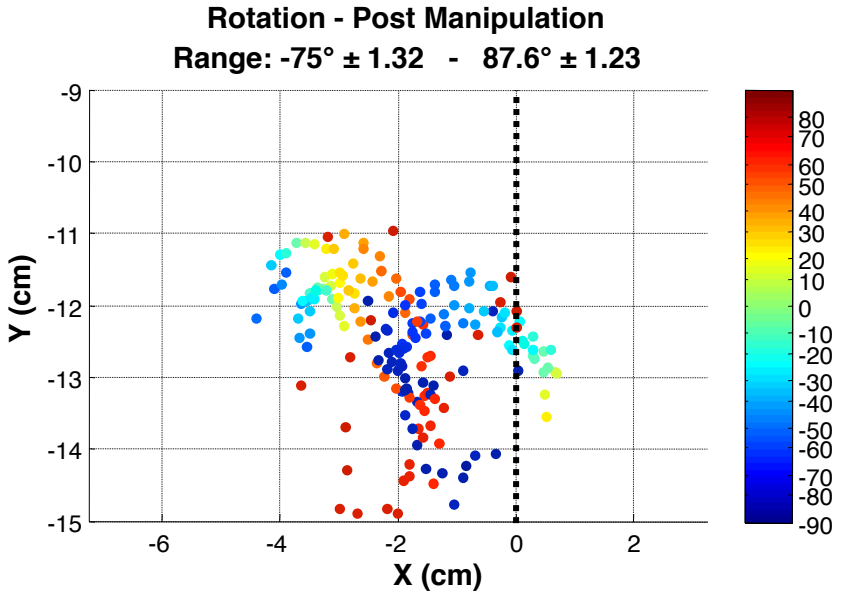

Flexion - Pre Mobilization - Angle: 3.03° ± 1.79°
Z (cm)
10
5
0
-5
-10
10
0
-10
Y (cm)
-30
-20
-10
0
10
20
30
X (cm)

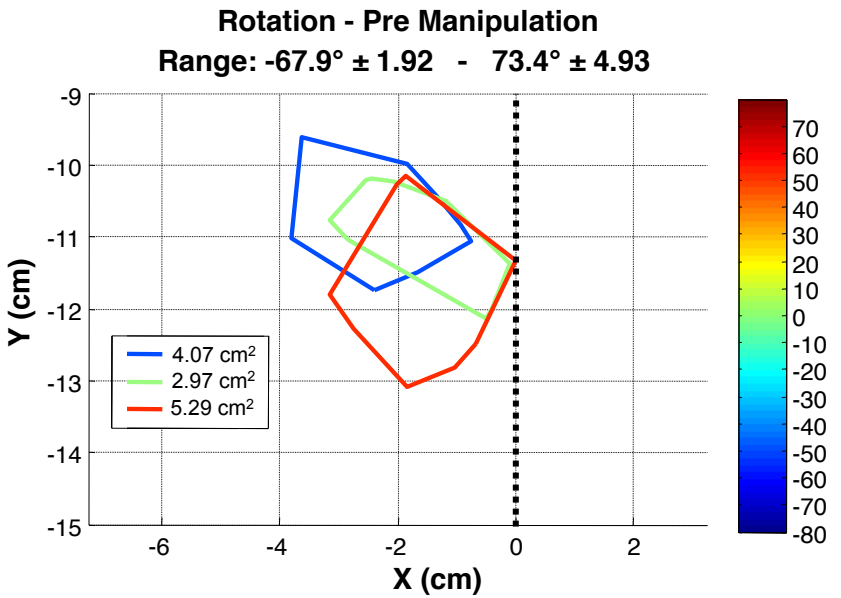

Flexion - Post Mobilization - Angle: 5.29° ± 3.82°
Z (cm)
10
5
0
-5
-10
10
0
-10
Y (cm)
-30
-20
-10
0
10
20
30
X (cm)

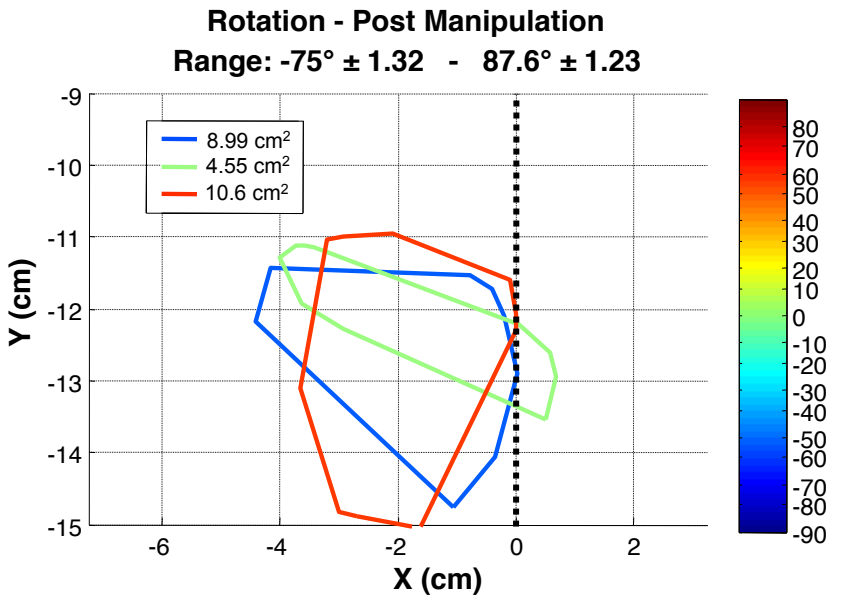

Rotation - Pre Manipulation
30
20
10
0
-10
-20
-30
-40
Z (cm)
10
0
-10
-20
Y (cm)
10
0
-10
X (cm)


Rotation - Post Manipulation
30
20
10
0
-10
-20
-30
Z (cm)
10
0
-10
-20
-30
Y (cm)
10
0
-10
X (cm)

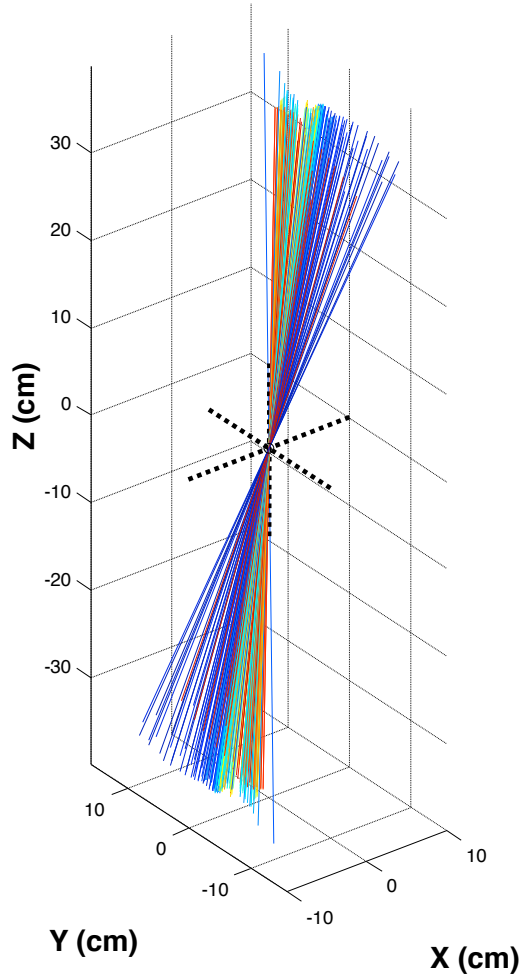

Rotation - Pre Manipulation
Range: -67.9° ± 1.92 - 73.4° ± 4.93
Y (cm)
X (cm)


Rotation - Post Manipulation
Range: -75° ± 1.32 - 87.6° ± 1.23
Y (cm)
X (cm)

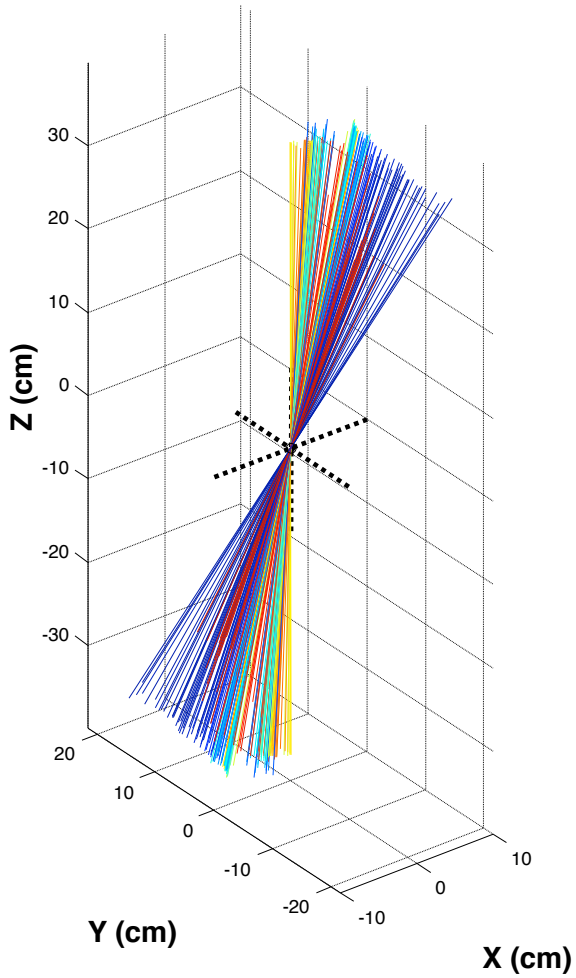

Rotation - Pre Manipulation
Range: -67.9° ± 1.92 - 73.4° ± 4.93
4.07 cm²
2.97 cm²
5.29 cm²
Y (cm)
X (cm)

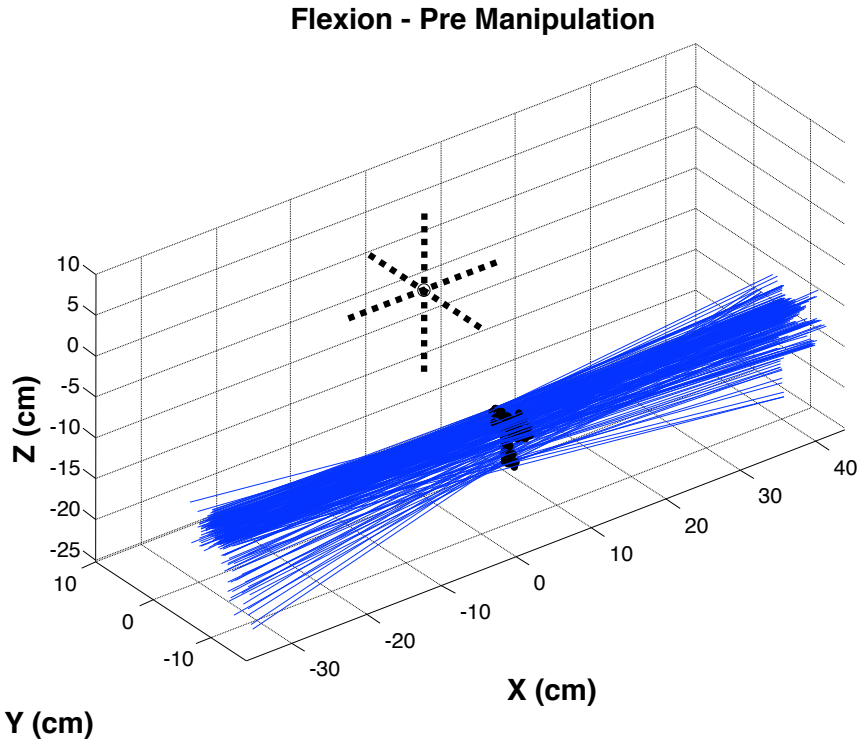

Rotation - Post Manipulation
Range: -75° ± 1.32 - 87.6° ± 1.23
8.99 cm²
4.55 cm²
10.6 cm²
Y (cm)
X (cm)

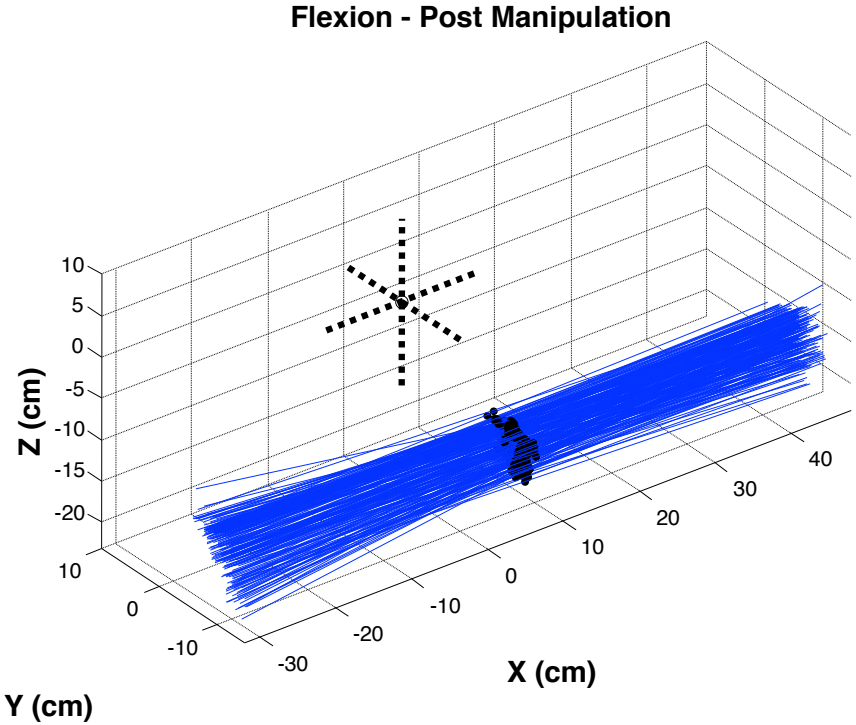
Rotation - Pre Manipulation - Angle: 4.91° ± 3.6°

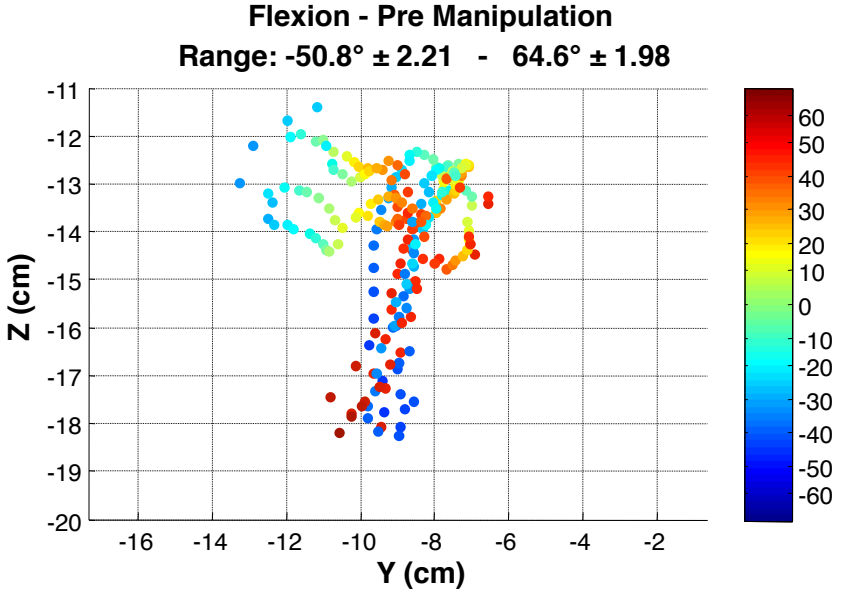


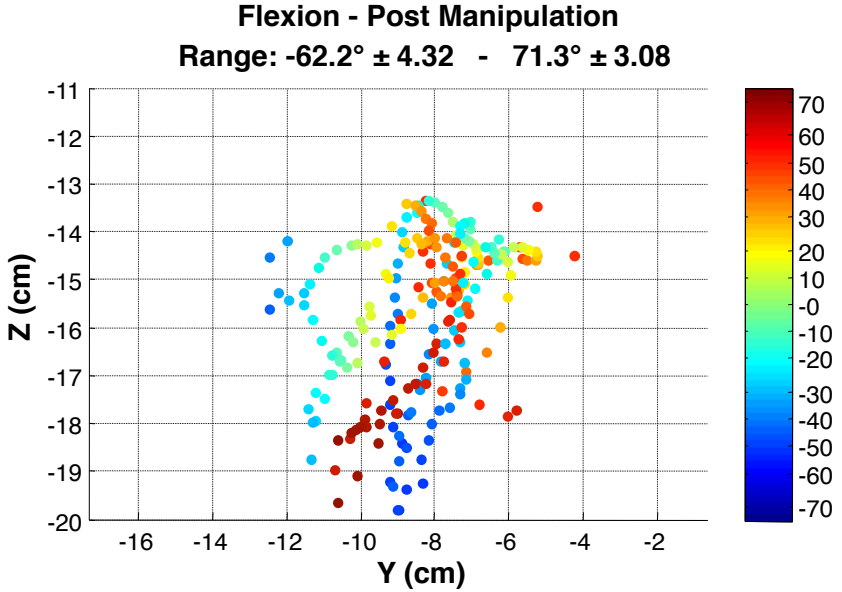
Rotation - Post Manipulation - Angle: 7.4° ± 4.15°

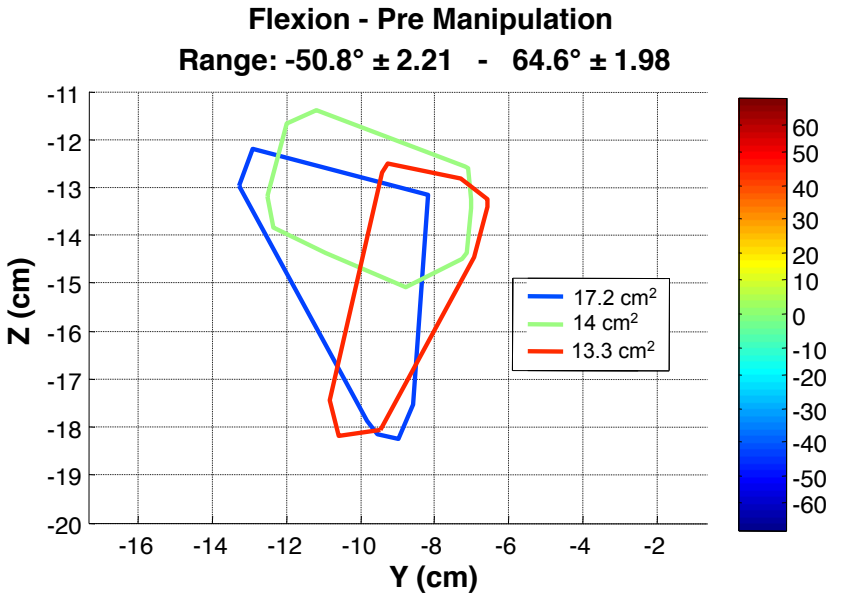


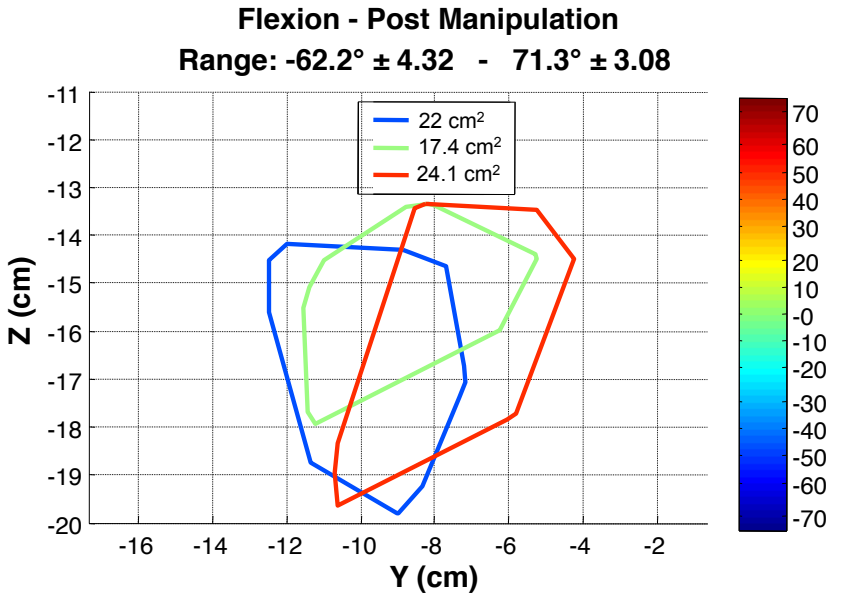

Flexion - Pre Manipulation
Z (cm)
10
5
0
-5
-10
-15
-20
-25
10
0
-10
Y (cm)
-30
-20
-10
0
10
20
30
40
X (cm)

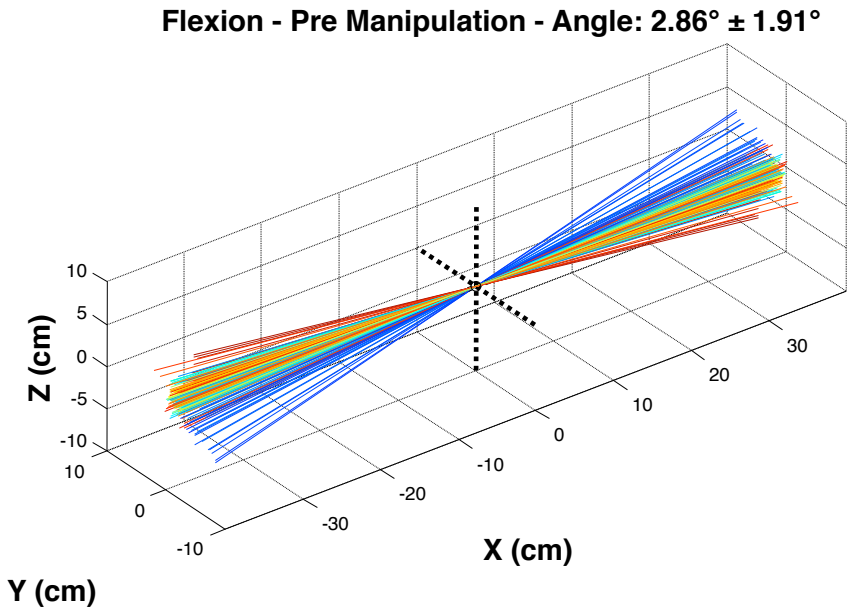

Flexion - Post Manipulation
Z (cm)
10
5
0
-5
-10
-15
-20
10
0
-10
Y (cm)
-30
-20
-10
0
10
20
30
40
X (cm)

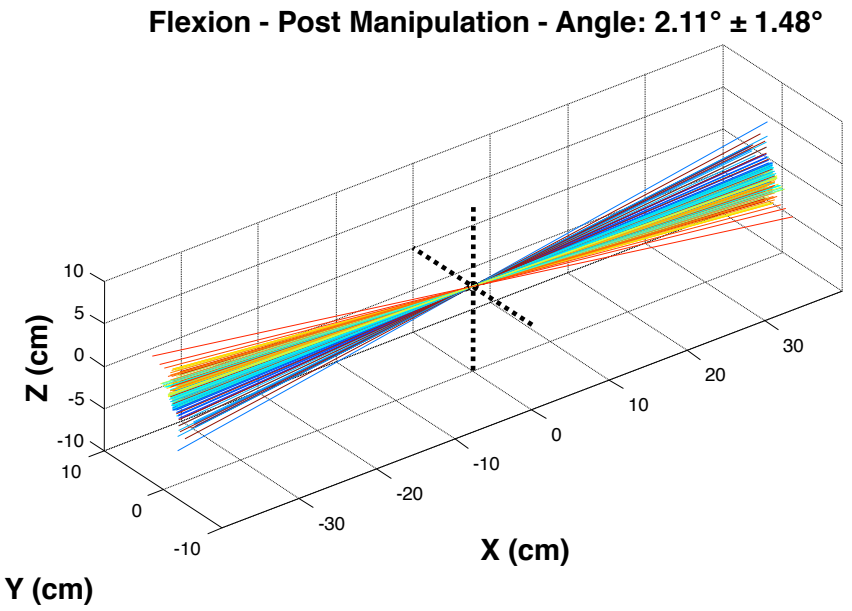

Flexion - Pre Manipulation
Range: -50.8° ± 2.21 - 64.6° ± 1.98
Z (cm)
Y (cm)


Flexion - Post Manipulation
Range: -62.2° ± 4.32 - 71.3° ± 3.08
Z (cm)
Y (cm)


Flexion - Pre Manipulation
Range: -50.8° ± 2.21 - 64.6° ± 1.98
17.2 cm²
14 cm²
13.3 cm²
Z (cm)
Y (cm)


Flexion - Post Manipulation
Range: -62.2° ± 4.32 - 71.3° ± 3.08
22 cm²
17.4 cm²
24.1 cm²
Z (cm)
Y (cm)


Flexion - Pre Manipulation - Angle: 2.86° ± 1.91°
Z (cm)
10
5
0
-5
-10
10
0
-10
Y (cm)
-30
-20
-10
0
10
20
30
X (cm)


Flexion - Post Manipulation - Angle: 2.11° ± 1.48°
Z (cm)
10
5
0
-5
-10
10
0
-10
Y (cm)
-30
-20
-10
0
10
20
30
X (cm)

Results

	Mobilization, PA C2 - Rotation					
	ROM Left (degree)	ROM Right (degree)	CH Left (cm^2)	CH Mild (cm^2)	CH Right (cm^2)	MA (degree)
Pre	-68.8 ± 2.21	62.2 ± 3.11	2.24	1.75	2.42	4 ± 2.65
Post	-70.5 ± 3.63	67.8 ± 2.12	2.8	3.1	3.25	3.46 ± 2.69

	Manipulation, C1-C2 rotatory - Rotation					
	ROM Left (degree)	ROM Right (degree)	CH Left (cm^2)	CH Mild (cm^2)	CH Right (cm^2)	MA (degree)
Pre	-67.9 ± 1.92	73.4 ± 4.93	4.07	2.97	5.29	4.91 ± 3.6
Post	-75 ± 1.32	87.6 ± 1.23	8.99	4.55	10.6	7.4 ± 4.15

	Mobilization, PA C2 – Flexion extension					
	ROM Left (degree)	ROM Right (degree)	CH Left (cm^2)	CH Mild (cm^2)	CH Right (cm^2)	MA (degree)
Pre	-50.3 ± 2.41	56.7 ± 2.11	4.6	5.01	4.91	3.03 ± 1.79
Post	-48 ± 5.27	59.3 ± 5.97	7.93	9.23	7.71	5.29 ± 3.82

	Manipulation, C1-C2 rotatory – Flexion extension					
	ROM Left (degree)	ROM Right (degree)	CH Left (cm^2)	CH Mild (cm^2)	CH Right (cm^2)	MA (degree)
Pre	-50.8 ± 2.21	64.6 ± 1.98	17.2	14	13.3	2.86 ± 1.91
Post	-62.2 ± 4.32	71.3 ± 3.08	22	17.4	24.1	2.11 ± 1.48

Conclusion

- The tested parameters provide an original description of the cervical spine kinematic
- Convex hull and mean angle deviation can useful to investigate the effect of MT techniques on cervical spine kinematics
- RCTs on NP patients using MT techniques are needed